KCE REPORT 354

Federaal Kenniscentrum voor de Gezondheidszorg
Centre Fédéral d'Expertise des Soins de Santé
Belgian Health Care Knowledge Centre

REMOTE MONITORING OF PATIENTS WITH COVID-19

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HEALTH SERVICES RESEARCH

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COLOPHON

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Disclaimer:

- **The external experts were consulted about a (preliminary) version of the scientific report. Their comments were discussed during meetings. They did not co-author the scientific report and did not necessarily agree with its content.,**
- **Subsequently, a (final) version was submitted to the validators. The validation of the report results from a consensus or a voting process between the validators. The validators did not co-author the scientific report and did not necessarily all three agree with its content.,**
- **Finally, this report has been approved by common assent by the Executive Board,**
- **Only the KCE is responsible for errors or omissions that could persist. The policy recommendations are also under the full responsibility of the KCE.**

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ABBREVIATION	DEFINITION
COVID-19	Coronavirus disease
ED	Emergency Department
EWS	Early Warning Score
GP	General Practitioner
NIHDI	National Institute for Health and Disability Insurance
RPM	Remote Patient Monitoring
RRT	Rapid Response Team
WHO	World Health Organisation

GLOSSARY

In the field of **e-Health or telehealth or digital health or telemedicine** (defined by the World Health Organisation (WHO) in 2010 as "the delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities") many terms and definitions are used interchangeably. E-Health encompasses domains such as tele-expertise, telemonitoring, tele-assistance, mHealth and teleconsultation.

In this glossary, terms and synonyms related to e-Health applications used throughout the report are explained. These are no gold standard definitions but is rather a description of how these terms should be interpreted in this report.

Mobile-Health or mHealth: the use of mobile devices and applications to measure health data in real time, and to possibly share with a healthcare provider. It may include, e.g. a smartphone that measures heart rate, or a smartphone app that shares health data with a healthcare provider.

Telemonitoring or 'remote patient monitoring' (RPM) or 'remote care' or 'care at a distance': Measurements and queries are collected from the patient by means of digital technologies to monitor and capture medical and other health data from patients (at a distance) and electronically transmit this information to healthcare providers for assessment. It is a technology to enable monitoring of patients outside of conventional clinical settings, such as in the home or in a remote area. For telemonitoring in COVID-19 disease the term **'COVID-19 RPM'** is often used.

Onboarding of patients: Patient onboarding is the process of welcoming new patients, getting them registered and into the system, and orienting them with how things work (e.g. telemetry devices, registration of measurements, downloading app). The onboarding process provides sets the tone for the patient's experience.

Telemetry: The remote measurement and recording of certain parameters (e.g. blood pressure (BP), heart rate (HR), temperature (t°)) and consequently transmitting them to another location via (often wireless) telecommunications.

Tele-expertise: Caregivers consult with each other remotely about a specific patient, without the patient being present. It can involve both a diagnosis and a second opinion. Usually, documents (the medical file, medical imaging, etc.) are exchanged or shown.

Tele-assistance: A physician remotely directs (or performs) a medical intervention, such as imaging or a surgical procedure. This is possible between two healthcare providers or between a healthcare provider and someone present with the patient e.g. informal caregiver or ambulatory care nurse.

Teleconsultations: A remote care service provided by a healthcare provider at a patient's home e.g. it may be a consultation via telephone, email, text message or chat.

Video consultation: It is a synchronous video and audio-based, interactive two-way communication between one or multiple healthcare providers and a patient about a health problem to replace a face-to-face communication.

The difference between teleconsultations (telephone, email, text, chat, etc.) and videoconsultations (video call) is often explained by the means of communication.

SCIENTIFIC REPORT

CHAPTER 1 – INTRODUCTORY CHAPTER

1 WHY TELEMONITORING IN COVID-19?

1.1 From a worldwide perspective

The coronavirus disease (COVID-19) pandemic endorsed healthcare services around the globe to rapidly respond to the needs of people diagnosed with the SARS-COV-19 virus.[1] During the subsequent waves of the pandemic, characterized by increased rate of infections, fast development and expansion of (new) healthcare services was boosted. Especially, because healthcare services in most countries were underprepared for this biological event.[2] There was a need for community management of those infected and presenting symptoms, to reduce the strain on hospital resources (intensive care bed capacity, ventilators, etc.) and healthcare worker exposure (personal protective equipment, staffing, safety, etc.). Community management involves monitoring symptoms while individuals remain at home (before or after admission to a hospital). It requires that patients who present deteriorating symptoms are identified in time which usually occurs within 14 days after illness onset.[3]

On the one hand, adoption of new care models is often challenged by unfamiliarity with program eligibility, services and logistics, leading most providers to default to the care option with which they are familiar (i.e. traditional hospitalisation, ED visits, or visits to the GP). On the other hand, patients can be reluctant to try out new approaches of care.

One strategy to extend a hospital's bed capacity is the expansion of virtual care services that can be provided in patients' homes instead of a traditional hospital.[4] Care models that provide acute hospital-level care in patients' homes, have been well characterized. Controlled trials and subsequent meta-analyses have suggested the efficacy of hospital at home, demonstrating noninferior or even superior mortality, readmission, and length of stay outcomes compared with traditional hospitalization for heterogeneous patient populations. However, frameworks for how to effectively implement and rapidly scale virtual strategies for providing hospital level care at home are lacking.[4]

Although healthcare organisations might be familiar with remote patient monitoring (RPM) in other (chronic) diseases such as heart failure or chronic pulmonary obstructive disease, COVID-19 is an unfamiliar pathology characterized by a rapidly changing nature and context. Therefore, there was limited evidence on the most successful healthcare model for community management of COVID-19 patients and RPM in this specific pathology.

1.2 From a Belgian perspective

As in the rest of the world the focus on endorsing e-Health in the Belgian care model gained from the momentum of the COVID-19 pandemic.

Before the COVID-19 pandemic important steps forward in the development of e-Health in Belgium were taken with the **e-Health action plan 2015-2018** for which the FOD Volksgezondheid/SPF Santé publique, het Federaal agentschap voor geneesmiddelen en gezondheidsproducten (FAGG)/l'Agence fédérale des medicaments et des produits de Santé (AFMPS) and the e-Health-platform organised already 24 pilot projects to evaluate how mHealth applications could be efficiently applied in our healthcare system. Based on those results **a validation pyramid for mobile applications** that are CE marked as medical device was introduced in 2018 by the public authorities. Level one (at the base) of the pyramid indicated CE certified medical devices. At level two the devices are CE marked and safely connected. On top of the pyramid (third level) the CE certified, safely to connect medical devices show socio-economic evidence and get reimbursed by the NIHDI.(https://mhealthbelgium.be/index.php) On 22 February 2022 there were 34 apps who received the CE certified medical device (level 1 or higher), of which 11 were also safe to connect (level 2). None of the apps showed socio-economic evidence yet.(https://mhealthbelgium.be/apps) Currently, the Belgian Health Care Knowledge Center (KCE) is conducting a study on digital health technologies assessment in order to develop a clear procedure to integrate such applications into the compulsory health insurance in Belgium.[5]

Moreover, the KCE published a report on 24 June 2020 in which an evaluation was made on the effect of **video consultations** on the health of patients with chronic diseases. The researchers evaluated how video consultations were applied in the Netherlands and France but there was lack of scientific evidence to estimate the effect on the health of chronic patients of video consultations compared to in-person consultations. It was seen that the integration of video consultation in the healthcare system was not going easily, and healthcare professionals were somehow reluctant towards it. However, during the writing of the report, the COVID-19 pandemic occurred, and the researchers were surpassed by reality as consultations at a distance (through telephone or video conferencing) were suddenly globally authorized and reimbursed. The researchers recommended to use the COVID-19 dynamics to enhance and implement further 'digital' care (including video consultation) in addition to face-to-face consultation (not replacing it).

In meantime, the NIHDI organized a **support committee 'Mobile Health'**, and therefore the NIHDI took also on an overarching role. The 'Mobile Health' support committee is composed of delegates from the various projects launched, representatives of the hospital umbrella organizations, the representative organizations of healthcare providers, the insurance committees and the NIHDI Health Care Service, and can be convened at the request of one of its members. The tasks of this support group are the follow-up and evaluation of the convention, to discuss alleged problems and to give feedback on the first analyses. The NIHDI foresees and guarantees in the financing of the projects as outlined in section 2.3, is responsible to conclude an agreement with an external independent research institution to prepare the evaluation report and the continuation and/or changes of the convention.

In all healthcare professions, teleconsultations gained momentum. A **scientific reflection group** (also endorsed by the 'Mobile Health' support committee) is currently working on a concept note for an optimal funding and organisation model for remote consultations with GPs, which will form the basis for a new definitive framework for teleconsultations in primary care.

Searching (innovative) solutions to increase responsiveness of healthcare providers during COVID-19 pandemic

Being suddenly confronted with a new pathology and pandemic, healthcare providers were also searching (innovative) ways to increase their responsiveness to the increase in patients presenting with COVID-19 symptoms at the emergency department (ED) and/or in primary care (GPs). Hospitals received signals from primary care (GPs, ambulatory care nurses) that the workload was too high, and healthcare professionals as well as patients had many questions as there was a large lack of information on the virus, treatment, prognosis, etc. Some hospitals started with test centers and therefore received also more questions of patients for which they provided answers. On the one hand there was primary care indicating they could not handle all requests, and on the other hand the ED's noticed that patients received too late adequate care (e.g. diagnosis days ago and no preferred treatment). During one of our scoping interviews an example was given of a patient been referred to the ED by the GP (as he did not have the time to go earlier to the patient, and the patient was unstable).

Thus, at the beginning of the pandemic it was especially difficult to increase hospital capacity and upscale staffing levels (as many healthcare professionals were also infected).[2] During the summer of 2020 and with the idea of a second wave in mind, healthcare providers started to adjust their preparedness and response protocols in order to be better prepared for a plausible second or even third wave. Since personal protective equipment was lacking, GPs initiated their own RPM by means of telephone calls and parameters measured by the patient or the ambulatory care nurses. Moreover hospitals (that had former experience in RPM) started to work out care paths to spare hospital beds. The idea arose to telemonitor as much as possible patients at home in order to prevent these patients going to the GP, and/or to avoid hospitalisation.

In setting up forms of remote care, healthcare professionals indicated that valid risk stratification scales and assessment tools were lacking. Based on the request of the GPs (SSMG, Collège de Médecine Générale), **the KCE studied how moderate to severe cases of COVID can be managed at home in the event of a saturation of hospital services**. From that study, a decision-aid was published on 1 June 2021 for intensified home-based care for COVID-19 worrisome adult patients in case of hospital saturation. However, it was also seen as a risk stratification scale and clinical evaluation scale of the status of the patient with advice towards the frequency of (tele)monitoring. Following the aid, intensified homecare consisted out of telemonitoring at least 2-3 times a day vital signs either done by the patient, the caregivers and/or the healthcare professionals. Based on that information, advises and therapy could be given such as thromboprophylaxis, oxygen therapy, corticosteroids or others (paracetamol, NSAID, antibiotics in case of bacterial sur-infection, etc.). The decision aid is added to Appendix 1.1. Moreover, in the light of remote patient monitoring and following the aid, oxygen therapy could be given at home and the NIHDI adjusted its reimbursement and access procedures towards short-term oxygen therapy.[6] Therefore, patients who were remotely monitored could also be sent home more early with oxygen therapy instead of being hospitalised.

A call for bottom-up driven community management projects that implemented remote monitoring for COVID-19 patients.

Remote patient monitoring before the COVID-19 pandemic was little applied in the Belgian healthcare sector, although many applications are theoretically possible. The pilot projects, created bottom-up, initiated to monitor patients with COVID-19 in a home-care setting could provide valuable insights into the use of telemonitoring in the Belgian context and the possibilities and limitations for future use, plausibly also for other target groups. Thus, NIHDI was willing to invest in these pilot projects to learn about COVID-19 RPM to create a sustainable framework for the future. Therefore, the NIHDI launched in December 2020 a call for bottom-up driven community management projects that implemented remote monitoring for COVID-19 patients.[7]

2 SCOPE AND RESEARCH OBJECTIVES

The convention states that on the basis of the collected and available data, such as billing data and surveys on the experiences of care providers and patients, an evaluation report must be drawn up by an independent research institute, possibly under the coordination of the KCE, which allows this new method of telemonitoring to be at least partially evaluated.

With this background and timeline in mind, at the beginning of the year 2021 the question was addressed to KCE to evaluate the RPM pilot-projects in COVID-19.

2.1 Research questions raised in the convention

From the point of view of the NIHDI, the main objectives are offering quality of care within a cost-effective and safe care model with user satisfaction and respect for patient privacy.

The NIHDI suggested that KCE should obtain invoicing data, use qualitative research methods to investigate all parties involved and to draw-up an evaluation report, answering at least the following research questions:

1. What were the characteristics of the patients in the pre- and post-hospital telemonitoring care pathway in this pilot project (socio-economic, demographic, increased reimbursement status, if possible: co-morbidities and chronic illness)
2. Does telemonitoring of COVID-19 patients avoid hospitalisations and/or does it allow earlier hospital discharge?
3. How did patients and the various healthcare providers involved experience telemonitoring?
   a) Do patients and caregivers perceive telemonitoring as a qualitative, safe, and efficient method?
   b) How do the various care providers perceive their role in the care process?
   c) Is the information provided sufficient to make a correct medical assessment of the patient's situation?
   d) How do patients experience the new technology? Are there any groups that experience difficulties (e.g. older people)?
4. Which target groups are reached? What is the distribution in age, home setting, self-reliance, and other characteristics?
5. How long are COVID-19 patients monitored on average? Are there differences per age group?
6. What is the regional distribution of patients included in a telemonitoring project?

The NIHDI indicated that data from the IMA database can be compared with COVID-19 patients who were hospitalised but not followed by telemonitoring. Both groups can be compared in terms of the characteristics of the patient groups (see question 1), hospitalisation duration and possibly healthcare expenditures. The pre-hospitalisation target group can potentially be compared via IMA data with the group of COVID-19 patients for whom follow-up and monitoring by nurses was charged via billing code 419333 before the start of the pilot project (costs, number of (tele)consultations, age, hospitalisation, etc.).

2.2 Research questions raised by KCE and subject of this report

After careful consideration of what was asked and outlined as research questions in the convention in relation to the availability of data (i.e. data of the intermutualistic agency (IMA) is only available 1 to 2 years after invoicing), the timeline of a KCE project, the timeline of the convention (valid up to 31 December 2021, but the contract may be renewed a maximum of two times for a period of six months with the agreement of both parties) and the set-up of these projects in practice (note that most projects already initiated telemonitoring before signing up to the convention), the KCE researchers and the NIHDI set out the following research aims:

1. **Description of the telemonitoring projects that signed the convention:** How do the projects approved under art 56 §1 concerning telemonitoring for COVID-19 patients at home by the NIHDI look like? Who does what, when, how? How are the patients selected, assessed and followed?
2. **Characteristics of patients included in telemonitoring and intervention outcomes (survey):** What are the socio-economic, demographic, and medical characteristics of the patients in the pre- and post-hospital telemonitoring care pathways (at the beginning and at the end of the intervention)? What are the outcomes of patients who received the intervention?
3. **Literature review on the characteristics of the telemonitoring interventions, characteristics of the patients and intervention outcomes:** How do the telemonitoring interventions for COVID-19 patients look like as described in (international) literature? Who does what, when, and how? What are strengths/weaknesses/opportunities/threats as experienced by the researchers?
4. **Interviews and focus groups of the main actors involved in telemonitoring:** What are the experiences of the different actors involved? What are success factors (strengths)? What kind of problems emerged (weaknesses)? Which solutions were implemented to resolve the problems (opportunities implemented)? How can the intervention be improved (possible threats and future opportunities)? Do they satisfy the needs of all actors involved and aims outlined in the convention? What went well, what went wrong, and why?

These questions should be answered for the **pre-hospitalisation patients** as well as the **post-hospitalisation patients**.

In Table 1 an overview is given of the research questions and main methods. The detailed information about the research methods is described in each chapter.

Table 1 – Overview of the scientific report: main research questions and methodology

Research question	Methodology	Chapter
How do the telemonitoring projects look like? **What are the patient characteristics and intervention outcomes of the projects?**	• Document analysis • Exploratory online interviews • Place visits • Survey to collect aggregated patient data • Press releases	Chapter 2
What are the experiences of the actors involved?	• In-depth interviews with patients • Semi-structured interview with GPs • Focus group interview with telemonitoring teams and ambulatory care nurses	Chapter 3
How do the telemonitoring interventions look like? What are the patient characteristics and intervention outcomes?	• Literature review	Chapter 4

CHAPTER 2 – DESCRIPTION OF THE PROJECT AND PATIENT CHARACTERISTICS

The objective is to receive a clear idea on how the projects that signed the convention up to 12 March 2021 look like. The projects are described in terms of characteristics such as patient population, actors involved, telemonitoring process, relative to what is outlined and aimed for in the convention. A clear overview of who does what, when and how, is aimed at. Moreover, the selection and assessment of patients, as well as the follow-up process is described. Differences and similarities between the projects in relation to each other and the convention should pop-out of the analysis and description and from the data.

1 KEY POINTS

Background

- **From the beginning of the COVID-19 pandemic, groups of healthcare providers created bottom-up a care path for remote monitoring of patients (RPM).**
- **RPM was initiated for several reasons such as (1) to meet the needs of the patients, who raised many questions, and were very anxious, requesting admission for specialised care, and (2) to save hospital beds, relieve strain on hospital workforce and to relieve primary care.**
- **The NIHDI initiated a convention for remote monitoring of COVID-19 patients under Art 56 by December 2020 and launched a call. A lump sum is foreseen of 65€ to 100€ per patient per week depending on the trajectory and on the use of telemetry. In the pre-hosp trajectory max 3 weeks and in post-hosp trajectory max 6 weeks of which 3 with and 3 without telemetry. Whether or not telemetry was provided depended on risk stratification.**
- **Thus, two trajectories were aimed for i.e. pre-hospitalisation patients (included at ED of GPs office) and post-hospitalisation patients (included in-hospital).**
- **The NIHDI aimed (1) to reduce the strain on hospital resources (i) by avoiding hospitalisation for patients with mild COVID-19 symptoms, and (ii) by sending partially recovered hospitalised patients to their home / place of residence earlier, while their medical condition continuous to be closely monitored by means of telemonitoring, and (2) to reduce the workload of GPs by referring patients to a telemonitoring team with sufficient expertise in monitoring the disease, as the point of contact for the patient is (partially) handed over to the telemonitoring team.**
- **Up untill 12 March 2021 application forms of 12 projects were approved. Nine projects are located in Flanders, 3 in Wallonia.**

Methods

- **Several ongoing COVID-19 RPM projects did not submit a application form, or the application form was approved later. Therefore, the described projects in this report only represent a part of the remote care for COVID-19 patients in Belgium.**
- **A 6 month study period to collect data was selected (1 January 2021 – 30 June 2021) including the third wave of the COVID-19 pandemic.**
- **Document analysis of the approved project application forms (n=12) was executed. Online meetings were held (n=11). Field visits were done with 7 projects, and popular press releases were gathered. Moreover, a survey was constructed to collect patient characteristics and patient outcomes of the RPM intervention (response rate: 42.3%). Due to differences in**

informed patient consent by project, survey data collection was limited to the collection of aggregated patient data.

Results – Characteristics of the projects

- Based on the first analysis of the application forms, it was noted that COVID-19 RPM is defined by a large variety of characteristics, built by elements which could vary across the projects.
- Projects did not succeed in defining a control group. Therefore, it was not possible to evaluate effectiveness, or compare the projects .
- During the online meetings and place visits, it became clear that the continuously changing context during the COVID-19 pandemic together with the rapidity with which RPM was created, contributed to the high heterogeneity across projects, and continuous adjustments made in the RPM process within projects.
- Due to the geographical location and high heterogeneity across projects, primary care services operating in a certain region might be confronted with different platforms and processes.
- Five projects were subcontracted and started from the same group of healthcare providers (i.e. B2B manufacturer). Even in these projects, heterogeneity was noted.
- NIHDI aimed to involve different actors in a collaboration framework (i.e. NIHDI, group of healthcare providers, helpdesk, telemonitoring team, GP, ambulatory care nurse, patient), and defined their roles.
- Although projects proposed care trajectories involving primary care (GP and/or ambulatory care nurses), in practice the involvement of primary care professionals in an active role was limited due to different factors (e.g. workload GPs, no need for logistics). Thus, the intensity in which all actors defined in the collaboration framework were involved (i.e. the intensity of their role) differed across projects.
- From the convention, it is not clear who has the medical responsibility in the collaboration framework. An important responsibility was attributed to the patient for the measurement of parameters, and an informed consent has to be signed for inclusion. In practice, medical responsibility is attributed to the physician of the telemonitoring team or the GP, depending on who enrolled the patient.
- Eleven projects are mainly hospital-led. One project set up similar trajectories to include and monitor patients through hospital physicians/units and through GPs.
- The initiation was facilitated when projects had gained experience in RPM in other (chronic) pathologies or ambulatory care, as solutions facilitating RPM (e.g. availability of telemetry, integration of platform and patient records, availability of experienced telemonitoring team) were already in place. Having experience also indicated that a care path for COVID-19 RPM was already developed before the convention was in place.
- Telemonitoring teams were (1) related to the unit of the medical project lead, (2) operating across hospital, or (3) an stand-alone monitoring center. The composition of the workforce and the experience needed was characterized by heterogeneity. The tasks related to remote monitoring were mainly on top of their regular work. This was considered feasible for small patient numbers.
- The communication between the patient and telemonitoring team was often passive and based on the principle ‘no news is good news’. In that case patients were provided a feedback screen after measurement and registration of the parameters. Some projects opted for a (more) active communication, not

providing automated feedback, but contacting the patient several times a day (e.g. text messaging).

- Patients could contact the telemonitoring team mainly by telephone. Telemonitoring teams contacted patients mainly by teleconsultation. Videoconsultation was not always implemented in the platforms but was considered feasible, especially to receive a clinical view of a patient.
- Telemetry was not always provided (according our survey data 54% in pre-hosp and 96% in post-hosp). The patient had to fill in at least a daily questionnaire (e.g. symptoms of dyspneu, fatigue). When telemetry was provided, parameters such as saturation, temperature, heart rate, breathing frequency, etc. were asked to be measure. The frequency of measurement could differ according to the phase, the symptom or risk stratification, the parameter and the project.
- Especially temperature and saturation appeared to be clinically important. The clinical presentation of patients during the 3th COVID-19 wave was characterized by 'silent hypoxia'. Moreover, fever might be indicative for a bacterial sur-infection.
- Due to the lack of connected devices, measured parameters were send (manually) by the patient to the platform at time-points, usually 3 times a day. Intensity of monitoring could differ based on risk and symptom profiling.
- The dashboard of the platform is rarely continuously projected. It is unclear if inserted parameters were followed-up actively at night, as mainly a kind of permanence was provided in case the patient wanted to contact the team during the night.
- The monitoring process set out actions performed by the telemonitoring team in case an alarm was generated. Most projects had a three colour system with different actions, and trajectories to follow. In practice, the telemonitoring team often observed a clinical trend across measuring points to verify for deterioration of the patient. Triggers for alarms varied by project.
- Most projects did not keep a logbook in which every action of the telemonitoring team was systematically noted. Not all RPM platforms were linked to the hospital system for patient records, making it difficult to collect data systematically and provide a logbook of performed actions. Registration of the parameters and actions in the patient record was facilitated when the platform was integrated.
- A patient could measure and send parameters more than the agreed frequency, however, it is unclear in which timeframe the telemonitoring team would respond.
- Written agreements and informed consents were signed to protect personal data and provide indications on responsibility. Due to the lack of general informed consent provided by NIHDI, these informed consents differed considerably from each other.
- Most patients were onboarded physically in-hospital. Rarely, a GP included a patient in RPM.
- The medical lead (initiator) of the project is seen as the driving force. The focus on a specific patient trajectory or care path is facilitated by departments/actors willing to collaborate and the affiliation of the medical project lead.
- Due to the lack of validated scales, different symptom and risk stratification scales as well as thresholds were used across the projects. Moreover, thresholds were often individualized. Therefore, a very heterogeneous population was likely included across projects. Projects indicated that they consider pre- and post-hospitalised patient clinically different. Inclusion of patients post-hosp was considered more feasible because the

patient was more clinically stable. Most projects focussed on the post-hosp trajectory.

Results – Characteristics of the population

- Data on 684 patients was received (299 pre-hosp / 385 post-hosp). 230 patients from the pre-hosp traject were included in one project. However, the data received was characterized by a low response rate with many missing data. Compared to the 6666 patients admitted to ED, only a very small number of COVID-19 patients was offered RPM, indicating that next to symptom and risk profiling, inclusion was influenced by other variables (e.g. digital literacy, motivation of the patient, language, education).
- As data collected in the survey on population characteristics (e.g. gender, symptoms, comorbidities, risk score) and outcomes of RPM was inclomplete, no conclusions can be drawn. The next results should be interpreted with care:
  - Most frequent symptoms reported pre-hosp were coughing, fever and anosmia. Also post-hosp coughing was frequently reported as well as headache and anosmia.
  - With regard to comorbidities, more than 60% of the pre-hosp patients was obese. Obesity and hypertension were also frequently reported in the post-hosp patients.
  - Also patients formerly admitted to ICU (length of ICU stay 4-10 days) were included in the post-hosp traject.
  - The length of hospital stay was on average ranging between 7.8-12.1 days.
  - The average length of telemonitoring was longer in the pre-hosp phase (16.6 days) compared to the length in the post-hosp phase (12.3 days).
  - Concerning medication, most patients were offered paracetamol & NSAID (pre-hosp > post-hosp), and thromboprophylaxis (post-hosp > pre-hosp)
  - Both pre-hosp and post-hosp patients could receive oxygen therapy with an average of 10.2 days in pre-hosp and 7.2-11.3 days in post-hosp.
  - The main reason reported to stop remote patient monitoring was improvement of the patients' clinical status.
  - Overall, patients seemed satisfied with the remote monitoring intervention, but it is unclear from the surveys what determines the degree of satisfaction
- Based on the NIHDI data, projects and healthcare professionals tend to pick up and continue remote monitoring in patients with COVID-19 in the next waves

Conclusions

- There is a large heterogeneity in how the funded projects brought RPM into practice.
- RPM in patients with COVID-19 seems feasible.

2 BACKGROUND: COVID-19 RPM AS DESCRIBED IN THE CONVENTION

2.1 Aims of the convention

The convention aims:

- To reduce the strain on hospital resources:
  - By avoiding hospitalisation for patients with mild COVID-19 symptoms (who present themselves at the ED or at the GPs office), and
  - By transferring partially recovered hospitalised patients to their home / place of residence earlier, while their medical condition is closely monitored by means of telemonitoring.
- To reduce the workload of GPs by referring patients to a telemonitoring team with sufficient expertise in monitoring the disease, as the point of contact for the patient is (partially) handed over to the telemonitoring team.

Thus, it is expected that RPM of these non-hospitalised COVID-19 patients at home (**pre-hospitalisation phase or pre-hosp phase)** and of patients after their discharge from hospital (**post-hospitalisation phase or post-hosp phase)** makes it possible to save hospital beds and, above all, to reduce the additional workload for the hospital staff and GPs through better support by means of technological solutions.

2.2 Target population

The convention targets two types of patient groups:

Pre-hospitalisation patients (or pre-hosp patients) are patients with a recently detected SARS-CoV-2 infection with multiple severe symptoms and/or an increased risk of complications who are still living at home or in a care institution other than a hospital (such as a convalescent home, rehabilitation center or residential stand-alone monitoring center) and have not (yet) been hospitalised. This group is followed daily in their home environment by means of at least structured questionnaires. Patients who turned to an ED but were not admitted to a hospital can also be included in this group. The inclusion of patients in these care pathways is done by means of a questionnaire about the symptoms, the severity of the symptoms and risk factors for the development of complications, based on scientific evidence or internationally used risk classifications. The NIHDI provided an example of an inclusion and risk stratification scale that can be used in the pre-hospitalisation phase (Appendix 2.1). Exceptionally, deviations from these inclusion criteria may be made according to the referring/treating physician's ('verwijzende arts'/'le médecin traitant') assessment of clinical necessity. Note that within this category, a distinction is made between persons with and persons without telemetry, based on the presence of risk factors.

- **Patients with clear risk factors**: Individuals with a history of pulmonary disease or other co-morbidities, pregnant women, or individuals with severe respiratory symptoms, *measurement of peripheral oxygen saturation* is initiated immediately upon inclusion in the care pathway.
- **Patients without clear risk factors**: In the absence of co-morbidities or risk factors, telemetry is only started if a deterioration of the physical condition is observed by the telemonitoring team during follow-up. If it is decided to initiate telemetry (at least peripheral oxygen saturation), an ambulatory care nurse may install the equipment in the patient's place of residence and continue to monitor in the following days.

The **post-hospitalisation patients (or post-hosp patients)** are COVID-19 patients who are discharged from hospital and for whom additional telemonitoring is deemed necessary by the treating/referring physician ('behandelende arts'/'médecin traitant') on the basis of the severity of the symptoms or the risk for complications. The convention does not include a list of inclusion criteria, nor an example of risk stratification to be used in the post-hospitalisation phase. The emphasis for follow-up lays on the one hand on follow-up of the recovery process in the weeks following discharge from hospital and, on the other hand, on follow-up and monitoring of the long-term consequences of the COVID-19 disease. In addition to

symptomatology, the emphasis here is also on objectification of re-activation and rehabilitation, but also health-related quality of life and persistent complaints. These patients can be monitored via telemetry (at least oxygen saturation, breathing frequency, temperature, and heart rate, possibly activity level, sleep) and at least daily structured questionnaires. If, on the basis of the severity of the symptoms and the risk factors present, the physician treating the patient ('behandelende arts'/'médecin traitant') considers that telemonitoring can be done without telemetry, the patient can also be monitored using at least daily structured questionnaires.

2.3 Financing and invoicing

The **group of healthcare providers** invoices their services to the sickness funds and use the nomenclature codes listed in Table 2. A calculation of the contribution fees for the patients included in our survey during the study period January – June 2021 is given.

Table 2 – Contribution fee and regulations provided for the NIHDI projects that signed the convention.

Code	Description	Contribution fee	Frequency	Range of the contribution fee during the duration of RPM per patient (one week – 3 weeks)
530891	Lump sum for the administrative start-up of the care path, the installation of the equipment, the use of the digital support platforms and logistics	34€	One time per patient	-
530913*	Lump sum for monitoring a patient via telemonitoring who is staying at home and was not hospitalized (pre-hosp), **without telemetry equipment**	65€	One time per week per patient	€99 - €229
530935*	Lump sum for monitoring a patient via telemonitoring who is staying at home and was not hospitalized (pre-hosp), **with telemetry equipment**	75€	One time per week per patient	€109 - €259
530950	Lump sum for monitoring a patient via telemonitoring who is staying at home after hospitalization (post-hosp), **without telemetry equipment**	65€	One time per week, maximum three times per patient	€99 - €229

530972	Lump sum for monitoring a patient via telemonitoring who is staying at home after hospitalization (post-hosp), **with telemetry equipment**	100€	One time per week, maximum three times per patient	€134 - €334

Codes 530913 and 530935 can be invoiced together up to a maximum of 3 times per patient for the duration of this project.

For advice, **consultations and visits of (general) practitioners**, the regular nomenclature of medical services is applicable, or the services provided for in Royal Decree no. 20 of 13 May 2020 containing temporary measures in the fight against the COVID-19 pandemic and to ensure the continuity of care in the compulsory healthcare insurance can be applied.

But specific nomenclature for tasks performed in telemonitoring (such as teleconsultations) is lacking. Currently a work group in NIHDI is working on a convention on teleconsultations for GPs.

Ambulatory nursing care is financed via the regular nomenclature, via the specific ambulatory nursing care benefits provided for in Royal Decree no. 20 concerning temporary measures in the fight against the COVID-19 pandemic and to ensure the continuity of care in the compulsory medical care insurance and via the framework of cohort care for COVID-19 patients.

But specific nomenclature for tasks performed in telemonitoring is lacking.

Note that the contribution fee is a fee that aims to cover expenses made in the remote care of a patients (except for the GPs and the ambulatory care nurses). The group of healthcare providers should share and divide the contribution fee with the (other) actors involved in the project such as the stand-alone monitoring center (in case they take up the role of telemonitoring team), the platform manufacturer (depending on the licensing agreement), the technical helpdesk, logistics for the delivery and installation of telemetry devices, the purchase or rental of telemetry devices, staffing of the telemonitoring team, staffing of the medical supervision of the telemonitoring team, etc.

In conclusion, a contribution fee is foreseen during a maximum of 3 weeks in the pre-hosp phase and during a maximum of 6 weeks in the post-hosp phase (of which 3 weeks with, and 3 weeks without telemetry).

2.4 Collaboration framework

Telemonitoring is an interaction between a healthcare professional at a certain place and a patient at another place, in which a certain number of patient's parameters are assessed and followed up for a certain duration of time. Setting up a continuous and qualitative telemonitoring is a complex task, where **collaboration with various actors (across care lines) must be organised in a clear interprofessional collaboration framework**. This framework, visualized in Figure 1 should take into account:

- The different actors involved,
- the role that each actor takes up, and
- the interaction between the actors.

The interprofessional collaboration and integration of care, including the communication between the various actors is of great importance.

Figure 1 – Obtained collaboration framework between the different actors involved in RPM.

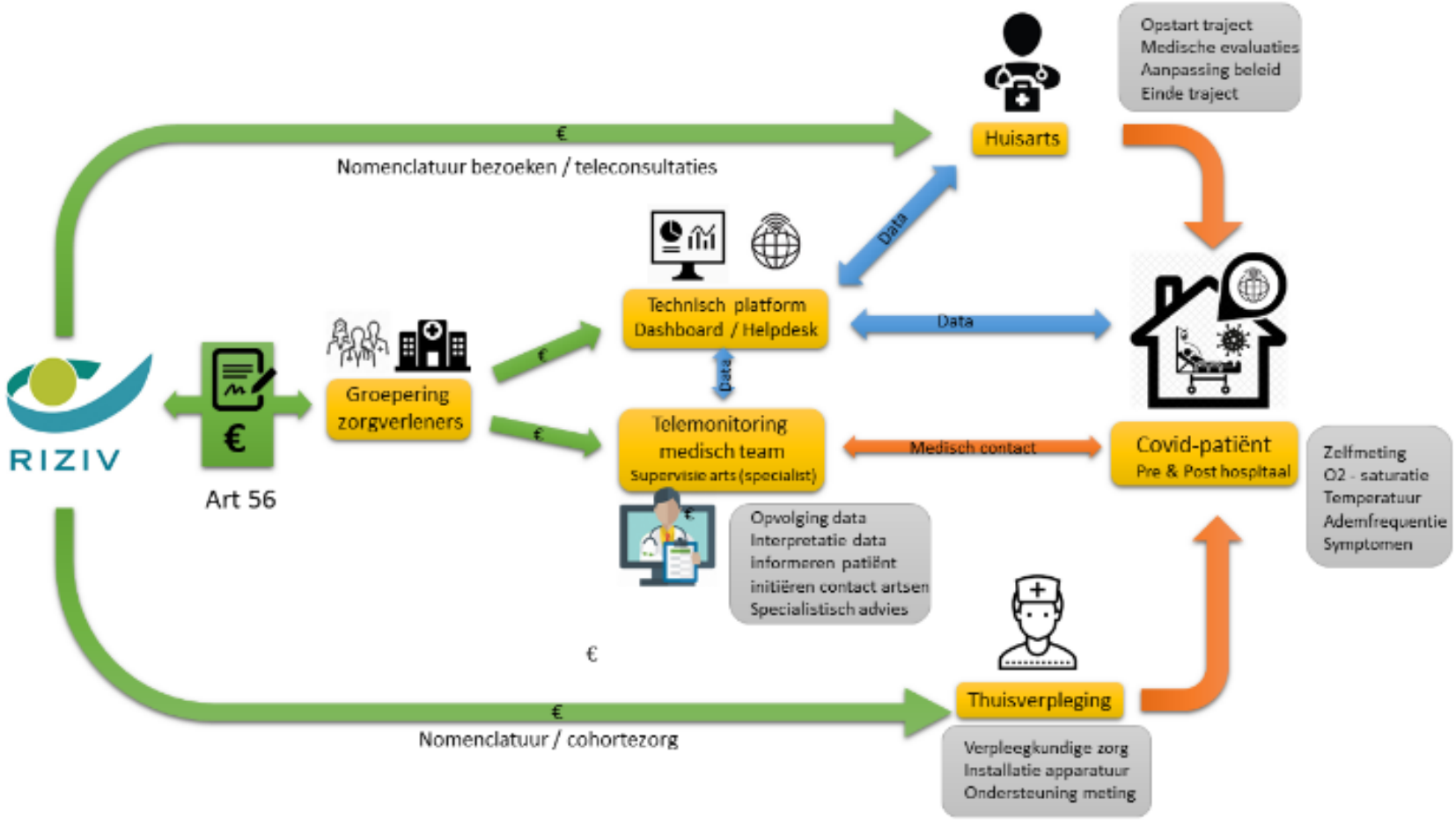


Figure adjusted and retrieved from [7]

In what follows the role of the different actors involved in the RPM collaboration framework as described in the convention is outlined.

2.4.1 The group of healthcare providers

The group of healthcare providers ('groepering zorgverleners'/'groupement de dispensateurs de soins') concludes an agreement with the NIHDI after the submission and NIHDI's approval of an application file that contains all the requested data, according to the procedure described in Article 8 of the convention.[7] In this agreement, invoicing is done through the group of healthcare providers who will be responsible for organizing the processes i.e. proposing and setting up the required collaboration framework and communication strategy between the various actors involved in RPM. This group of healthcare providers can be hospitals, as well as groups of GPs, ambulatory care nurses, or a combination.

The group of healthcare providers:

- Provides procedures and points of contact where patients can be registered.
- Organizes the composition and continuity of the telemonitoring team.
- May rely on third parties for the supporting digital platforms, delivery and the logistical processes of the telemetry devices and providing a helpdesk for technical issues.
- May call upon ambulatory nursing practices to provide support to the patient if necessary.
- Ensures that the telemonitoring team has validated medical protocols available, in terms of monitoring data and for emergency procedures.
- Invoices the services delivered to the sickness funds.

2.4.2 The technical platform/helpdesk/dashboard

Looking at the technical platform/helpdesk/dashboard, the groups of healthcare providers may rely on third parties for the technical support for the delivery of, and logistical processes behind the **telemetry equipment**, the **storage and exchange of the data** and **a helpdesk** for technical problems. This requires the use of **secure platforms that are compliant with the General Data Protection Regulation (GDPR) and applicable standards on privacy, information security and data sharing** in healthcare.

If a collaboration with third parties is set up, the grouping of caregivers needs to conclude an agreement with them and needs to pay the third party for the services provided. The group needs to ensure that these third parties' services and applications comply with the commonly used standards in terms of privacy, information security and data exchange in the healthcare sector. This includes that the identification and authentication of the patient and care providers involved should take place in a safe way. The measuring devices used must be CE-marked medical grade devices.

Any processing of personal data will be carried out in accordance with all applicable laws and regulations regarding the protection of personal data. In the event that a processor is engaged to process personal data on its behalf**, the controller and the processor will enter into a written agreement to this effect prior to processing.** The controller will **ensure that the personal details are treated as confidential and kept secure at all times.** To that end, it will take the appropriate technical and organisational security measures needed to comply with the laws and regulations on the protection of personal data, in particular Article 35 of the **GDPR** and Article 42(2)(3) of the Law of 13 December 2006 containing various provisions relating to health.

The technical platform or dashboard is seen as a secured electronical platform where the telemonitoring team can save the patient data. Certain data can be automatically collected and send to this platform, other data needs to be inserted by the patient (or informal caregiver or ambulatory care nurse) through digital applications.

The technical helpdesk is seen as (a team of) persons who provide technical support to the telemonitoring team, the group of healthcare providers, or platform manufacturers.

2.4.3 The telemonitoring team

The telemonitoring team ('Telemonitoring (medisch) team'/'Equippe de télémonitoring') is a team of healthcare professionals (consisting of nurses and/or physicians) who is able by technological means to monitor a patient remotely. A number of parameters and systematic questioning of the patient's symptoms are collected by means of digital applications and telemetry, forwarded and followed up by a professional medical team that can consist of doctors and/or nurses. This team receives appropriate training, is under the responsibility of the 'doctors' ('supervisie arts (specialist)'/'médecin superviseur (specialiste)') involved in the telemonitoring team and has the necessary expertise in the follow-up and treatment of COVID-19 patients. Validated medical protocols are applied. The patient may contact the telemonitoring team any time. In case of significant new symptoms, deterioration of the situation, or when a new medical evaluation is required, the treating GP is contacted by the telemonitoring team to adjust medical policy if necessary. If required, and in consultation with the GP, an attending specialist-physician may also be contacted. This medical team is thus in contact with the patient, the GP, the ambulatory care nurse, and the specialist-physician with expertise in COVID-19.

The **telemonitoring team** is responsible for the **24/7 monitoring of the delivered data** The telemonitoring team should be capable of **monitoring at least 200 patients simultaneously.** The team uses **validated medical protocols** to monitor data **and evaluate the health status of the patient** based on the **outlined thresholds or parameters adapted to the specific health status of the patient**. These validated protocols and thresholds are provided and set by the group of healthcare providers as described earlier. The telemonitoring team is also responsible for initiating contacts with the treating physicians ('behandelende artsen'/'médecins traitants') and for the advice given. The team ensures regular reporting to the (treating) GP, such as at intake or discharge from the care pathway or important changes in medical treatment or in nursing care support. The team collects contact information of all involved healthcare providers necessary to ensure continuity of care. Moreover, the telemonitoring team informs the patient about the course of the illness, reassures (if necessary) and provides advice on medication for which no prescription is needed. The telemonitoring team is composed by the group of healthcare providers who also ensures continuity of care. This includes being available for **physicians ('artsen'/'médecins') and patients, at least by telephone**. If necessary, the advice of a treating specialist-physician ('behandelende arts-specialist'/'médecin spécialiste') can be sought in consultation with the treating GP ('behandelende huisarts'/'le médecin généraliste traitant').

The telemonitoring team **works under the supervision of physicians who are part of this team**. The physicians in the telemonitoring team are responsible for the medical monitoring of the data supplied, for initiating contact with the treating physicians, for the (medical) advice provided and for regular reporting to the treating GP ('behandelende huisarts'/'médecin généraliste traitante'). If the telemonitoring team **considers it necessary, contact with treating physicians and/or ambulatory care nurses should be initiated**.

The members of the team have **received training** that includes at least (i) the disease course of COVID-19 and possible complications, (ii) the alarm signals during telemonitoring, (iii) the medical and emergency protocols used, (iv) the technical instructions for using the supporting digital platforms, (v) the contacts for specialist advice if necessary.

Ensure that validated **medical protocols** are available to the telemonitoring team for (i) data monitoring and (ii) emergency procedures. These protocols should include:

- the parameters to be collected per target group,
- the assessment/survey of the patient,
- the frequency of assessment/survey and collection of the measurements,

- the thresholds when certain values are considered abnormal,
- the thresholds to contact the patient, the treating physician or when the emergency services need to be notified immediately.
- These protocols should be based on validated medical protocols, recognised at least by national or international scientific associations.
- The grouping should keep these protocols available for the NIHDI.

2.4.4 The general practitioner(s)

The GP is an essential actor in this project. Each patient followed up via telemonitoring must have a GP available who can come on-site if necessary to examine the patient and can make medical decisions. The number of the local on-call service is also requested for urgent problems that arise in the evening or at the weekend when the GP is not available.

- The referral RPM is made by the GP ('huisarts'/'le médecin généraliste'), a coordinating physician ('coordinerende arts'/' un médecin coordinateur'), or by the physician-specialist ('arts specialist'/'médecin spécialiste');
- The treating GP ('behandelende huisarts' / 'le médecin (généraliste)') retains medical decision-making authority, in consultation with the patient and supported by the data provided;
- Discontinuation of RPM is done in consultation with the GP and depending on the clinical course of the acute infection.
- If necessary, the advice of an attending specialist-physician ('behandelende arts-specialist'/'médecin spécialiste') can be sought in consultation with the treating GP ('behandelende huisarts'/'le médecin généraliste traitant'). As usual, the (treating) GPs ('behandelende huisartsen'/'le médecin généraliste') are responsible for their medical actions.

2.4.5 The ambulatory care nurse(s)

The group of heathcare providers ensures that a patient, if necessary, can receive **ambulatory nursing care** for the installation of the telemetry equipment and the performance of the measurements if the patient or his/her informal caregiver is unable to do so. For this purpose, the group of healthcare providers were also asked to propose a collaboration with (a team of) ambulatory care nurses. Ambulatory care nurses can be actively involved in the follow-up process of tasks such as:

- Supporting the installation of telemonitoring;
- Measurements of patients' parameters if the patient or his informal caregiver are unable to provide the necessary data to the telemonitoring team;
- Assisting with oxygen administration where appropriate, assisting the patient with prevention and hygiene measures, wound care, taking medication according to medication schedule, etc.

These nursing tasks may be prescribed by the treating physicians as well as the physicians of the telemonitoring team.

2.4.6 The patient

The patient is an important actor in this telemonitoring pathway. The intervention is given for his/her health, but the patient is also responsible for his/her follow-up, including the measurement and delivery of data. First the patient is registered by the treating physician. Extensive information is given to the patient and an informed consent is signed before the start of the care path. The patient or his/her informal caregiver will be jointly responsible for the provision of data such as queries or objective measurements (e.g. oxygen saturation, temperature, breathing frequency, physical activity). If this is not possible for the patient and/or his/her informal caregiver, the patient can be supported by ambulatory care nurses. The patient can also contact the telemonitoring team via the digital applications or by telephone if necessary. The patient can contact his/her treating GP or attending physician-specialist as usual. The target population for which the convention is installed, is described in Appendix 2.2.

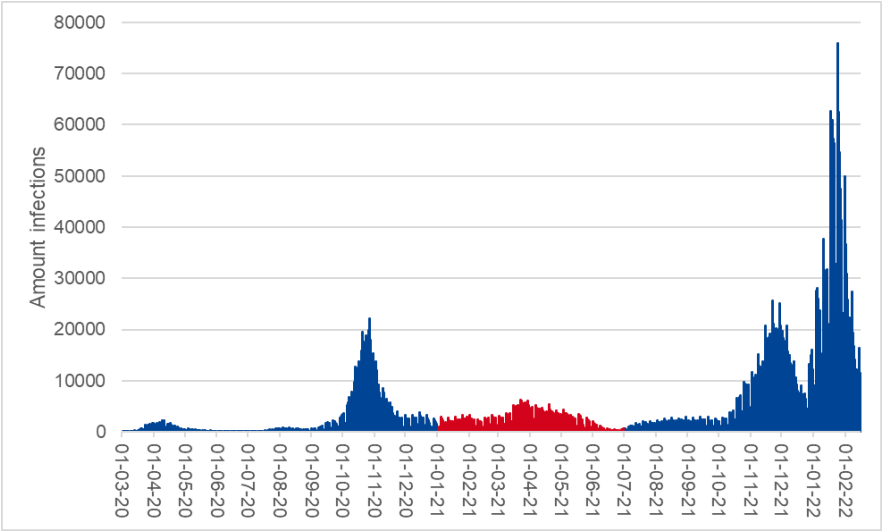
3 METHOD

In the selection of the methods used, the continuously changing context of the COVID-19 pandemic and the moment of launching the convention in December 2020 had to be taken into account. Therefore, the study period was defined together with the projects, as well as the selection of the methods to gather information on the characteristics of the projects.

3.1 Selection of study period and eligible projects

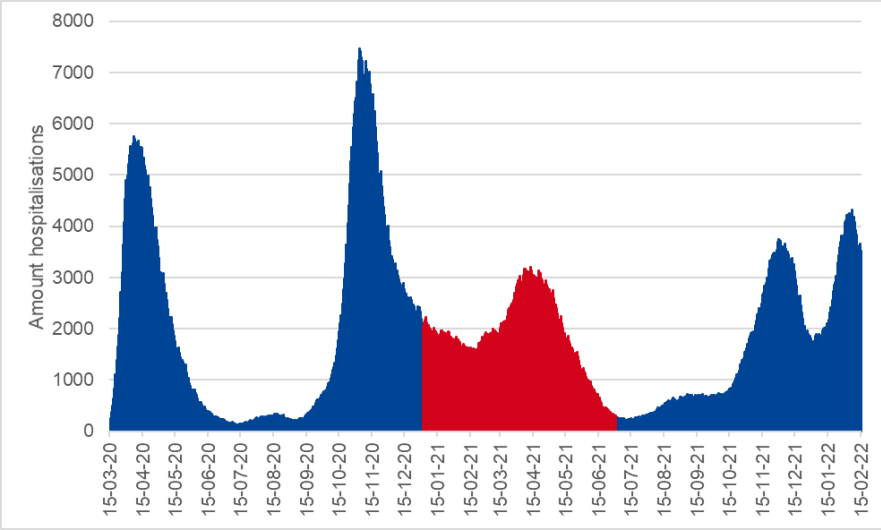
Considering the timing of our report and the rapidly evolving context, **this research focusses on a specific time period.** For the data collection, we included patients who were infected with SARS-CoV-19 and consequently followed with telemonitoring during the **6-month period from 1 January 2021 until 30 June 2021**. This way, **the third wave** of SARS-CoV-19 infections and hospital admissions in Belgium were covered (see Figure 2 and Figure 3).

Figure 2 – Visualisation of the studied period and number of registered SARS-CoV-2 infections in Belgium during the pandemic (period 01/03/2020 until 15/02/2022)



Source: Sciensano, red wave corresponds to our study period

Figure 3 – Visualisation of the studied period and number of COVID-19 hospitalisations in Belgium during the pandemic (period 01/03/2020 and 15/02/2022)



Source: Sciensano, red wave corresponds to our study period

After consultation and in agreement with NIHDI, it was decided to include projects who signed the convention up until 12 March 2021.

3.2 Methods to gather information on project characteristics

Several methods were applied to receive a thorough understanding of how the projects look like in practice and the characteristics of the included population.

First, a document analysis of the **project application forms ('candidacies')** approved by NIHDI was performed to obtain an overall view of each project. We broke down the projects into building blocks (e.g. patient inclusion criteria, patient discharge criteria, risk profile of patients, follow-up of parameters, etc.) that allowed cross-project comparison. An in-house excel table was made to analyse the building blocks both for the pre-hospitalisation and post-hospitalisation patients. The research team discussed the table to identify similarities and differences.

Second, during **an exploratory semi-structured online interview** with the group of healthcare providers or sub-contractants, we asked to describe their project (in practice), share (first) experiences, and answer some questions that were pointed out after document analysis (step 1). Moreover, it was aimed to capture in how far the initial process outline as submitted to NIHDI had evolved in the meantime in function of lessons learned. Certain projects have been including patients for a longer period of time and may have encountered difficulties for which changes in for example process flow were made. Other projects were just starting to be implemented. An interview guide is added in Appendix 2.3. Also, the manufacturers of the platforms, the 'stand-alone monitoring center' and a project that did not sign the convention were interviewed. Relevant information from these interviews was added.

Third, **field visits** were conducted to on the one hand introduce the research project and on the other hand familiarize the research team with the projects, i.e. to receive a more in-depth understanding of the workflow, experiences with telemonitoring and a state of affairs of the projects.

Fourth, the included projects were asked to fill out a **structured online survey** to collect **aggregated data regarding patients included between 1 January 2021 and 30 June 2021. In addition, NIHDI shared the total numbers of included patients, projects have to submit monthly with the research team**. The construction of the online survey was based on the document analysis, the online interviews and field visits. A draft survey was shared with NIHDI for validation. The final version contained 31 questions related to 5 main themes i.e. general information (e.g. total number of COVID-19 patients seen by the hospital, number of patients included in the intervention), patient characteristics at the time of inclusion (e.g. age, gender, symptoms), specific questions about post-hospitalisation patients, characteristics of the telemonitoring intervention (e.g. duration, devices,

etc.), comorbidities[a] and intervention outcomes (e.g. satisfaction, rehospitalization, etc.). The survey was made in Dutch and translated to French and can be found in Appendix 2.4.

Finally, we collected articles from the **popular press reporting** on the telemonitoring projects during the writing of our report (up until 15 December 2021).

4 RESULTS

4.1 Overview of the included telemonitoring projects

In case the **candidacy** was approved by the NIHDI on 12 March 2021 the latest, the project was included in this study. The NIDHI provided a template for candidate projects to fill out. The following information had to be provided: identification data (contact person NIHDI, identification of the grouping of healthcare providers, identification of the members of the telemonitoring team, and the physician-specialists involved), information on the organisation of the telemonitoring intervention (protocol and workflow, including references to validated protocols and scientific organisations), the registration procedure, the geographical reach, a description of the collaboration with physicians, GPs and ambulatory care nurses, the technical platform, the presence of a helpdesk for technical problems, the foreseen telemetry equipment, the education plan for the telemonitoring team, the maximum capacity for patient follow-up, the professional indemnity insurance, and previous experience in telemonitoring).

Twelve projects were included in this research. NIHDI extended the submission date until 6 May 2021, and finally 17 projects signed the convention. The five remaining projects that were not included in this evaluation were initiated by one and the same cluster organisation i.e. CovidCare@Home vzw (CC@H) and were therefore based on the same application form submitted to the NIHDI (for example in terms of telemetry platform used, process flow, etc.). Although it was assumed that in practice there could be differences, we assumed that these differences would also emerge from the evaluation of the other five CC@H projects included in this evaluation report. In Appendix 2.2 a figure illustrates the number of patients included in the projects selected for this study (n=12), as well as the total number of patients included in all NIHDI projects (n=17).

Table 3 gives an overview of the hospitals or groupings of caregivers that signed the NIDHI convention (n=17), together with their subcontractors.

[a] https://kce.fgov.be/sites/default/files/atoms/files/Decision-aid-Worrisome%20patient-FR_01062021.pdf

Table 3 – Overview of the NIHDI projects (n=17) and indication of the included projects in this evaluation (n=12)

Submitter: Hospital / Grouping caregivers	Subcontractor: hospital	Start date of signing the convention	Included in evaluation
Algemeen Ziekenhuis Maria Middelares (AZMM)		15-01-2021	X
Universitair Ziekenhuis Antwerpen (UZA)		15-01-2021	X
Mederi NV / Onze-Lieve-Vrouw Ziekenhuis Aalst (OLVZ Aalst) / Algemeen Stedelijk Ziekenhuis Aalst (ASZ Aalst)		05-02-2021	X
Ziekenhuis Oost-Limburg (ZOL)		09-02-2021	X
EpiCURA Hospitalisation à Domicile (EpiCURA-HAD) asbl		01-03-2021	X
Center Hospitalier de Wallonie picarde (CHwapi)		12-02-2021	X
Clinique André Renard		05-03-2021	X
CovidCare@Home vzw (CC@H)		21-02-2021	
	Onze-Lieve-Vrouw van Lourdes Ziekenhuis Waregem	01-03-2021	X
	Universitair Ziekenhuis Gent (UZ Gent)	01-03-2021	X
	Heilig Hartziekenhuis Mol (HH Mol)	01-03-2021	X
	AZ Jan Palfijn Gent	05-03-2021	X
	AZ Sint-Lucas Gent	05-03-2021	X
	Heilig Hart Ziekenhuis Lier & Imelda Bonheiden	25-03-2021	
	AZ Oudenaarde	17-03-2021	
	GZA & ZNA Antwerpen	25-03-2021	
	AZ Damiaan Oostende & AZ West Veurne	17-03-2021	
	Jan Yperman Ziekenhuis Ieper	06-05-2021	

Note that other hospitals or caregivers also set up COVID-19 RPM, without entering the convention. Besides some projects in CC@H, also a big grouping of GPs (endorsed by Réseau Santé Wallon (RSW) and 'Brussels Gezondheidsnetwerk – Réseau de santé Bruxellois') that applied COVID-19 RPM (via the 'SafeLink' platform) did not apply to the convention. During the writing of this report, it became clear that several GPs also performed a kind of COVID-19 RPM (e.g. they asked an ambulatory care nurse to measure patients' parameters and communicate them through a platform used in primary care (linking ambulatory care nurses with GPs).

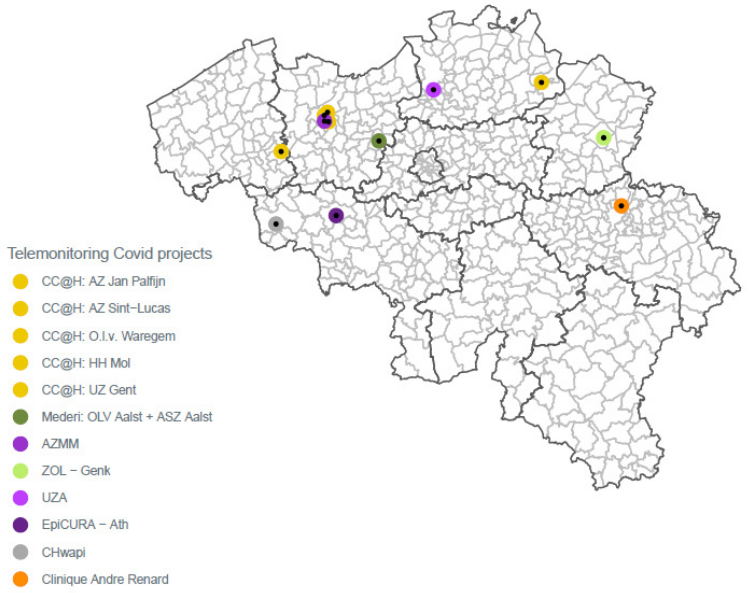
4.2 Geographical location of the studied projects

The NIHDI took on an initiating role with the provision of the convention and handled the candidacies of these pilot projects.[7] The medical department of the NIHDI evaluated the completeness of the application form and monitored the regional distribution of the various candidate projects. The capacity mentioned in the application form, the number of inhabitants per province and the capacity of the ongoing were considered. If a project had already started in a certain region, the NIHDI could decide to approve additional projects, based on the factors mentioned above.

A sufficient spread across the various provinces was aimed at, taking into account the capacity of each group and the number of inhabitants in each province. An overview of the geographical location of the participating hospitals (as submitter or subcontractor) is given in Figure 4.

Of the 12 projects, nine were submitted or subcontracted by a hospital or grouping of caregivers in Flanders, and three in Wallonia. Of the nine projects in Flanders, five were subcontractors of CC@H (who submitted the application form). Note that the project in Aalst is submitted by a grouping of caregivers i.e. Mederi nv, OLV Aalst and ASZ Aalst. NIHDI received no candidacies from Brussels Capital Region. The projects are marked on the map as a dot, rather than a visualization of the plausible reach. In fact, all projects have the intrinsic capacity to monitor patients across Belgium (and possibly also beyond). Note that in East Flanders, and more specific the region of Aalst and Ghent there are 3 different initiators (i.e. AZMM, CC@H, and Mederi) and 3 different subcontractors within CC@H (AZ Jan Palfijn, AZ Sint Lucas, UZ Gent).

Figure 4 – Geographical location of the hospitals involved in the 12 telemonitoring COVID-19 projects included in the study



4.3 Information gathered to describe the characteristics of the included projects

To make the projects more tangible for the KCE researchers an **exploratory semi-structured online interview** was conducted with 11 projects (Table 4). One project could not be reached since its launch was delayed. In addition, interviews were done with three platform manufacturers (Byteflies, BeWell, and H3S), with the stand-alone monitoring center (Z-plus) that represents the telemonitoring team of one project, and with a project that did not participate in the convention i.e. SafeLink.

Table 4 – Overview of the dates of the online interview and field visits with the different actors

Actor	Date online interview	Date field visit
UZA	01-04-2021	09-07-2021
AZMM	24-03-2021	17-06-2021
UZ Gent	26-03-2021	NA
AZ Jan Palfijn	02-04-2021	NA
HH Mol	29-03-2021	NA
ZOL	12-04-2021	07-07-2021
AZ Sint Lucas	25-03-2021	NA
CHwapi	16-04-2021	25-06-2021
EpiCURA	NA	03-08-2021
AZ Waregem	26-03-2021	28-06-2021
Clinique André Renard	13-04-2021	NA
Mederi	26-03-2021	29-06-2021
BeWell	10-05-2021	NA
CC@H	01-04-2021	NA
H3S	11-05-2021	NA
Z-plus	26-04-2021	29-06-2021 (with Mederi)
SafeLink	03-06-2021	NA

NA: Not applicable or meetings not executed

During the period mid-June up till mid-July 2021 7 **field visits** were conducted to elaborate more in-depth the projects' characteristics and to present the KCE research team (Table 4).

The **quantitative data** listed in this results section is based on an online **survey**. The survey was sent out on 16 July 2021 and closed on 29 October 2021. For one project we received a correction of the provided data on 21 December 2021. As stated before, the aggregated data described 6 months (January – June 2021) and included the third COVID-19 wave in Belgium. Ten out of 12 projects filled out the survey. However, one project filled out only the number of included patients (corresponding with a response rate of less than 1%). Also, other projects skipped questions. Hence, we were confronted with a lot of missing data. An overview of missing data is given in Appendix 2.5. In the tables presented in this report, missing data is marked in red and as 'non applicable (NA)' in orange.

The response rate[b] for the entire survey including 12 projects was 42.3% for the pre-hospitalisation phase and 53.3% for the post-hospitalisation phase. Excluding the aforementioned three projects (with a response rate of less than 1% or no response at all), the global response rate was 60.9% and 71.4% respectively. In Table 5, the response rate by project is given, ranging between 49.6% and 88.8% in the pre-hospitalisation phase and 44.3% and 91.7% in the post-hospitalisation phase. The median response rate is 54.7% (P25: 51.8%, P75: 59.0%) and 76.0% (P25: 58.1%, P75: 85.2%) respectively.

[b] The response rate is $\left[1 - \frac{Number\ of\ missing\ answers}{Total\ expected\ answers}\right]$ where the number of expected answers corresponds to the total number of applicable responses subtracted by the number of answer non-applicable - "NA" responses.

Table 5 – Response rate survey per project

	UZA	AZMM	HH Mol	AZ Jan Palfijn	Mederi	OLV Waregem	ZOL	EpiCURA	CHwapi
Pre-hospitalisation phase	88,8%	49,6%	54,7%	49,6%	59,1%	54,1%	59,0%	NA	NA
Post-hospitalisation phase	88,5%	44,3%	53,8%	58,4%	85,2%	58,1%	91,7%	76,0%	78,6%

A daily check for **press releases** was done to collect supplementary information on the projects. An overview and links to press releases up to 15 December 2021 is given in Appendix 2.6. The information of these press releases was used in the results section for a better understanding of the projects when appropriate.

Characteristics of the included projects

In the next sections, the characteristics of the included projects will be described.

4.3.1 Focus on actors involved and collaborations set up

Main motives to initiate COVID-19 RPM comply with the aims of the convention.

The **main motives** to introduce COVID-19 RPM in their organisation was (1) to comply with needs of the patients, who raised many questions, and were very anxious, requesting admission for specialised care, and (2) to save hospital beds, relieve strain on hospital workforce and to relieve primary care providers. These motives comply with the aims of the convention.

Some projects were initiated from experience while others were triggered by NIHDI funding.

Some projects that signed the convention at the beginning of 2021 (such as UZA and AZMM) were **experienced** in RPM of COVID-19 patients, as they developed a care path and implemented RPM since the beginning of the pandemic in 2020 (Table 3). Projects that provided RPM early in the pandemic often had already some experience with remote transmural care paths in other (chronic) diseases (such as UZA, ZOL and EpiCURA), and/or had already some boundary conditions in place such as an in-house platform (e.g. UZA, AZMM, ZOL), collaborations with primary care providers, an in-hospital telemonitoring team (such as the rapid response team (RRT) in AZMM), etc that facilitated COVID-19 RPM.

Other projects were invited to participate by a B2B manufacturer (CC@H provided by Byteflies) providing them with equipment to remotely monitor patients during the first and second wave of the COVID-19 pandemic, in order to support them and learn from their experiences. Before the convention was constructed, CC@H had the policy to deliver kits (with devices to measure temperature, oxygen saturation, etc.) to several hospitals. Those hospitals could use these services (kits, monitoring platform, technical assistance etc.) of CC@H by paying a fee per patient. When the convention was started, they let the hospital decide to sign a subcontract, or not. In case they did not sign the subcontract, the projects could continue to use the CC@H services at the same fee. The projects who decided to sign a subcontract paid a lower fee to CC@H (as a compensation was calculated based on the NIHDI reimbursement).

Some projects used the **funding** of the NIHDI to implement remote care in their organisation (such as Mederi, CHwapi and Andre Renard). While for some projects remote care was already in use before the convention, other projects used the convention as an incentive to start remote care and thus had to go through a learning phase.

Project initiations are mainly hospital-led

In Table 3, eight groupings of healthcare providers are listed representing 12 projects. Half of the projects (n=6; 3 in Flanders and 3 in Wallonia) were initiated by a hospital. One grouping of caregivers (named in this report 'Mederi') located in Flanders is a collaboration between two hospital settings (OLV Ziekenhuis Aalst & ASZ Aalst), two ambulatory home and nursing care organisations (Mederi and i-Mens), a stand-alone monitoring center (Z-plus), the platform manufacturer (Remecare), and an association of GPs. Five projects were initiated by the same grouping of healthcare providers, but in fact, the grouping (a not-for-profit organisation) is controlled by a company that provides B2B-services (Byteflies) to enable lean development of wearable health applications (named in this report 'CC@H'). They subcontracted the convention contract to 5 groupings of healthcare providers using their platform. These subcontracted groupings of care givers are all hospital-led. For the descriptions outlined in this report, we considered these 5 subcontractors as 5 separate projects. They were individually approached and described. Therefore, it is concluded that 11 of the 12 projects are hospital-led.

Dedicated (medical) project leaders are driving forces behind the projects and facilitate collaboration

Dedicated (medical) project leaders are seen as the **driving forces** behind the projects. We identified two types of project leaders; on the one hand hospital wide profiles, such as a medical director or quality manager. On the other hand, profiles affiliated to a specific department, such as physician pneumologist or physician internal medicine.

It was noticed that healthcare professionals differentiate between the two patient populations targeted in the convention (i.e. pre-hosp patients and post-hosp patients). In the application forms, a distinction was made between the inclusion of pre-hospitalisation and post-hospitalisation patients (see targeted population section 2.2). The two patient groups follow different care trajectories, (See Table 6). Inclusion of patients in a specific trajectory or care path is facilitated **by collaboration across units** and the affiliation of the (medical) project leader i.e. in most projects, patients were mainly included in the post-hospitalisation trajectory as the project leader and affiliated department were associated with in hospital care (and discharge) and did not involve the ED for patient inclusion in a pre-hospitalisation trajectory.

In practice, collaborations with primary care professionals were limited

The convention aimed to involve primary care providers (GPs and ambulatory care nurses) in COVID-19 RPM.

The grouping of caregivers offering COVID-19 RPM should ensure that patients can receive **ambulatory nursing care and support** for the installation of the telemetry equipment and the performance of the measurements if the patient or his/her informal caregiver is unable to do so. The list of tasks for ambulatory care nurses mentions the installation of RPM, taking measurements, but also specific nursing tasks such as oxygen administration, wound care, assisting with the medication schedule, etc. (see section 2.4.5)

In the application forms reference is made to an organisation of ambulatory nursing care with whom the projects (intended to) collaborate. There is a point of contact mentioned. However, in practice collaborations were limited and not systematically implemented. Table 6 shows that CC@H projects did not actively involve ambulatory care nurses, neither did CHwapi and AZMM (although a close collaboration was set up at the initiation of the project with Wit-Gele Kruis Oost-Vlaanderen). The projects in which ambulatory care nurses are not systematically involved, indicated that they provided patients with sufficient information to support the patient with the installation. In addition, they encountered only few problems with patients' registration of measurements. However, they admitted that for ***logistic support***, an ambulatory care organisation could be an added value, especially for the (delevery and) returning of telemetry devices, as patients were often still in quarantine when RPM stopped and the devices were returned by a family member or informal caregiver. In some projects, a check-up with the physician-specialist was planned a few weeks after hospitalisation and the patient could return the telemetry equipment. Another option to return the telemetry devices was via the ambulatory care nurse who made an

appointement with the patient to pick up telemetry devices at home and check-in with the patient regarding their status.

Projects who actively involved ambulatory care nurses considered logistic services such as delivery and installation of the saturation measurement by ambulatory care nurses as an added value. This way telemetry equipment could be delivered fast to patients, especially the patients included in the pre-hosp traject. Moreover, since no therapeutic relation was built at the ED in the pre-hosp phase, ambulatory care nurses could providingprovide some support (in case the patient would deteriorate). In the Mederi project, the ambulatory care nurses visited patients multiple times to guide them, and help them out with the use of oxygen (post-hosp patients were send home with oxygen). The involvement of ambulatory care nurses was more frequent for the inclusion of pre-hosp patients (staying at home or registered by GP).

From the application forms it was clear that the ambulatory care nurse involved in COVID-19 RPM (in these projects) differed from the ambulatory care nurses providing daily care in function of patients' needs other than COVID-19 (such as administring medication, wound care, etc.). The ambulatory care nurses involved in COVID-19 RPM were specifically trained for RPM, and their role was limited to RPM.

Following the convention, the grouping of caregivers needed to guarantee that **a treating GP** could be called by the patient, and a home visit could be carried out in case a physical examination or medical assessment would be needed (see section 2.4.4). From the document analysis we learned that GPs were not always included in the project set up (especially in Wallonia). In practice when patients were registered in the platform the name of their treating GP was noted in the platform. Some projects also explicitaly outlined that patients could only be included when a treating GP was available. For projects in Wallonia, this was often seen as an important factor for which patients were excluded from the intervention, especially in the pre-hosp trajectory. In certain regions of Wallonia, patients seem to not have a treating GP. All projects indicated that the GP received a hospital discharge letter or email from the hospital informing the GP that the patient was admitted (and discharged) from the hospital. However, there was often a delay in sending this information. Many projects informed some regional GP associations before the initiation of the COVID-19 RPM project. However, follow-up communication was limited. Most projects argued that GPs were not actively requesting to be involved in COVID-19 RPM. Even in the projects where GPs had access to the platform, there was doubt about GPs actual involvement. Most projects stated that in case of specific problems, for which advise of the GP was needed, they called the treating GP and aimed for shared decision making. In case a prescription was needed, the decision was taken together with the GP. The project physicians did not prescribe medication but could inform the GP that parameters were deteriorating such as increase of temperature (fever) indicative for a plausible sur-infection for which antibiotics could be prescribed by the GP. Projects also noted that in practice GPs were not readily available, potentially leading to problems in the continuity of care.

As seen with the ambulatory care nurses, GPs tend to be more activily involved in pre-hosp trajectories. In some projects (Mederi and UZA) GPs could sign-up patients for telemonitoring and they were especially involved in shared-decision making on medical actions (prescribing medication, evaluation of the patient) since especially in the pre-hosp trajectory there was no **therapeutic relationship** between patients and hospital/ED physicians.Primary care professionals seem to be more actively involved when there is a **clear role defined and agreement on medical responsibility**. In Mederi, the GPs that signed up patients, were responsible for their patients, while the physician pneumologist was the main responsible for the post-hosp patients. In this project, the **stand-alone monitoring center was involved for the remote monitoring of patients, reducing the workload** for GPs and physicians.

Table 6 – Overview of the project partners and actors

Project	Driving force	Previous experience with RPM	(Medical) project lead / initiator	In-hospital collaborations	Focus (reason)	Telemonitoring team	GP	Ambulatory care nurses	Helpdesk
UZA	Hospital led	Since 2012 in other patient populations	Medical Director	ED > across hospital	Pre-hosp (highest value)	7 physicians (each one day) 2 nurses	Active, signing up patients through hospital platform, videoconferencing and prescription of medication	Yes, installation of telemetry (oxygen measure)	2 IT technicians in hospital (providing technical support but also maintenance of devices); ambulatory care nurses for technical issues with patient
AZMM	Hospital led	Since March 2020 with daily survey	Head physician anesthesiology and intensivist	Across hospital with RRT team > ED	Post-hosp across hospital (lack collab ED)	RRT (nursing team) across hospital	Not active. GP cannot consult dashboard.	Initially yes but not activated	Technician in hospital
HH Mol	Hospital led	Initiation with CC@H	Physician pneumology	Pneumology (ED initiation mid-April)	Post-hosp (aim to discharge patients earlier (after critical window day 7 first wave) with oxygen, to have beds)	Treating physicians pneumology (4) and staff unit pneumology (3)	Not active. GP can consult dashboard.	No	CC@H
AZ Jan Palfijn	Hospital led	Initiation with CC@H	Care manager Director ICT and facilitation	COVID unit (ED initiation mid-April)	Posthosp (initiation from COVID unit)	Physician pneumology Head of nursing unit Nurse of unit	Not active, GP cannot consult dashboard.	No	CC@H
Mederi	Collaboration	Since the initiation of	Physician Pneumology	Integrated – Prehosp: GP	Prehosp (to relieve primary care)	Stand-alone monitoring center (nurses)	Active, signing up and follow up through dashboard.	Yes, onboarding patients,	Remecare for platform, ambulatory

		the convention	GP association Ambulatory nursing care organisation	Posthosp: Pneumology	Posthosp (to send patients earlier to home with oxygen, and onco-pneumo patients)			installation telemetry, follow-up	care nurses for technical problems
OLV Waregem	Hospital led	Initiation with CC@H	Quality manager	Pneumology	Posthosp	Quality manager and cell	Not active, GP can consult dashboard	No	CC@H
ZOL	Hospital led	Experience built-up since 2010 in clinical call center (especially cardiology)	Division manager	Pneumology, ED, Cardiology, Geriatrics	Posthosp (as in cardiology experience)	Nursing team (6 nurses, 1 head nurse, 2 biomedical persons, departement cardiology)	Not active, GP can consult dashboard	Yes, as logistic service	Technician in hospital
EpiCURA	Hospital led	Since 2013 in other patient populations	Medical Director	HAH cell: GP attached to the hospital and Covid unit	Posthosp only (aim to discharge patients earlier)	HAH Cell, leading by a GP attached to the hospital	Not active, GP can consult dashboard	Yes, on day 1, for installation of telemetry and on patient request	For patients: Telemonitoring team. For Telemonitoring team: H3S available 24/7
CHwapi	Hospital led	Since 2016, experience built-up for other projects	Registered nurse	Infectiology: Covid unit and anesthesists	Posthosp only (aim to discharge patients earlier)	2 nurses, and 1 coordinator physician	Not active, GP can consult dashboard	No	For patients: Telemonitoring team. For Telemonitoring team: H3S available 24/7
AZ Sint Lucas	Hospital led	Initiation with CC@H	Pneumology (Oncology) Manager	Pneumology (ED mid-April)	Posthosp (onco-pneumo patients)	2 nurses pneumology	Not active, GP can consult dashboard.	No	CC@H

UZ Gent	Hospital led	Since July 2020 out of hospital COVAD trial & initiation with CC@H	2 physicians internal medicine and infection diseases	ED (Pneumology, not operational)	Prehosp (lack collab pneumology)	2 physicians / initiators	Not active, GP can consult dashboard	No	CC@H
André Renard	Hospital led	Since the initiation of the convention	Physician in ED	Covid unit, geriatric department and ED	Posthosp and prehosp (aim to reduce strain on hospital)	One ED physician, 2 geriatric physician and 2 coordinator nurses	Not active, GP can apply to consult dashboard. Very limited collaboration	Yes, every day: onboarding patients, installation telemetry, follow-up	For patients: Telemonitoring team. For Telemonitoring team: H3S available 24/7

The composition of the telemonitoring team took many forms across projects and depended on the implementation process

Across the projects we identified two types of telemonitoring teams who worked in-hospital i.e. (i) a telemonitoring team employed at the department of the (medical) project lead, and (ii) telemonitoring teams operating hospital-wide. In addition, some projects opted for a stand-alone monitoring center (Z-plus) to monitor patients.

Telemonitoring teams employed at the initiators department *(e.g. pneumology)* consisted mainly of hospital nurses who verified at certain moments during the day (mostly 3 times per day) the parameters of the patients in remote monitoring. When parameters were deteriorating across measuring points (trend) or alarms were evoked (see also section 4.3.3) the nurses called a physician member of the team. The physician is responsible but trusts the nurses of the team to evaluate the parameters, to take action following the protocol when problems emerge (e.g. contacting the patient by telephone), and to call a physician in the team in case there is a medical advice needed. In one project, a physician oversaw the monitoring, without any nurses involved.

In **telemonitoring teams operating hospital-wide** the project lead often was not related to a specific ward (e.g. head of anesthesiology, medical director, research nurse or quality manager). An example of a hospital-wide operating telemonitoring team is a 'rapid response team' (RRT). This RRT usually monitors hospitalized patients 24/7 as each in-hospital nurse should measure the 'Early Warning Score' (EWS) once for each patient per shift. Monitoring in COVID-19 RPM came on top of the RRT usual work. The platform is integrated in the patient record software hospital-wide, and the dashboards are continuously projected. Another example is a telemonitoring team operating across hospital, initiated from the quality unit. In case of deteriorating parameters or alarms, a physician (pneumologist) was contacted. UZA was the sole project for which staff (one physician-specialist per day, and two nurses) was exempted from other duties.

Monitoring by a stand-alone monitoring center was offered in the CC@H projects, but none of the projects included in our analysis opted for that possibility. The stand-alone monitoring center as telemonitoring team was a partner in the Mederi project. Similar to an in-hospital telemonitoring team, nurses from the stand-alone monitoring center (Z-plus) monitor patient parameters and contact the patients or responsible doctor when parameters are deteriorating, or the generated alarms require plausible medical action.

It is clear that the stand-alone monitoring center involved in COVID-19 RPM has to deal with different platforms, thresholds and processes. Due to confidentiality of data and the absence of an integrated electronic patient record, the stand-alone monitoring center performed an intake of the patients by teleconsultation. The stand-alone monitoring center maintained a logbook of the actions undertaken for each monitored patient. In case the patient had no alarms during 3 consecutive days, the stand-alone monitoring center in consultation with the hospital physician or the GP decided to stop the remote monitoring.

The way of communication between the telemonitoring team and the patient (and vice versa) varied

Note that two types of **communication from the telemonitoring team towards the patient** emerged from the data: active and passive. Active means that members of the telemonitoring team took the initiative to contact the patient by phone or messaging to verify the patient's health condition, irrespective of whether or not alarms were generated (e.g. sending several text messages a day to each patient). Passive is based on the 'no news, good news' principle. A teleconsultation (or video consultation) with the patient was only held when alarms were generated or the telemonitoring team 'did not trust' the generated data.

In both ways of working the nurse or physician of the telemonitoring team opens the platform and evaluates the parameters at certain moments during the day. There was often no push of alarms (e.g. towards the cell phone of the healthcare professional)(only with H3S) nor a continuous display of the platform.

Concerning the **communication from the patients towards the telemonitoring team**, a telephone number of the telemonitoring team is provided. As that the patient can call the telemonitoring team 24/7. However, during the night and in weekends, the telemonitoring team switched often towards an "on call" mode. After dialing the number, the patient is connected to a nurse of the night shift, or to the ED of the hospital. These are often other healthcare professionals than the telemonitoring team operating during daytime and on weekdays. In case of an emergency, patients were advised to contact their GP or ED.

An overview of the characteristics of the communication between patient and telemonitoring team is given in Table 7.

Table 7 – Characteristics of the communication between patient and telemonitoring team

Project	Response system	Follow up day time	Follow up night time	Response ways (telemonitoring team -> patient)	Feedback to the patient after inserting data	Response ways (patient -> telemonitoring team)
UZA	Dynamic, active	Continuous push of alarms (projection dashboard)	Assistance schedule ED night-time	5 text a day, videoconsultation, teleconsultation (technical)	No	Text, telephone
AZMM	In case of alarm	Continuous push of alarms (projection dashboard RRT)	Continuous push of alarms (projection dashboard RRT)	Teleconsultation	No	Telephone
HH Mol	In case of alarm	Telemonitoring team, 3 times a day	No, patient can call (arriving at ED). No	Teleconsultation	Yes – green, yellow (advise to measure parameters again	Telephone

			push message in case of alarm (-)		after one hour) or red screen (advice to call hospital)	
AZ Jan Palfijn	In case of alarm	Physician Head of nursing unit Unit nurse	No, patient can call unit nurse – call to physician if needed. No push message in case of alarm	Teleconsultation	Yes – green, yellow (advise to measure parameters again after one hour) or red screen (advice to call hospital)	Telephone
Mederi	In case of alarm	Stand-alone monitoring center	Stand-alone monitoring center	Teleconsultation	Yes – green, yellow (advise to measure parameters again after one hour) or red screen (alarm to stand-alone monitoring center who calls GP or physician or ED)	Telephone
OLV Waregem	In case of alarm	Quality manager	Quality manager but no push message in case of alarm	Teleconsultation	Yes – green, yellow (advise to measure parameters again after one hour) or red screen (advice to call hospital)	Telephone
ZOL	In case of alarm	Nurses cardiology unit following ambulatory cardiac patients consequently	Nurses cardiology unit following ambulatory cardiac patients. No push message in case of alarm	Teleconsultation	No	Telephone
EpiCURA	In case of alarm	Telemonitoring team - Continuous push of alarms (dashboard and phone)	HAH cell or ED	Teleconsultation	Alert is shown on the screen or sent to the smartphone	Telephone
CHwapi	In case of alarm	Telemonitoring team (home hospitalization team) - Continuous	Permanence of the middle care anesthesia team	Teleconsultation	Alert is shown on the screen or sent to the smartphone	Telephone

		push of alarms (dashboard and phone)				
AZ Sint Lucas	In case of alarm	Unit nurses pneumology (1 week) changed by ED nurses (1 week)	Unit nurse at night time pneumology (1 week), changed by ED nurse night time (1 week) but no push of alarms.	Teleconsultation	Yes - – green, yellow or red screen with advice	Telephone
UZ Gent	In case of alarm	At least ones a day active opening of dashboard	No, patients do not insert data at night. No push message in case of alarm.	Teleconsultation	Yes - – green, yellow or red screen with advice to call hospital	Telephone
André Renard	In case of alarm	Telemonitoring team - Continuous push of alarms (dashboard and phone)	ED	Teleconsultation	Alert is shown on the screen or sent to the smartphone	Telephone

An example of a feedback trajectory and actions taken in case of a red, orange or green screen is given in Figure 5.

Figure 5 – Example of a feedback trajectory and actions in relation to thresholds

	2	1	0	1	2
ACTIE	Alarm naar ZC	Herhaal PM na 1u	Geen actie	Herhaal PM na 1u	Alarm naar ZC
AH-frequentie in rust (x/min)			9-20	21-25	> 25 of 21-25 (2x)
Saturatie (%) in rust	< 93 of 93-96 (2x)	93-96	> 96		
Temp (°C)	< 35 (2x)	< 35	35-39	> 39	> 39 (2x)
Hartslag (x/min)	< 40 of 40-50 (2x)	40-50	51-110	111-130	> 130 of 111-130 (2x)

Remote monitoring raises questions about medical liability

During exploratory interviews telemonitoring teams pointed to the **high degree of responsibility given to the patient** in a telemonitoring trajectory. This is also illustrated in the **informed consent forms** patients had to sign at intake (see quote). In the interviews, the reporting of the measures by the patient was compared to the therapy compliance for a patient towards prescribed medication. The NIHDI outlined a high degree of **responsibility to the GP**, however, primary care professionals were rarely intensively involved in RPM COVID-19. In practice, the **physician responsible for the telemonitoring team** often takes up the medical responsibility. In case the telemonitoring team is a stand-alone monitoring center (without physicians involved), the hospital physician or GP who enrolled the patient is considered medically responsible.

> *"De uitkomst van de bevragingen (risico-inschatting) en de adviezen die geformuleerd worden zijn louter indicatief en kunnen op géén enkele manier beschouwd worden als een medisch advies, een medisch onderzoek of een voorschrift. Het gebruik en het invullen van deze bevragingen en telemetrische opvolging kunnen dan ook nooit een consultatie of onderzoek door een arts of zorgverlener vervangen. (…) Hoewel we trachten de inhoud van de vragenlijst nauwkeurig, volledig en actueel te houden, geven wij geen garanties op de correctheid van de uitkomst en zijn de ontwikkelaars niet verantwoordelijk voor eventuele schade of gevolgen die kunnen voortvloeien uit het gebruik van deze applicatie. [Project name] en het opvolgteam kan ook niet verantwoordelijk gesteld worden voor de nauwkeurigheid, volledigheid of tijdigheid van de informatie." (Excerpt from an informed consent form)*

All projects provided a helpdesk, telemetry equipment and had different regulations on the gathering, storage, and exchange of data.

Patients could be involved in RPM **with and without telemetry**. A detailed overview of the telemetry devices is given in Table 9. In case no telemetry was provided, patients had to fill out a **daily survey** with subjective parameters. These daily surveys were characterized by high heterogeneity across the projects. Most frequent subjective parameters asked were feelings of dyspnoea, fatigue, malaise, etc. Examples of daily surveys are given in Table 8. Note that general wellbeing of the patient could be asked with an open question (project X), a drop-down list (project Y), or a smiley (project Z).

Table 8 – Example of daily surveys

Project X	Project Y	Project Z
*Vervolgens wordt dagelijks een bevraging aangeboden die de aanwezigheid en ernst van de majeure en mineure symptomen (zie Sciensano oplijsting) bevat. Hierbij worden in totaal **22 symptomen/klachten bevraagd**, gaande van verhoogde temperatuur, dyspnoe, tot diarree en dermatologische verschijnselen. Bij de **laatste vraag (vraag 23) heeft de patiënt de mogelijkheid om nog bijkomende klachten te vemelden of toelichting te geven** tot eerdere rapportering. De elementen uit de bevraging resulteren in een onmiddellijke bepaling van een risico-score (punt zero van de opvolging) maar worden ook als samenvatting doorgegeven aan de huisarts om de evaluatie te doen van de klinische toestand van de patiënt bij de aanvang van de opvolging.*	- Ervaart u kortademigheid (Borgschaal) : Op een schaal van 10 : hoe beoordeelt u uw kortademigheid : Score / Betekenis score 0 Geen kortademigheid 1 2 Milde kortademigheid (bij trappen lopen) 3 4 Matige kortademigheid (bij aankleden) 5 6 Ernstige kortademigheid (in rust) 7 8 Zeer ernstige kortademigheid (kan moeilijk spreken) 9 10 Zeer zeer ernstige kortademigheid - Heeft u koorts gehad > 38°C in de laatste 8 uren? o Ja o Neen - Hoe voel je je in het algemeen? o Uitstekend o Goed o Redelijk o Matig o Slecht - Gaat het … o Beter dan gisteren o Zelfde gevoel als gisteren o Slechter dan gisteren	Gevoel vandaag: ☹ Gevoel t.o.v. gisteren: ↗ Hoofdpijn: **Zeer veel** Duizelig: **Een beetje** G-I: **Ja**

If the platform for remote monitoring was integrated in the hospital-infrastructure, the technical support was mainly provided by hospital staff. In case the platform for remote care was delivered by an external company, the company also offered a **helpdesk** for technical issues and data quality (Table 6).

Regarding the **gathering, storage and exchange of data** it is clear that in practice the data is stored at the servers of the third parties who delivers and provides the platform, logistics and dashboard. In case a stand-alone monitoring center, the data is collected, stored, and gathered on their own servers. They also perform a specific patient intake through teleconsultation at the beginning of the RPM. If the telemonitoring platform is hospital-based, the data is not pushed to third parties and remains at the in-hospital servers.

For 3S Homecare (H3S), the data are stored in Intersysto, and accessible to the hospitals. No direct connection is made with the patient's file in hospital. But a connection is made with the healthcare networks (as RSW – Réseau Santé Wallon), meaning that data can also be accessed by caregivers (and the patient) via the healthcare networks.

The remote monitoring platform is not always linked to the patient records or in-hospital infrastructure

As stated above, five subcontracted hospital-led groupings of healthcare providers made use of the B2B services providing a platform, telemetry equipment, dashboard and logistics of Byteflies® and is called CovidCare@Home (CC@H). CC@H delivered its own telemetry equipment under the form of a V0 or V1 box (see Table 9).

The three projects located in Wallonia made use of the services provided by 3S Homecare (Intersysto). The telemetry equipment was provided by BewellConnect, and had to be purchased by the hospitals. The collaboration with BewellConnect allows to have general control on the system, including the security of the devices and the way they are paired to the app (automatic pairing). The hospital delivers the devices to the patient, and at the end of the intervention the patient returns them. 3S Homecare provides a web-based platform to the hospitals, and a separate application for patients (3S-Patient App) and care givers (3S-Staff App). Similar, also in Remecare, an app was integrated in the infrastructure of the group of healthcare providers, and could therefore be easily accessed. Note that this is not a semi-integration between the platform and patient records.

Three Flemish projects integrated and designed the platform for remote monitoring in the hospital-infrastructure, allowing to link the platform with the patient records. The telemetry equipment was bought by the hospital. Only one project provided a smartphone in case the patient did not have one. The provided telemetry devices were, according to the projects, all CE marked. Some telemetry devices were more expensive than others. An overview of the third parties and the type of telemetry devices is presented in Table 9.

The app of Remecare, BeWell and CC@H (cardiocare) are also mentioned in the e-Health validation pyramid (level 1 or 2).

Rarely an integrated electronic patient record was developed

Two projects developed an **integrated electronic patient record** in order to easily share patient characteristic data with primary care professionals (Table 9). The main disadvantage is that it took a lot of time to construct it. But there are several advantages such as primary care professionals can access the patient data (including monitoring data) easily, data arrives more structured, no need to open multiple screens, etc. It may increase work efficiency and collaboration across care lines and allow increase in quality of care. It is a complex task to provide primary care professionals access to the hospital data environment. Telecovid (part of UZA@Home) is a separate digital platform, that runs on the same servers, within the same firewall. Primary care professionals have access to all data that are collected in the care path Telecovid. Note that the hospitals only have access to the data from the GP via HUBs[c]. Sign up of patients could be done through a webpage (e.g. www.telecovid.be), email, or telephone by primary care professionals or even the patient him/herself.

[c] There are currently four hubs in Belgium, where general practitioners and specialists can share health data electronically among themselves and in a secure manner. This is done both in a hospital and in a private practice.

Table 9 – Platform manufacturer, data collection, access, and measurements collected

Platform name	Provider	Helpdesk	Data pushed in patient record, hospital	Access primary care and/or stand-alone monitoring center	Subjective parameters	Telemetry, objective parameters
My MMM	White label BeWell	In-hospital	Yes	Onboarding through website; primary care has access to platform and patient record in-hospital	Daily questionary	Saturation Smartphone (in case patient did not have one)
MY UZA	White label BeWell	In-hospital	Yes	Primary care has access to platform and patient record in-hospital	Daily questionary	Saturation (all patients) Temperature Heart rate Breathing frequency (manual) (sleep monitor)*
MY ZOL	In-hospital, HIX, chipsoft	In-hospital	Yes	Primary care has access through website	Daily questionary	Saturation Temperature Heart rate Breathing frequency (manual)
Remecare	Remecare	Remecare	Semi (App) integrated in different systems of healthcare professionals	Access through app link in patient record	Daily questionary	Saturation Temperature Heart rate Breathing frequency (manual)
H3S	H3S	H3S	No. A connection is made with the RSW that can be visualized from the hospital. Hospital have also their own access to the data	Primary care has access of TM data through the app. Also access via the platform of RSW.	Daily questionary	Blood pressure, saturation, temperature, heart rate

			on the server of H3S (in a separate window).			
CC@H	Byteflies	CC@H	No, separate window to open, patient characteristic number	Access through website	Daily questionary	V0: temperature, saturation, heart rate V1: temperature, saturation, docking station with patch for continue measurement of heart rate and breathing frequency

**Sponsored kits*

Projects made data protection agreements and constructed informed patient consents.

The patients' informed consent is mandatory for each clinical study. There are, however, numerous differences in the modalities. The Belgian law concerning experiments on the human person refers to any trial, study or research with an experimental character. It states that the patient's written informed consent is needed to participate in a trial (art. 6).[d] The information relates to the character, the circumstances, the scope, the targets, the consequences, the expected advantages, the risks linked to the trial, the identification and the advice of an Ethics Committee.[8] A confidentiality guarantee section has also to be mentioned in the informed consent form, guaranteed by the general European data protection regulations (GDPR) of 27 April 2016 (in force since 25 May 2018) and by the Belgian law of 30 July 2018.[e]

To protect personal data following GDPR written agreements were concluded between the third parties and the (subcontracted) groupings of caregivers i.e. **written data protection agreements**. In addition, the grouping of healthcare providers obtains the informed consent of the patient with respect to the telemonitoring care pathway. These **informed patient consents looked very heterogenous** on different levels.

In this study, all the projects have their own informed consent form, where all the requested information is found. They all mentioned a paragraph concerning the data, nevertheless some disparities were found, especially concerning the treatment of these data. Some projects explicitly mentioned the use of the data by the medical telemonitoring team (including physician and GP) for medical follow-up only:

> *« Uw gegevens worden ingelezen door de projectverantwoordelijke van het ZOL COVID-19 telemonitoring team. Aan de hand van deze gegevens zal het telemonitoring team uw gezondheidstoestand van op afstand kunnen volgen om zo nodig meer ondersteuning te bieden bij afwijkende waarden. De gegevens zullen uitsluitend worden gebruikt ter ondersteuning van uw medische behandeling. Enkel de (huis-)arts*

[d] Law concerning experiments on the human person 7 May 2004, Belgisch Staatsblad 18 May 2004, updated on the 16 november 2018. Available from: https://www.ejustice.just.fgov.be/cgi_loi/change_lg_2.pl?language=fr&nm=2004022376&la=F

[e] Law concerning the protection of individuals with regard to the processing of personal data 30/07/2018. Available from: https://www.ejustice.just.fgov.be/cgi_loi/change_lg.pl?language=fr&la=F&cn=2018073046&table_name=loi

en het telemonitoringteam hebben inzage in de gegevens. » (excerpt from Informed consent ZOL)

« Afin de pouvoir dispenser des soins hospitaliers adéquats au domicile du patient, le personnel HAD doit avoir accès au dossier médical du patient. le patient marque son accord pour que le personnel de l'HAD chargé de lui dispenser des soins à domicile ait accès au dossier médical qui a été constitué au sein de l'hôpital » (Excerpt from Informed consent EpiCURA)

L'ensemble des paramètres relevés ainsi que les notifications concernant votre état de santé sont transmis de façon sécurisée à un portail qui centralise les données. L'équipe pluridisciplinaire responsable du projet peut ainsi y accéder à partir d'un ordinateur localisé à la Clinique André Renard. Ce portail peut également être accessible à votre médecin traitant si vous le souhaitez. » (Excerpt from Informed consent Clinique André Renard)

Some projects explicitly mentioned the use of the data for medical follow up and research:

«Ik stem toe dat de gegevens die ik nu of later meedeel worden gebruikt zoals hieronder beschreven in het kader van mijn opvolging van een mogelijke behandeling voor Covid-19, en voor wetenschappelijk onderzoek. Met mijn toestemming via het platform geef ik uitdrukkelijk toestemming aan hen om in het kader van mijn behandeling en voor wetenschappelijk onderzoek toegang te hebben tot en gebruik te maken van de gegevens die ik via het platform invoer. » (Excerpt from Informed consent AZMM)

« Le CHWAPI veille à la protection des données privées et un contrat a été rédigé afin de garantir le respect des dispositions RGPD. L'analyse des données récoltées permettra d'évaluer l'utilité du dispositif et sa fiabilité dans la prise en charge ambulatoire. Le médecin utilise les informations recueillies par télésurveillance uniquement comme complément afin d'optimiser la prise en charge et le traitement. » (Excerpt from Informed consent CHwapi)

« Ik geef toestemming om mijn data gepseudonimiseerd te laten verwerken voor wetenschappelijk onderzoek naar telemonitoring in COVID-19 door het RIZIV » (excerpt from Informed consent Covidcare@home)

One project explicitly mentioned the use of the data by KCE.

"Aangezien dit om een pilootproject gaat van het RIZIV, delen we overeenkomstig het aangaande contract met voorgaande, volgende data met het RIZIV (Het Belgisch Rijksinstituut voor Ziekte-en Invaliditeitsverzekering) en het KCE (Federaal Kenniscentrum) voor verder onderzoek in het gebruik voor telemonitoring in de Belgische gezondheidszorg. Via de verkregen facturatiegegevens en kwalitatieve bevragingen bij alle betrokken partijen zoals voorzien in artikel 2 wordt een evaluatierapport opgesteld door een externe, onafhankelijke onderzoeksinstelling, eventueel gecoördineerd door het KCE, dat ten minste een antwoord biedt op de volgende onderzoeksvragen." (Excerpt from Informed consent Mederi)

One project did not explicitly mention the use of the data.

« Ik geef toestemming dat de resultaten van de bevraging (of eventueel meerdere bevragingen) opgeslagen worden binnen de beveiligde ICT-omgeving van het UZA. De gegevens worden aan niemand kenbaar gemaakt en kunnen op eenvoudig verzoek van patiënt verwijderd worden» (Excerpt from Informed consent UZA)

Due to the lack of uniformity in the informed consent forms and the fact that the use of the data by the KCE is not mentioned, only aggregated data per project could be analyzed, not anonymized data at patient level.

4.3.2 Focus on onboarding, patient inclusion and characteristics

Most patients were included and onboarded in a hospital setting. Rarely, a GP included, or ambulatory care nurse onboarded a patient in RPM.

Most hospitals enrolled patients in a hospital setting, providing them with instructions and the request to sign an informed consent, providing them with telemetry devices, etc. However, in one project patients can be signed up through a secured website (linked to eHealth and the in-hospital platform). However, the responsible physician did not feel comfortable not seeing the patient. Therefore, the procedure has been adjusted: patients had to come to the ED in order to be included in RPM. In the project involving primary care providers, the GPs can sign up patients to the platform and the stand-alone monitoring center monitored the patients (and performed an intake). The GPs has access to the platform for RPM and is responsible for the patient.

Most projects described two or three entrance points in their application form but in practice the focus was mostly on the post-hospitalisation traject

As described in the convention, referrals to telemonitoring are made by GPs, a coordinating doctor or by a physician-specialist. The projects outlined one or multiple onboarding trajectories. It includes **(i) point of entrance** and **(ii) a selection process of the targetted population**.

The **pre-hospitalisation trajectory** can be entered through (1) the ED of the hospital, or (2) a GP / other actor in primary care (e.g. ambulatory care nurse, gynaecologist). Few projects succeeded in the prehospitalisation trajectory.The data presented in Table 10 shows that inclusion in the pre-hospitalisation phase was rather limited compared to inclusion in the post-hospitalisation phase. One project (UZA) included more patients in the pre-hospitalisation than post-hospitalisation phase.

In the **post-hospitalisation trajectory**, the hospitalised patient can be enrolled in telemonitoring by the treating physician. The initially invisaged trajectories outlined in the application forms differed somewhat from the actually implemented trajectories, and the amount of patients enrolled. As seen in Table 10, most projects focussed in practice on the post-hospitalisation phase.

Table 10 – Number of included patients per project in the pre- and post-hospitalisation phase (data received through NIHDI)

	UZA	AZMM	HH Mol	Jan Palfijn	Mederi	Waregem	ZOL	Epicura	Chwapi	AZ St Lucas	UZ Gent	Andre Renard	TOTAL
Pre-hospitalisation phase	219	8	1	1	14	4	1	0	0	26	36	9	319
Post-hospitalisation phase	45	38	6	5	55	51	97	2	28	28	1	9	365
Total	264	46	7	6	69	55	98	2	28	54	37	18	684

Irrespectively of the entrance point, the patient should have a **confirmed COVID-19 infection** to enter telemonitoring. From the application form it was not always clear whether a positive PCR test was necessary to be included. Also, the timing of the infection was not further detailed in the convention. The data (Table 11) shows that one project did not mention (missing value) whether COVID-19 infections were confirmed, even more the data suggests that patients could be included in telemonitoring without confirmation of COVID-19 infection.

Table 11 – Number of included patients per project in the pre- and post-hospitalisation phase (data received through survey)

	UZA	AZMM	HH Mol	AZ Jan Palfijn	Mederi	OLV Waregem	ZOL	EpiCURA	CHwapi	AZ St Lucas	UZ Gent	André Renard	TOTAL
Pre-hospitalisation phase	230	9	14	1	15	7	1	0	0	22	Missing	Missing	299
Post-hospitalisation phase	45	40	11	12	55	58	97	2	28	37	Missing	Missing	385
Covid confirmed	275	49	25	13	70	64*	98	2	27*	Missing	Missing	Missing	623/684

**The received data indicates that in one patient COVID-19 was not confirmed*

No validated risk and symptom profiling scales were used for the inclusion of COVID-19 patients

Most projects included patients based on **COVID-19 screening** together with **symptom profiling** (acute presentation of symptoms related to COVID-19) and **risk profiling** of the COVID-19 infection based on parameters such as gender, age, BMI, and comorbidities (an example is given in Table 12). Although the convention asked the use of validated scales, it is shown in this example (and in the background of this report) that these scales were not (yet) available at the moment of setting up the convention, and they were rarely validated for a COVID-19 population. Initially, the 4C mortality score was published and in France, a symptom and risk profiling survey was created nationally. Also the NIHDI suggested to include a symptom and risk profiling survey (and offered an example) in the application form procedure.

It is clear that there was little known about COVID-19 and that the published scales lacked validity. The aim of the scales was to assist with the triage of the patients, often into 3 categories (mild, moderate, or high risk) especially in **the pre-hospitalisation phase**. Table 12 shows that based on the application forms the suggested scales and threshold scores for risk and symptom stratification, and consequently inclusion of patients in telemonitoring, differed across projects. Also the scoring was different, and often it is unclear why a specific scoring threshold was set out. Other projects (CC@H) used the symptom and risk stratification scale suggested by UZ Gent with 3 risk profiles coupeled to the outcome from assessements, symptoms and clinical characteristics (Figure 6). Again, it was unclear from the application forms and interviews to which degree the other CC@H projects put this into practice.

Table 12 – Example of COVID-19 screening, risk and symptom profiling (pre-hospitalisation phase) as proposed by projects.

Project	Application form: screening, risk and symptom profiling	Remarks
A	▪ Heeft u één van deze klachten? ▪ - Koorts (>38°C) of verhoogde lichaamstemperatuur (>37,4°C) ▪ - Moeilijk ademen of kortademigheid ▪ - Pijn bij het ademen ▪ - Hoesten ▪ - Niezen ▪ - Neusloop (niet: verstopte neus) ▪ - Keelpijn ▪ - Spierpijn ▪ - Grieperig gevoel ▪ - Vermoeidheid ▪ - Hoofdpijn ▪ - Verlies van reuk of smaak ▪ - Diarree ▪ Zo ja: verdacht voor COVID-19: doorgaan vragenlijst: ▪ Filter alarmsymptomen ▪ Kan u nog volledige zinnen spreken? Ja/Nee ▪ Ademt u in rust > 25 keer op een minuut?Ja / Nee ▪ …	• No positive PCR needed • COVID-19 symptoms or risk factors needed • Unclear scoring / No scoring explained
B	Vastgestelde covid-19 patiënten die voldoen aan vooropgestelde inclusiecriteria. **Inclusie vanaf een score van 3.** **Geslacht**: vrouw (**0**), zwanger (**1**), man (**1**) **Leeftijd**: >50j (**1**), >60j (**2**), >70j (**3**), >80j (**6**) **BMI**: <30 (**0**), >30 (**1**) **Symptomen**: Minstens 2 die acuut ontstaan (**2**): - Koorts (>38°C) of verhoogd (>37,4°C) - Moeilijk ademen of kortademheid - Pijn bij het ademen - Hoesten - Niezen - Neusloop (niet: verstopte neus) - Keelpijn - Spierpijn - Grieperig gevoel - Vermoeidheid - Hoofdpijn - Verlies van reuk of smaak - Diarree **Comorbiditeit**: diabetes, problemen met hart- en bloedvaten, hoge bloeddruk (**1**); niet stabiele chronische aandoeningen (**2**); actieve ernstige aandoening (**3**)	• Positive PCR test needed • COVID-19 symptoms or risk factors needed (?) (scored together, score of 3) • With this score, a person of 70 years old can be included, even when not presenting symptoms or other risk factors then age.

C

Via le poste médical de dépistage, Inclusion si
- Le patient présente une infection COVID récemment diagnostiquée (telle que définie par Sciensano).
- Le patient ayant un risque de dégradation clinique (score <7) peuvent être inclus dans le projet

Critère	Valeur patient	Score
Sexe	Femme	0
	Homme	1
Age	> 50	1
	> 60	2
	> 70	3
	> 80	6
BMI	> 30	1
Comorbidité	HTA	1
	Diabète	1
	Dialyse	1
	Hépatopathie	1
	Médication immunosuppressive	1
	Cardipathie / Pneumopathie	2
	Néoplasie Active	3

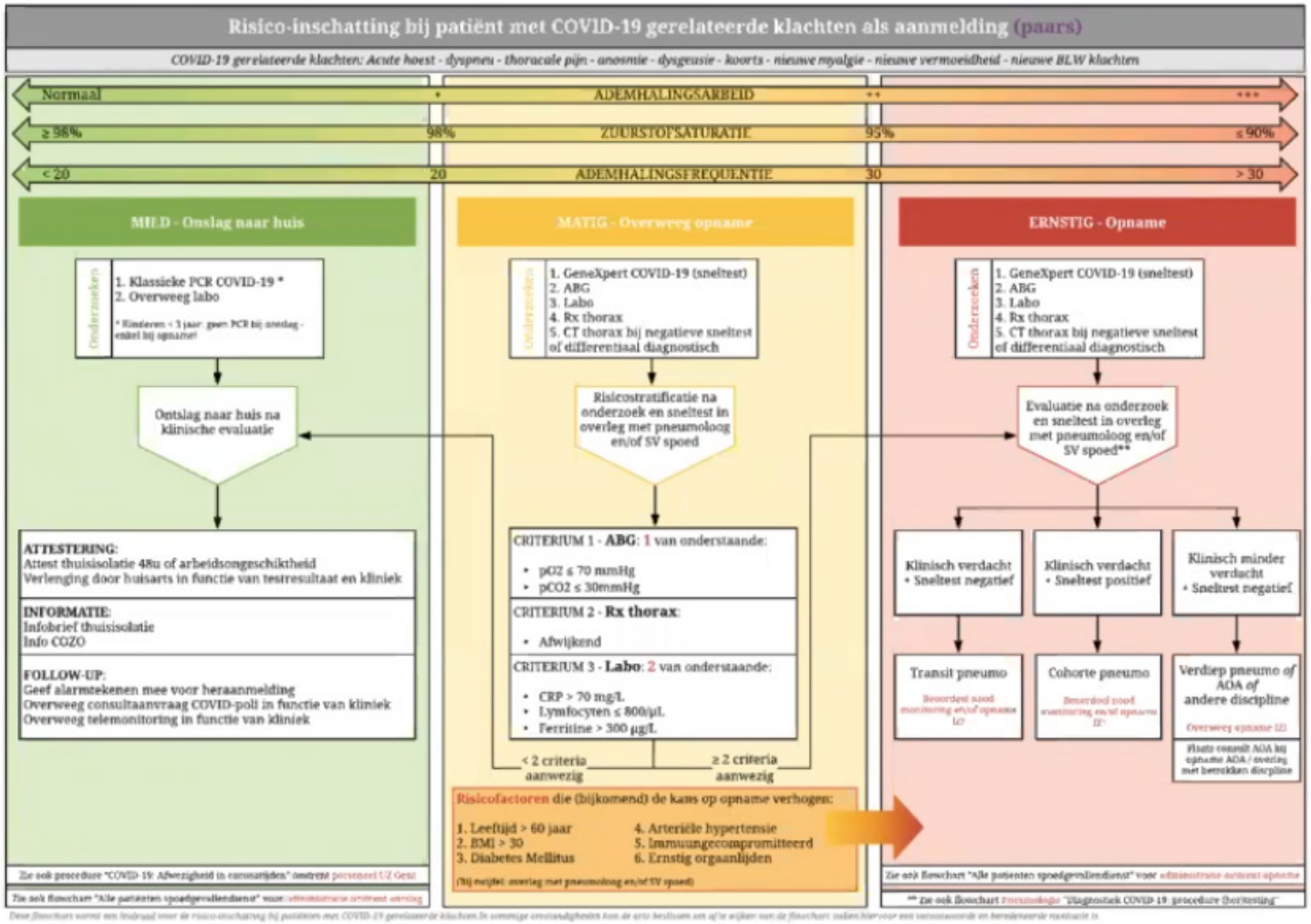
Le patient refuse de signer le consentement éclairé.
Le patient refuse une oxygénothérapie à domicile prescrite par le médecin.
Le patient souffre de troubles cognitifs sévères.
Le Patient est mineur (Sauf consentement des parents)
Le lieu de résidence du patient est insalubre.
Les personnes qui vivent sous le même toit que le patient ne sont pas immunisées et/ou pas
vaccinées (deux doses) et/ou non immunisées.
Le patient et/ou aidant proche ne possède pas d'outils connectés et/ou ne sait pas s'en servir
afin de communiquer les paramètres enregistrés.
Le patient vit seul.
Le patient souffre d'addiction pouvant altérer sa compréhension au projet
Le patient ne bénéficie d'aucune couverture mutuelle et/ou de couverture de soins de santé
La demande d'adhésion au projet émane du patient et non d'un membre du personnel médical.
Pas d'inclusions de patients la nuit et le Week-end.

- No positive PCR test needed
- COVID-19 symptoms or risk factors needed (?) (scored together, score of less then 7)
- With this score, every patient can be included except patients with mild to severe risk profile / symptoms as the score should be below 7.

The use of different scales across projects has important implications as in theory totally different patients could be (not) included in these telemonitoring interventions. For example, a male person of 81 years old will receive score 7 in both project B and project C. Although the person does not present any symptoms or comorbidities, the person can be followed up at home by B but cannot be included in project C. On the other hand, a 30 year old female with fever, pain during coughing, sneezing, dyspnea, soar throat, headache, anosmia, other symptoms but no other comorbidites, cannot be included in project B but can be included in project C.

From the document analyses together with the interviews, we learned that in case the projects implemented what they described in their application form, the included patients will differ significantly and cannot be compared across the 12 projects. Most projects gave (more) importance to symptom profiling and/or risk profiling in the pre-hospitalisation phase compared to the post-hospitalisation phase. Consequently, we will not be able to assess the effectiveness of the intervention. During the exploratory interviews with the projects, it became clear that across time, they were applying other risk stratification tools or symptom stratification (red flags) as for example outlined in the KCE ambulatory COVID-19 tool, then initially proposed. It has to be taken into account that with the context of the COVID-19 pandemic the knowledge was also increasing and together with increase in experience, teams were changing their assessments and care paths.

Figure 6 – Example of symptom and risk stratification for patients arriving at ED, modified for COVID-19



Note that no specific risk profiling scales were suggested in the application forms for the patients in the **post-hospitalisation phase**. There were no clear inclusion criteria based on valid scales to include patients in the post-hospitalisation phase. During the exploratory interviews projects indicated that they included patients in the post-hospitalisation phase based on e.g. relieve of most symptoms such as fever but patient is afraid to go home, or physicians indicating that they were more at ease to discarge patients earlier (to increase bed capacity) if they knew they could detect for plausible deterioration (since the course of the disease was relatively unknown). Onboarding of patients who were hospitalized for COVID-19 symptoms and/or complaints was experienced to be more easy for the healthcare professional as well as for the patient. As the patient was recovering and there was already a therapeutic relation, the healthcare professionals were more at ease. Often patients were onboarded in-hospital and they could practice the use of telemonitoring while being hospitalized. In most projects, the physician informed the patient and assigned nurses (trained for that purpose) to provide the patient with instructions. The nurses enrolled hospitalised patients providing them with information on telemonitoring asking to sign the informed consent form. They also helped patients with the installation and use of the telemonitoring application, filling out the survey, and conduct telemetry measurements before discharge.

In the survey data, four projects indicated the use of a **risk profiling score** measurement tool (Appendix 2.9.3). However, only two projects provided data on risk classification of their included population (4-item scale). In UZA, either in pre- or post-hospitalisation phase, there was a majority of high-risk patients (78.3% and 86.7% respectively). While in the post-hospitalisation phase in CHwapi, only one patient (3.6%) was classified as high-risk, and 46.4% of patients were classified in the no-risk category. The observation that especially in the post-hospitalisation phase low risk patients were included could possibly be explained by the fact that telemonitoring was suggested for reassurance and decrease patient anxiety at discharge.

Other reasons not to include patients in telemonitoring apart from symptom and risk profiling

The number of patients to whom the telemonitoring intervention was proposed was generally lower than the number of patients admitted to the ED and/or the number of hospitalized patients. From the survey we learned that from all included patients 6 066 (ranging from 157 to 3679 across projects) have been admitted to the ED and 2 623 (ranging from 70 to 516 across projects) have been hospitalised. This is on average 328 patients per project (see Appendix 2.7). The average number of patients transferred from another hospital is 19 (ranging between 3 and 31). The number of transfers does not explain why the number of hospitalized patients is in some projects higher than the patients who visited the ED.

Besides symptom and risk profiling and need for hospitalisation, reasons to not propose intervention such as lack of digital literacy, the lack of a smartphone (in only one project a smartphone could be provided), language barriers, comorbidities or symptoms such as dementia, blindness or confusion, lack of motivation of the patient, lack information on telemonitoring (e.g. not enough resources, lack of education for GPs, (des)information), organisational barriers (e.g. no (link with) patient records, no coordinating nurse) were mentioned. The number of patients accepting the telemonitoring intervention was equal or less (ranging between 22 and 130) than the number of patients to whom the intervention was proposed. Reasons were a lack of motivation, too much work for the patient, patients' preference to be followed by a GP, and having the feeling telemonitoring is not necessary. In one project, a patient was included in the intervention (n=15), but did not accept the intervention in the end as data were only reported on 14 patients in the pre-hospitalisation phase (Table 11). The reason for this is unclear.

Overall, slightly more patients were included in the post-hospitalisation phase, but in most projects post-hospitalisation patients were included, as more than 70% of the pre-hospitalisation patients were included in one and the same project.

Based on the NIHDI data in Table 10, 684 patients were included across the 12 telemonitoring projects.

In the **pre-hospitalisation phase**, on the total of 319 patients, UZA included the highest number of patients (69% of patients, n=219). In the remaining 11 projects, the number of included patients is lower than 36. Three of them only included 1 patient and two of them did not include any patient.

In the **post-hospitalisation phase**, on a total of 365 patients, one project included 97 patients, four projects included between 38 and 55 patients, and two projects included 28 patients. Five projects included less than 10 patients.

Based on the survey data (Table 11), 684 patients were included across 12 telemonitoring projects.

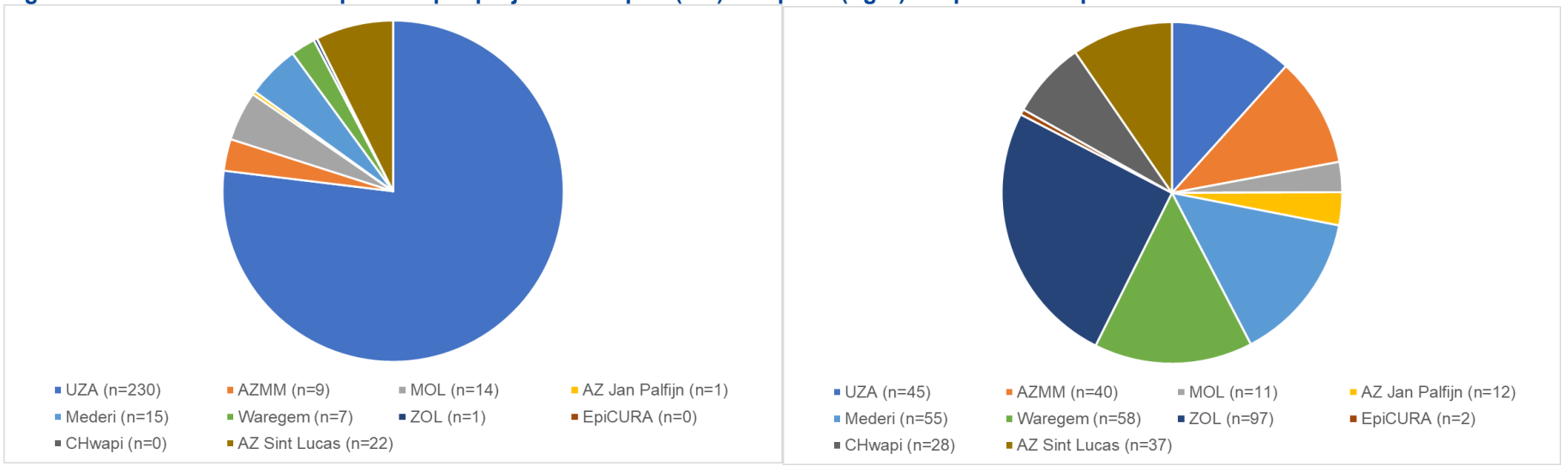
In the **pre-hospitalisation phase**, on a total of 299 patients, UZA included the highest number of patients (77%, n=230). The number of included pre-hospitalisation patients in the other projects varied between 0 and 22 (n=70; 23%).

In the **post-hospitalisation phase**, on a total of 385 patients. The number of included post-hospitalisation patients varied between 2 and 99 patients across 10 projects.

A visualisation of the included patients based on the survey data is given in Figure 7

Note that one project did not deliver further details on 22 pre-hospitalisation 37 post-hospitalisation patients. Thus, the survey data that will be discussed further in this report is related to 625 patients included in 9 out of 12 projects.

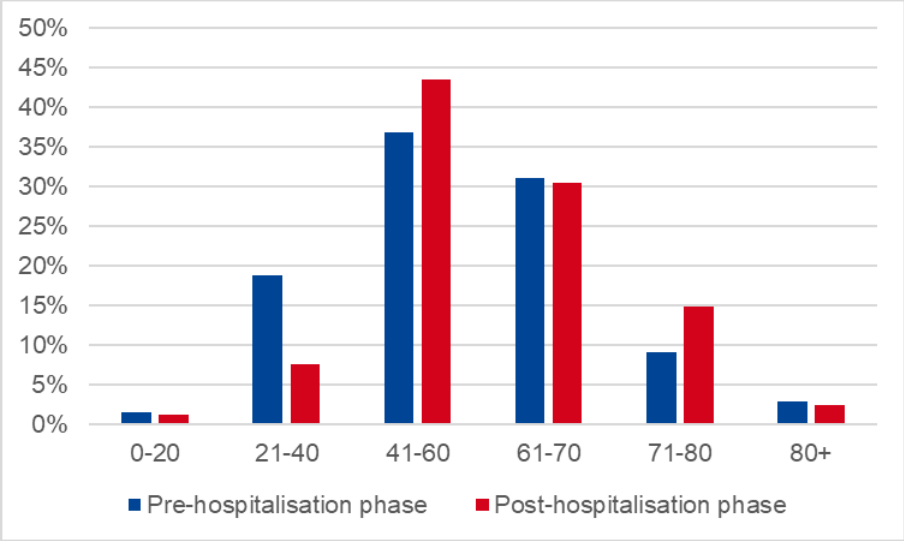
Figure 7 – Number of included patients per project in the pre- (left) and post- (right) hospitalisation phase



Slightly more male patients were included, especially in the post-hospitalisation phase. Patients in the pre-hospitalisation phase were generally younger.

Across projects and trajectories, 53.4% males were included (46.2% pre-hosp; 59.1% post-hosp). In the pre-hospitalisation phase, the patients were generally younger compared to the patients included in the post-hospitalisation phase (Figure 8). Most patients spoke Dutch or French, 13.1% spoke another language (across 6 projects). In terms of geographical reach patients can come from another province then where the project was located. The included patients were not only living at home but could also be residing at a nursing home or another facility. They had several levels of education ranging from a primary school degree to a high school or university degree. Some patients could make use of an increased allowance. Note that data on patient characteristics were too scarce to draw firm conclusions. For more detailed information, we refer to Appendix 2.8.

Figure 8 – Percentage of patients per age category in pre- and post-hospitalisation phases



Data received on symptoms and comorbidities of included patients were scarce.

Data regarding **the symptoms** patients presented were incomplete. Based on one project, the most presented symptoms in the **pre-hospitalisation phase** were coughing (80.4%), fever (49.6%), anosmia or hyposmia (46.1%), increased respiratory rate (33.9%), headache (28.7%), and abdominal pain (17.8%). Symptoms such as tachycardia, diarrhoea, altered consciousness, desaturation, decreased systolic blood pressure, and dehydration or hypovolemia occurred in less than 10% of the patients.

For the symptoms presented by the patients in the **post-hospitalisation phase**, we received data from six projects (but not on all included patients). Coughing is the predominant symptom presented between 14% and 100% of patients across the six projects (and in more than 50% of the patients in four projects). This is followed by headache (17.8%-100%), tachycardia (6.2%-35.6%), anosmia or hyposmia (1.0%-100%), increased respiratory rate (2.1%-32.1%), diarrhoea (2.1%-15.5%), altered consciousness (0%-13.3%), and fever (0%-62.1%). Abdominal pain, desaturation, and decreased systolic blood pressure were present in less than 10% of the patients across the projects who filled out the survey. Some projects did also list other symptoms such as fatigue, asthenia, decrease of appetite, and joint pain.

A more detailed description and overview of the number of patients presenting symptoms in both phases per project can be found in Appendix 2.9.1.

Also regarding **comorbidities** the data we received was incomplete. Based on one project in the **pre-hospitalisation phase,** 61.7% of the patients were obese. The comorbidities hypertension, diabetes type I/II, cardiac disorders, neurological disease and severe immunosuppression were presented in 10.4% to 16.5% of the patients. Some patients (less than 10%) presented chronic pulmonary disease, kidney disease, haematologic disease or active cancer, or chronic liver disease.

For the comorbidities presented by the patients in the **post-hospitalisation** phase, seven projects replied (but not on all included patients). Most reported comorbidities are obesity (8.6%-100%), hypertension (1.7%-50%), diabetes type I/II (12.5%-50.9%), chronic pulmonary disease (1.7%-21.8%), cardiac disorders (3.4%-20.0%), and severe immunosuppression (1.8%-17.8%). Comorbidities such as kidney disease, haematologic disease or active cancer, neurological disease, and chronic liver disease were reported in less than 10% of the patients. In two projects, 19.6% and 27.5% of the patients did not present comorbidities and in one project 35.1% presented other comorbidities such as hypercholesterolemia, sleep apnoea with a normal CPAP, rheumatoid arthritis, hypothyroidism, and depression.

A more detailed description and overview of the comorbidities of the included patients in both phases per project can be found in Appendix 2.9.2.

The survey data suggest that post-hospitalisation patients were often onboarded on the COVID-19 unit after a stay at ICU.

Most patients were hospitalised in a unit for COVID-19 before entering telemonitoring (Appendix 2.9.4). Some patients were admitted to ICU during their hospital stay, ranging from 12.7% to 50%, with a medium interval between 4 and 10 days. Duration of stay at ICU was on average ranging between 5.6 days and 13.2 days. Patients staying at the Antwerp University Hospital had on average a longer ICU stay. The calculated average duration of hospital admission ranged between 7.8 and 12.1 days.

Paracetamol and NSAID (especially pre-hosp) and thromboprophylaxis (especially post-hosp) were often administered or prescribed. Both in the pre-hospitalisation phase as well as in the post-hospitalisation phase patients were provided with oxygen therapy when returning to home.

In the pre-hospitalization phase, based on available data of one project, 87% of the patients received paracetamol or NSAID, followed by thromboprophylaxis (21.3%), corticoids (4.8%), and antibiotics (2.6%). Patients can be discharged with oxygen therapy. Data from the same project indicated that 29 patients (12.6%) received oxygen therapy during 4 to 19 days (10.2 days on average).

In the post-hospitalization phase, there is data on 5 projects administering thromboprophylaxis, however 4 projects administered this medication to almost all patients (92.9%-100%) while one project only offered thromboprophylaxis in nearly 20% of the patients. Paracetamol or NSAID was administered in 10.7% to 67% of the patients included in 4 projects. Corticoids and antibiotics were given in 6.7%-49.1% and 0-36.1% of the patients respectively across 4 projects. There is data of 4 projects discharging 9 (20%), 48 (87.3%), 37 (38.1%) and 4 (14.3%) patients with oxygen therapy up to 39 days (between 7.2 and 11.3 days on average)(note that data on oxygen therapy duration of one project including 4 patients was missing).

Notable, 3 projects in the post-hospitalization phase indicated to offer another form of therapy to 80 (82.5%), 1 (50%), and 22 (78.6%) patients. No details on the medication or therapy were asked.

An overview of the available data on treatment and duration of oxygen therapy is added in Appendix 2.10.

4.3.3 Focus on the process of remote monitoring

By the NIHDI, validated medical protocols to define the care path for patients with COVID-19 in telemonitoring, approved by (inter)national scientific associations, were requested. By analogy with the diversity in used symptom and risk stratification tools, different scales were proposed to set thresholds for patient monitoring (Figure 9). Most projects provided a minor or major adjustment of the (N)EWS score. The modifications imply that many different parameters and thresholds were applied.

Figure 9 – Alarm thresholds proposed for remote patient monitoring in COVID-19

APPENDIX 1: ALARMDREMPELS THUISMONITORING SYSTEEM PRE-HOSPITALISATIE

Ademhalingsfrequentie: normaal 12-20/min Tussen 20-25/min: nieuwe meting na 1 u > 25/min of 2x > 20/min: contacteer arts	**Hartfrequentie in rust:** Normaal 51-90/min 91-130/min: nieuwe meting na 1u > 130/min of 2x >110: contacteer arts 40-50/min: nieuwe meting na 1u < 40 of 2x < 50: contacteer arts
Zuurstofsaturatie: Normaal: 98% 95-97%: nieuwe meting na 1u < 95% of 2de meting < 98%: contacteer arts	**Temperatuur** Normaal 35-38°C > 39 °C of < 35°C: co na 1 u Zo 2x > 39°C of < 35°C : contacteer arts
Deze alarmdrempels kunnen op individuele basis worden gewijzigd op advies van de artsen van het telemonitoringteam.	

PARAMETERS	3	2	1	0	1	2	3
Age				<65			≥65
Respiration Rate	≤8		9-11	12-20		21-24	≥25
Oxygen Saturations	≤91	92-93	94-95	≥96			
Any Supplemental Oxygen		Yes		No			
Systolic BP	≤90	91-100	101-110	111-219			≥220
Heart Rate	≤40		41-50	51-90	91-110	111-130	≥131
Consciousness				Alert			Drowsiness Lethargy Corona Confusion
Temperature	≤35.0		35.1-36.0	36.1-38.0	38.1-39.0	≥39.1	

Score	3	2	1	0	1	2	3
AH-freq. (p/min)	<7			9-20	20-25	25-30	>30
Saturatie (SPO2)		<95%	95-97%	>98%			
Temp. °C	<34	34-34.9	35-35.9	35-38	38-38.9	>38.9	
Hartfreq (F/min) in rust	<30	30-39	40-49	51-90/min	91-129	129	>129

Chart 1: The NEWS scoring system

Physiological paramete r	Score 3	2	1	0	1	2	3
Respiration rate (per minute)	≤8		9–11	12–20		21–24	≥25
SpO_2 Scale 1 (%)	≤91	92–93	94–95	≥96			
SpO_2 Scale 2 (%)	≤83	84–85	86–87	88–92 ≥93 on air	93–94 on oxygen	95–96 on oxygen	≥97 on oxygen
Air or oxygen?		Oxygen		Air			
Systolic blood pressure (mmHg)	≤90	91–100	101–110	111–219			≥220
Pulse (per minute)	≤40		41–50	51–90	91–110	111–130	≥131
Consciousness				Alert			CVPU
Temperature (°C)	≤35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	

Some projects proposed to use different thresholds for the pre-hospitalisation versus post-hospitalisation phase (Figure 10). Breathing frequency and heart rate in rest had similar thresholds while temperature could be higher (worse) and oxygen saturation had to be higher (better) in post-hospitalisation.

Figure 10 – Alarm thresholds proposed for remote patient monitoring in COVID-19 pre-hosp (left) versus post-hosp (right) phase

PRE-HOSPITALISATION		POST-HOSPITALISATION	
Ademhalingsfrequentie: Normaal 12-20/min Tusssen 20-25/min: nieuwe meting na 1u >25/min of 2 x >20/min: contacteer arts	**Hartfrequentie in rust:** Normaal 51-90/min 91-130/min: nieuwe meting na 1u >130/min of 2 x 110: contacteer arts 40-50/min: nieuwe meting na 1u <40 of 2x 50: contacteer arts	**Ademhalingsfrequentie:** Normaal 12-20/min Tusssen 20-25/min: nieuwe meting na 1u >25/min of 2 x >20/min: contacteer arts	**Hartfrequentie in rust:** Normaal 51-90/min 91-130/min: nieuwe meting na 1u >130/min of 2 x 110: contacteer arts 40-50/min: nieuwe meting na 1u <40 of 2x 50: contacteer arts
Zuurstofsaturatie: Normaal: >95% 92-95%: nieuwe meting na 1u <92% of 2de meting <95%: contacteer arts	**Temperatuur:** Normaal 35-38°C >38.2°C of <35°C: co na 1 u Zo 2x >38.2°C of >35°C: contacteer arts	**Zuurstofsaturatie:** Normaal: >95% 95-97%: nieuwe meting na 1u <95% of 2de meting <98%: contacteer arts	**Temperatuur:** Normaal 35-38°C >39°C of <35°C: co na 1 u Zo 2x >39°C of >35°C: contacteer arts

Alarm thresholds were often adjusted and individualized to avoid alarm tiredness

In practice, however, alarm thresholds had to be adjusted for many patients, for reasons such as comorbidities or other patient characteristics, especially in order to avoid 'alarm tiredness'. Physicians need to adapt their alertness to the health profile of individual patients. Since validated assessment scales to set thresholds were lacking, the thresholds set were highly project and patient dependent. The outcomes of telemonitoring depend on the individual thresholds and actions set. Thus, more alarms do not necessarily mean more deteriorated patients. Therefore, no possible conclusions on effectiveness of telemonitoring could be drawn based on number of alarms evoked during the intervention.

Since patients manually register their parameters in the app (discontinuous measurements, not-connected telemetry) several times a day, telemonitoring teams were often confronted with incorrect measurements. In case a (semi-)connected telemetry and continuous measurement of breathing frequency and heart rate was provided, the data could contain a lot of noise.

In the survey, four projects indicated they individualized the alarm threshold for 131, 6 (saturation threshold adjusted), 2 (temperature and saturation threshold adjusted) and 1 patient (saturation threshold adjusted). Data on other projects was missing.

The follow-up of the telemonitoring team was mostly based on trends across measuring points, instead of individual alarms.

Most telemonitoring teams had different care pathways and actions implemented depending on green, orange or red alarms (emergency procedures). Telemonitoring teams mostly watch clinical trends in the data. The most important parameters to be watched as mentioned in the exploratory interviews were **saturation and temperature**. The third phase of the COVID-19 pandemic was characterized by patients looking clinically stable but in fact having a low saturation, also called 'silent hypoxia'. These patients were especially present in the pre-hospitalisation phase. These patients suddenly deteriorated, they seemed clinically stable in the morning

and were admitted to ICU to be intubated in the afternoon. In addition, a sudden increase in temperature can be an indication of a (bacterial) sur-infection for which antibiotics are needed.

Not all projects provided the patient with a passive feedback system after filling out the measurements. Some projects opted for an active communication between the team and the patient.

In most projects **a feedback system towards the patient** was implemented e.g. the patient gets to see a green (indicating thresholds are fine), orange (indicating measurement should be repeated within one hour) or red screen (contact number of telemonitoring team, GP or ED). In these projects a 'no news is good news' strategy was used. In some projects however, no feedback system was implemented because the telemonitoring team experienced that the feedback caused anxiety and that consequently patients contacted the telemonitoring team more often. These projects opted for a more active communication between the telemonitoring team and the patient and vice versa, as the telemonitoring team provided feedback through text messages up to 5 times a day (e.g. UZA). Patients could also text back at any moment. An example of communication through text is 'We notice you feel more tired than yesterday, is it because you were more active'?

Moreover, sometimes the telemonitoring team contacted the patient (often by telephone) to verify some clinical signs of plausible deterioration or to verify plausible technical errors. Also video consultation was used to verify clinical signs or to make shared decisions on medication and follow-up.

Several projects relied on the principle 'no news is good news', but applied also active communication in case of alarms or a deteriorating trend. Most projects used the telephone when needed, but other projects also implemented and used videoconferencing in their platform.

Most telemonitoring teams used the telephone to communicate with patients (teleconsultation), especially to verify technical problems, deteriorated parameters, missing values etc. Through the phone healthcare professionals can hear whether the patient is suffering from dyspnoea or tachypnoea. However, patients may not pick up the phone or let an informal caregiver answer in their place. Therefore, in some projects, a secured base for conducting **videoconferencing** was integrated in the platform. Patients received an automated meeting request sent by the platform. Other physicians, as well as the GP could also sign in as there was room for 4 participants. Moreover, through screen sharing patient records' could be viewed by several doctors for shared decision making. The most important value of videoconferencing however was that the patient's condition can be evaluated on sight. As outlined before, the clinical view of the patient was considered important in this relatively unknown disease. The videoconferencing system was integrated in the platform and the platform was integrated in the patient records, facilitating access and sharing of patient records.

The integration of the telemonitoring platform in the patient record software facilitated the registration of parameters and performed actions.

As shown in the example above, some projects invested a lot work and time to link the **electronic patient record** with the telemonitoring platform. The result however was an integrated in-house system that could also be used by primary care. Advantages reported during exploratory interviews were accessibility for primary care givers, structuration of the data, user friendliness (e.g. there is no need to open other windows to consult patient records) etc. The integrated platform may increase work efficiency and collaboration between primary and secondary care providers. In another project, an app was integrated in the different platforms of the group of healthcare providers. They could easily click on the app in their own system to verify a patient. In CC@H, due to time constrains the system was not integrated in the hospital's patient records. The data was not retrieved automatically into the hospital's patient record and patient information could not be consulted at a glance.

Most projects did not systematically register the actions of the telemonitoring team.

The telemonitoring teams did not have **a logbook** in which every action taken was systematically noted. Most in-hospital initiated projects took certain notes in the patient record. In case the patient record was linked to the platform the measurement data were directly pushed into the patient record and healthcare practitioners could easily switch between applications and take notes.

In contrast, when the follow-up was outsourced to a stand-alone monitoring center, a logbook was carefully kept listing all actions taken. In case the platform was integrated through an app, all healthcare professionals involved in the telemonitoring of a patient could access the data of the patient, through the app. In case the platform was not linked to the patient records, the notes had to be taken in the patient record and the measurements had to be extracted towards the patient record after follow-up.

Not all patients got telemetry devices

Six projects provided telemetry devices to all included patients, while two projects indicated to provide respectively 44.4% and 48.7% (54% of the pre-hosp patients) of the pre-hospitalisation patients, and 72.5% and 100% of the post-hospitalisation patients with telemetry devices. The other patients were followed only by means of a survey (Table 13)

Table 13 – Number of patients receiving telemetry devices during the pre- and post-hospitalization phase

Number of patients	UZA	AZMM	HH Mol	AZ Jan Palfijn	Mederi	OLV Waregem	ZOL	EpiCURA	CHwapi
Pre-hospitalization phase	112 (48.7%)	4 (44.4%)	14 (100%)	1 (100%)	15 (100%)	Missing	1 (100%)	NA	NA
Post-hospitalization phase	45 (100%)	29 (72.5%)	11 (100%)	12 (100%)	55 (100%)	Missing	97 (100%)	2 (100%)	28 (100%)

Patients registered subjective as well as objective parameters. The frequency of measurement varied depending on the phase, the parameter and the project.

An overview of the registered parameters and the frequency of registration (expressed in times a day) is given in Table 14 for both phases. The frequency of the measurements varies (from 0 to 5 times per day) between projects for the same parameter and within a project depending on the phase or the parameter. Temperature, saturation, and subjective health status were followed by all projects for which data was available. One project did not register heart rate, and two projects did not register respiratory rate both in the post-hospitalization phase. Two projects did not register blood pressure in both phases. One project also applied a sleep monitor.

Note that during follow-up, and depending upon symptom presentation and risk stratification, the frequency of measurement could be adjusted as well as which parameters to measure.

Table 14 – Parameters and frequency of measurement during the pre- and post-hospitalization phase

Number of patients	UZA		AZMM		HH Mol		AZ Jan Palfijn		Mederi		Waregem		ZOL Genk		EpiCURA		CHwapi	
	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-	Pre-	Post-
Temperature	3	1	Missing		3	3	3	3	1	2	3	3	3	3	NA	3	NA	2
Heart rate	5	5	Missing		3	3	3	3	2	2	3	3	3	3	NA	0	NA	2
Peripheral oxygen saturation	5	5	Missing		3	3	3	3	2	2	3	3	3	3	NA	3	NA	2
Respiratory rate	5	5	Missing		2	2	3	3	2	2	3	3	3	3	NA	0	NA	0
Blood pressure	0	0	Missing		2	2	0	0	Missing		Missing		Missing		NA	3	NA	2
Subjective health status (via Questionnaire)	1	1	Missing		3	3	1	1	2	2	1	1	3	1	NA	3	NA	2
Detail other parameter	NA	Sleep monitor	Missing		Missing		Missing		NA		Missing		Missing		NA	NA	NA	Missing

Improvement of the patients' clinical status was the main reason to stop telemonitoring.

In the convention it is stipulated that discontinuation of telemonitoring is done in consultation with the GP and in function of the clinical course of the acute infection.

The main reason to stop telemonitoring in 82.2%-100% and 62.9%-100% of the patients in respectively the pre-hospitalisation and post-hospitalisation phase was the improvement of the patients' clinical status to the point where telemonitoring was no longer needed (Table 15 and Table 16).

Other reasons to stop monitoring in the pre-hospitalisation phase were patient request (15.2%, 1 project) and hospital admission (2.9%, 2 projects). Other reasons to stop monitoring in the post-hospitalisation phase were patient request (1.6%, 4 projects), death (1 patient (2.2%), 1 project), and hospital readmission (5.6%, 5 projects). In three projects, 1 (3.6%), 3 (5.2%) and 33 (34%) patients stopped measuring parameters by themselves.

Table 15 – Reasons to stop telemonitoring in the pre-hospitalisation phase

Number of patients	UZA (230 patients)	AZMM (10 patients)	HH Mol (14 patients)	AZ Jan Palfijn (1 patients)	Mederi (15 patients)	OLV Waregem (7 patients)	ZOL (1 patients)	EpiCURA (0 patients)	CHwapi (0 patients)
Improvement of the clinical status to the point where telemonitoring is no longer necessary.	189 (82.2%)	Missing	14 (100%)	1 (100%)	14 (93.3%)	7 (100%)	Missing	NA	NA
Admission to hospital	6 (2.6%)	Missing			1 (6.7%)		Missing	NA	NA
Death	0	Missing					Missing	NA	NA
Patient's request	35 (15.2%)	Missing					Missing	NA	NA
No more records		Missing					Missing	NA	NA

Table 16 – Reasons to stop telemonitoring in the post-hospitalisation phase

Number of patients	UZA (45 patients)	AZMM (99 patients)	HH Mol (11 patients)	Jan Palfijn (12 patients)	Mederi (55 patients)	Waregem (58 patients)	ZOL (97 patients)	EpiCURA (2 patients)	CHwapi (28 patients)
Improvement of the clinical status to the point where telemonitoring is no longer necessary.	42 (93.3%)	Missing	11 (100%)	12 (100%)	51 (92.7%)	59	61 (62.9%)	2 (100%)	24 (85.7%)
Admission to hospital	1 (2.2%)	Missing			3 (5.5%)	6 (10.3%)	3 (3.1%)		3 (10.7%)
Death	1 (2.2%)	Missing							
Patient's request	1 (2.2%)	Missing			1 (1.8%)	1 (1.7%)	1 (1.0%)		
No more records		Missing				3 (5.2%)	33 (34.0%)		1 (3.6%)

It is possible that the numbers do not correspond to the number of patients per project due to missing data or coding errors.

Gradual improvement of the patients' clinical status was most reported outcome of telemonitoring

The most reported outcome of telemonitoring was a gradual improvement of clinical status. In case of a deteriorating clinical status, distinction was made between deterioration needing an emergency (or GP) visit or needing hospitalisation. In prehospitalization phase, in Table 17, there are 2 projects for which all the included patients showed no improvement nor deterioration.

Telemonitoring was stopped because patients were considered 'stable'. In UZA, in 1.3 % of the patients no improvement or deterioration was seen. Gradual improvement was the most encountered outcome ranging between 87.4% - 100% of the patients. Deterioration was marked for 26 patients (11.3%) in UZA, among which 6 needed hospitalisation. Moreover, one patient (6.7%) in Mederi needed to be hospitalised too. There were no deaths reported in the pre-hospitalisation phase.

Table 17 – Outcome of telemonitoring in the pre-hospitalisation phase

Number of patients	UZA (230 patients)	AZMM (10 patients)	HH Mol (14 patients)	Jan Palfijn (1 patients)	Mederi (15 patients)	Waregem (7 patients)	ZOL (1 patients)	EpiCURA (0 patients)	CHwapi (0 patients)
No improvement (or deterioration)	3 (1.3%)	Missing	14 (100%)			Missing	1 (100%)	NA	NA
Gradual improvement	201 (87.4%)	Missing		1 (100%)	14 (93.3%)	Missing		NA	NA
Deterioration without hospitalisation (but visit to the GP or to emergency ward)	20 (8.7%)	Missing				Missing		NA	NA

In the post-hospitalization phase (Table 18), three projects reported no improvement for 37 patients. The high number (n=35) reported in one project might be explained by the fact that 20 patients were telemonitored less than 1 day, and 20 patients between 1 and 3 days.

Gradual improvement was mainly seen in the post-hospitalisation phase and reported for 50%-100% of the patients. Clinical deterioration was reported in 19 patients across 7 projects. In 8 patients across 4 projects no hospitalization was needed. One patient died, and 10 patients needed to be hospitalized across 5 projects.

Table 18 – Outcome of telemonitoring in the post-hospitalisation phase

Number of patients	UZA (45 patients)	AZMM (99 patients)	HH Mol (11 patients)	AZ Jan Palfijn (12 patients)	Mederi (55 patients)	OLV Waregem (58 patients)	ZOL (97 patients)	EpiCURA (2 patients)	CHwapi (28 patients)
No improvement (or deterioration)	1 (2.2%)	Missing			1 (1.8%)	Missing	35 (36.1%)		
Gradual improvement	40 (88.9%)	Missing	7 (63.6%)	12 (100%)	50 (90.9%)	Missing	59 (60.8%)	1 (50.0%)	25 (89.3%)
Deterioration without hospitalisation (but visit to the GP or to emergency ward)	2 (4.4%)	Missing	4 (36.4%)		1 (1.8%)	Missing		1 (50.0%)	

Outcomes towards death and (re)hospitalisation were similar to “reasons to stop telemonitoring” (see above).

The average length of telemonitoring was longer in the pre-hospitalisation phase (16.6 days) compared to the post-hospitalisation phase (12.3 days)

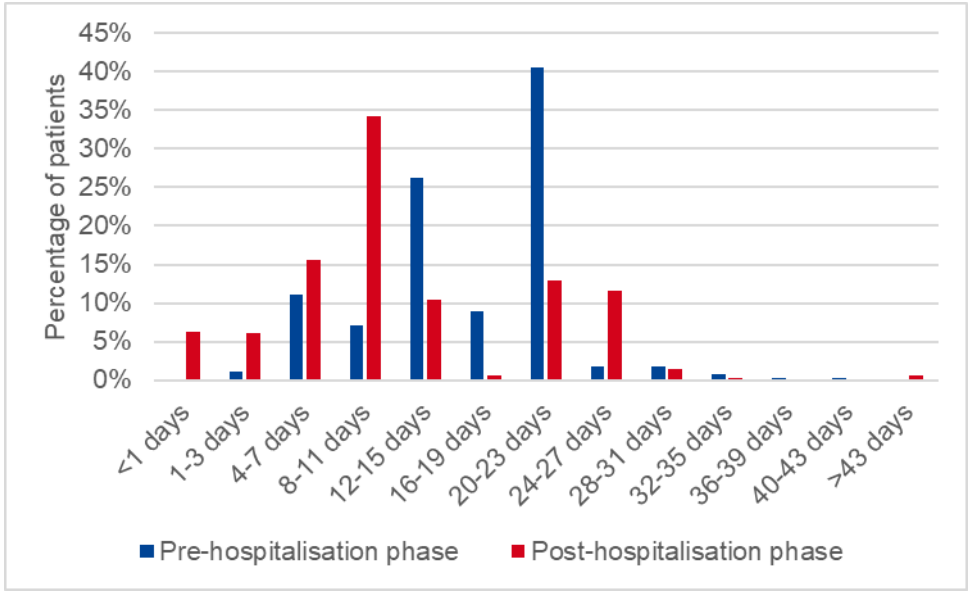
The NIHDI foresees a contribution fee per patient (see Table 2) during 21 days (3 weeks) in prehospitalization phase, and until 42 days (6 weeks) in post-hospitalisation phase (3 weeks with telemetry and 3 weeks without telemetry).

In the pre-hospitalisation phase and post-hospitalisation phase the average length of telemonitoring across all projects and patients was respectively 16.6 and 12.3 days (see Table 19, Table 20, Figure 11).

In the pre-hospitalisation phase, about 54.5% of the cohort were telemonitored less than 20 days, for 40.5% of the cohort the length of telemonitoring was between 20-23 days, and for 5% more than 23 days. In post-hospitalisation phase, we can see 2 different peaks in the graph, the first in the interval 8-11 days and the second in the interval 20-27 days.

The length of the pre-hospitalisation phase is mainly influenced by the patients from UZA (77%). As also indicated on their website, they foresee 21 days 'standard' follow-up of the patients in the pre-hospitalisation phase. They indicated that there is a peak often at day 5-7 of the infection. The symptoms can be present longer, and the critical phase lasts up to 21 days. The follow-up can be stopped earlier at patient request. It also happened that patients wanted to be followed longer than 3 weeks (especially when there are persisting symptoms that could evolve to long-covid).

Figure 11 – Visualisation of the duration of telemonitoring for the pre- and post-hospitalisation phase



The calculated average length of follow up in the pre-hospitalisation phase for 3 projects describing 230, 14, and 7 patients was respectively 17.8, 6.1 and 11.2 days. In the two other projects, each describing one patient, the patient was followed between 40-43 days and 1-3 days (Table 19).

Table 19 – Length of telemonitoring in the pre-hospitalisation phase

Number of patients	UZA (230 patients)	AZMM (9 patients)	HH Mol (14 patients)	AZ Jan Palfijn (1 patients)	Mederi (15 patients)	OLV Waregem (7 patients)	ZOL (1 patient)	EpiCURA (0 patients)	CHwapi (0 patients)
<1 days	0	0						NA	NA
1-3 days	0	0	1		1		1	NA	NA
4-7 days	12	5	10		4			NA	NA
8-11 days	8	3	3			6		NA	NA
12-15 days	68	2			3			NA	NA
16-19 days	25							NA	NA
20-23 days	107				5	1		NA	NA
24-27 days	5							NA	NA
28-31 days	2				3			NA	NA
32-35 days	2							NA	NA
36-39 days	1							NA	NA
40-43 days				1				NA	NA
>43 days								NA	NA
Average	Missing	Missing	Missing	Missing	16.1	Missing	3	NA	NA
Calculated average	17.8	8.3	6.1	41.5	16.3	11.2	2.0	NA	NA

It is possible that the count does not correspond to the number of patients per projects due to missing data or coding errors.

The calculated average of follow up in the post-hospitalisation phase for 9 projects ranged between 6.1 and 20.3 days (Table 20). A high proportion of patients in one project (21%) had a length of telemonitoring <1 days. For these patients, after inclusion in the study, no parameters were recorded (reasons given: difficulties with the use of the technology, lack of motivation, etc.).

Table 20 – Length of telemonitoring in the post-hospitalisation phase

Number of patients	UZA (45 patients)	AZMM (40 patients)	HH Mol (11 patients)	AZ Jan Palfijn (12 patients)	Mederi (55 patients)	OLV Waregem (58 patients)	ZOL (97 patients)	EpiCURA (2 patients)	CHwapi (28 patients)
<1 days	0	2					20		
1-3 days	0	4			1		16		
4-7 days	0	8	5	6	4	5	23		3
8-11 days	5	7	6	2		49	31		19
12-15 days	3	7			20		4	1	1
16-19 days	0	0					2		
20-23 days	30	4				5		1	5
24-27 days	6	4			29		1		
28-31 days	1	3		1					
32-35 days	0	1							
36-39 days		0							
40-43 days		0							
>43 days		0		2					
Average	Missing	Missing	Missing	Missing	20.1	Missing	5.5	Missing	11.5
Calculated average	20.3	13.1	7.7	15.4	19.1	10.2	6.1	17.5	11.4

It is possible that the numbers do not correspond to the number of patients per project due to missing data or coding errors.

4.3.4 *Focus on patient satisfaction and usefulness of telemonitoring for healthcare professionals*

Overall, patients seemed satisfied with the telemonitoring intervention, but it is unclear from the surveys what determines the degree of satisfaction.

Four projects conducted a patient survey which was asked at the closure of telemonitoring (i.e. UZ Gent (CC@Home), EpiCURA, Mederi, CHwapi). As there was no standardized survey suggested, the four received surveys differed considerable. There were between 10 and 15 questions, with 1 to 8 open questions. The response categories in the closed questions differed across the three questionnaires.

Two projects provided survey data on patient satisfaction at the end of telemonitoring and classified the patients into 5 categories of satisfaction. All patients (15 in pre-hospitalisation; 55 in post-hospitalisation) of Mederi indicated to be (very) satisfied, except for one patient in the post-hospitalisation phase who was not satisfied. All 28 patients of CHwapi in the post-hospitalisation phase except one (neither satisfied nor dissatisfied) indicated to be (very) satisfied (Appendix 2.11).

Based on the NIHDI data, projects and healthcare professionals tend to continue telemonitoring of patients with COVID-19 in future waves.

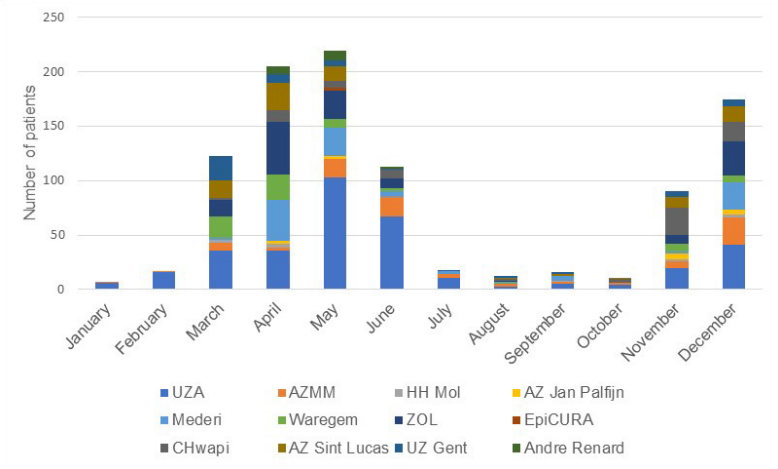
Looking at the number of patients included per month in each project (Table 21 and Figure 12) we can see that most of the patients are included during the months march to June, which corresponds to the 3th wave of COVID-19. In November and December, we saw another peak of inclusion, corresponding with the 4th wave of COVID-19.

The fact that most projects restarted telemonitoring in COVID-19 after the summer period of 2021 might indicate that healthcare professionals were satisfied and considered it as a useful intervention.

Table 21 – Number of included patients per month per project during the period 01/01/2021 to 31/12/2021 (NIHDI data)

	January	February	March	April	May	June	July	August	September	October	November	December	TOTAL
UZA	6	16	36	36	103	67	11	3	5	4	20	41	348
AZMM	1	1	7	2	17	18	3	2	2	2	6	25	86
HH Mol	0	0	3	4	0	0	0	0	1	0	2	3	13
AZ Jan Palfijn	0	0	0	3	3	0	0	0	0	0	5	4	15
Mederi	0	0	1	37	26	5	3	1	4	0	2	25	104
Waregem	0	0	20	24	8	3	0	1	0	0	7	7	70
ZOL Genk	0	0	15	48	26	9	0	1	0	0	8	31	138
EpiCURA	0	0	0	0	2	0	0	0	0	0	0	0	2
CHwapi	0	0	2	11	7	8	0	2	0	4	25	18	77
AZ Sint Lucas	0	0	16	25	13	0	0	1	2	1	10	14	82
UZ Gent	0	0	23	8	5	1	1	1	2	0	5	7	53
Andre Renard	0	0	0	7	9	2	0	0	0	0	0	0	18

Figure 12 – Number of included patients per month per project during the period 01/01/2021 to 31/12/2021 (NIHDI data)



4.3.5 Claims made should be interpreted with care

During our scoping interviews it became clear that healthcare professionals involved in telemonitoring indicated they felt the aims of the convention were met. They perceived that in-hospital days were saved, especially in the post-hospitalisation phase. Most of the teams we spoke subjectively estimated that the length of hospital stay was decreased with one to three days. In the pre-hospitalisation phase the projects indicated to be able to avoid or delay hospital admission and unburden GPs.

As popular press releases also appeared in the google advanced searches in the systematic literature review (chapter 4), more claims on savings were retrieved in Appendix 4.3. Most claims are however based on subjective estimations of the physician(s) and on the assumption that 'all patients who receive oxygen post-hosp should normally be hospitalized in case of absence of RPM. As oxygen therapy is not an hard indication for hospitalization {NIHDI oxygen therapy, 2021}[9], we consider these claims falls. As outlined in a recent letter-to-the-editor written by authors of ZOL [10], it should be taken into account that these claims were not based on findings from randomized controlled trials, and that in COVID-19 RPM represents a small sub-group of COVID-19 patients.

Two projects in our study stated to save 1 to 2.3 in-hospital days with telemonitoring (CC@H (*source* popular press release) and Mederi (*source* stakeholdermeeting). These claims were related to the post-hospitalisation phase, but methods for calculation were not described.

5 DISCUSSION

In this section, we discuss the comparison of the descriptions of the projects with the text of the convention. We try to identify some attention points and to raise questions to be explored in future studies.

The 12 projects that signed the convention up until 12 March 2021 are described in terms of characteristics such as patient population, inclusion of patients, actors involved, thresholds, duration of telemonitoring, communication between actors, platforms, etc. Between these projects **a large heterogeneity** is noted on how telemonitoring is implemented in practice. Different choices are made in the characteristics for telemonitoring and heterogeneously combined together to set up telemonitoring. Even if the group of healthcare providers is the same, the chosen characteristics of telemonitoring are (partly) implemented differently from each other. Probably, important lessons can also be learned from projects not included in our study (e.g. SafeLink) and other forms of telemonitoring in COVID-19 set up by individual GPs for example.

Telemonitoring was initiated, by a group of healthcare providers for several reasons such as (1) to meet the needs of patients, who raised many questions, and were very anxious, requesting admission for specialised care, and (2) to save hospital beds, relieve strain on hospital workforce and to unburden primary care. Later, the NIHDI especially focused on the second **goal**. It is however important to realize that patients' needs might exceed the monitoring of parameters from a distance.

Many implementations of telemonitoring have been introduced independently from eachother and under high time pressure in order to start as soon as possible, without the opportunity to learn from one another. This also limited our data collection, since no systematic registry was done. Moreover, no control group was foreseen to investigate effectiveness of an intervention. Due to the lack of (solid collected) data, **no conclusions can be drawn on effectiveness and cost-effectiveness** of COVID-19 RPM.

Since the beginning of 2021, these Belgian projects were temporarily financed **by Art.56**. It is inherent to Art.56 projects that they are characterized by a large heterogeneity as they are endorsed and created by healthcare professionals. Projects financed in art. 56 are often characterized by a collaboration framework across care lines. The NIHDI obtained to involve several actors, but in practice most projects were hospital-led and the intensity in which primary care providers were involved was limited. It is questionned to what extend all these actors should be involved? Or should these telemonitoring projects be especially primary-care led? Or hospital-led? Or would a combination be better, and go more towards integration of care?

The more actors involved, the more the **financing** has to be devided Whether the provided contribution fee is sufficient, is doubtful. It depends on several characteristics such as the actors involved, the workforce involved (number and qualification), the cost of telemetry devices, the licensing agreement with the platform manufacturer, the number of patients monitored, etc. Further research, and research linked to remote care in other pathologies could help to verify the adequate amount of financing.

The NIHDI initially obtained not to create overlap in **geographical location** of the projects. However, in some parts of the country, especially primary care might be confronted with different telemonitoring projects (and thus high heterogeneity in platforms used, parameters, actors, roles, etc.). Note that other telemonitoring projects are initiated outside of our study period or outside the convention. It can be questioned to which extend a standardised framework would be useful in the future. Should everyone follow the same protocol for inclusion and monitoring or should the whole process flow be outlined to ensure adequate patient care? Should there be a centralized telemonitoring team across the regions?

Implementation of the projects was facilitated by the active role played by **dedicated clinical leaders** in establishing the remote home monitoring models. Acute hospitals that already had pathways in place (i.e. ambulatory care) or digital protocols that could be repurposed by IT teams were able to set-up these models at a faster pace. **Motivation** of the group of caregivers (as it is an exhaustive process to set up the collaboration framework for telemonitoring) and a dedicated clinical leader were succes factors.

Most projects described an inclusion strategy for both **pre-hospitalisation and post-hospitalisation trajectories** in their application formapplication forms, but in practice the inclusion of post-hospitalisation patients was easier compared to the inclusion of pre-hospitalisation patients. It is unclear why exactly, but factors such as place of initiation and affiliation of the medical project lead, collaboration with primary care, communication strategy, experience in telemonitoring before COVID-19, availability of telemetry, etc. were mentioned.

In the aims set out in the convention, **the point of entrance** for patients to be included in the projects is mentioned i.e. through the ED or GP (pre-hosp) or hospital (post-hosp). The majority of projects involved in our study were hospital-led and patients were rarely signed up by the GP. In one project, the GP could sign up and monitor his/her patients through a stand-alone monitoring center (pre-hosp) while the post-hosp patients could be included from the hospital and monitored by the COVID-19 physicians together with the stand-alone monitoring center as telemonitoring team. However, developing the pre-hospitalisation trajectory and involving the GPs was a difficult task. The question is raised whether both goals can be obtained together or whether one excludes the other.

Along with this, the question is raised who takes up **the responsibility** in the telemonitoring interventions. In the convention, different physicians, specialist-physicians, GPs, treating GPs, treating physicians, etc. are mentioned. On the other hand, the convention states “the telemonitoring team works under the supervision of physicians who are part of the telemonitoring team. If the telemonitoring team considers it necessary, contact with treating physicians and/or ambulatory care nurses should be initiated”. On the other hand, the convention states “the treating GP (‘behandelende huisarts’ / ‘le médecin (généraliste)’ retains medical decision-making authority, in consultation with the patient and supported by the data provided. Discontinuation of telemonitoring is done in consultation with the GP and depending on the clinical course of the acute infection.” In practice the intensity in which primary care, including the GPs, was involved largely differed across projects. The reasons for this are unclear, but often the telemonitoring teams referred to the already high workload of the GPs. Again, the question is raised whether both aims of the convention can be achieved together.

In practice the patient was supposed to be responsible for the delivery of the data (as outlined in most informed consents) and often the physician involved in the medical telemonitoring team took responsibility. If the GP included a patient in telemonitoring, the GP was supposed to be medically responsible. It is clear that medical responsibility should be a topic for further discussions. However, a main responsibility is outlined for the GP as (s)he should be involved in medical decision-making and a patient should be excluded from telemonitoring if (s)he has no treating GP. Moreover, in this matter we noticed important differences in the Dutch and French translations of the convention.

Together with the question on responsibility, the **communication strategy** and a description of **the roles of each actor involved are key** in the development of a collaboration framework. In practice, a very heterogenous representation of the proposed collaboration framework was seen across the projects. Also within each project, communication strategies between the actors varied e.g. active communication between telemonitoring team and patient, in some projects the GP was only involved in case of emergency, etc. The communication strategy seems to be related to the roles that were defined and actors involved, and that differed across projects. Although all projects indicated at some point in their application form the involvement of all the different actors (except for one project that indicated no GPs were involved), it was seen in practice that the extend of the *involvement or the intensity of their role (especially for primary care professionals)* was very different across the projects and also changed over time. An example of this is the collaboration with ambulatory care nurses. In some projects an initial call for ambulatory care nurses was launched and/or agreements were made with ambulatory nursing care organisations. However, over time and in practice the ambulatory care nurses did not fulfil a role while in other projects the ambulatory care nurses explained the use of the telemetry devices, helped patients with collecting their parameters, brought a weekly visit to the patient, etc. In practice, it was seen that the role of ambulatory nursing care became more important in projects that were initiated from primary care (who are more used to work with each other vs.

across care lines). Defining of roles also involves the role of the government. Although the NIHDI initiated the convention, it can be questioned what the role of the government is in telemonitoring policy design, upscaling, solving barriers, reimbursement, technology requirements, setting up a research program and evaluation frameworks, specifically for patients with COVID-19, but also for telemonitoring in patients with other conditions? The roles of each actor and consequently their communication strategy should be carefully described and consequently evaluated in the future.

The aims also mention the **clinical status of the patient** (i.e mild COVID-19 patients, partially recovered patients earlier discharged). However, no/little validated scales on symptom and risk stratification in COVID-19 were available. As requested, the projects indicated symptom and risk stratification scales to be used, especially in the selection of patients in the pre-hospitalisation trajectory. Similar or no scales were mentioned in the selection of patients in the post-hospitalisation trajectory. In case similar scales were mentioned it is doubted if pre-hospitalisation patients show the same symptoms and risks than the post-hospitalisation patients, and if they are therefore implemented in practice. Most projects indeed indicated that pre-hospitalisation patients ran a higher risk to deteriorate, and that in this initial phase they wanted to get familiar with telemonitoring through more 'stable' patients in the post-hospitalisation trajectory. It is unclear which criteria where used to decide whether patients could leave the hospital and free up a bed (e.g. afebrile, oxygen independent, certain medication needed, many comorbidities). The descriptions made and data collected in this study do not allow us to make any statement on risk-stratification of the patients included. However, based on the proposed risk stratification and symptom scales, it is suggested that the population ranges from no risk to high risk, and the pre-hospitalisation patients were seen as at higher risk for deterioration.

The **duration of telemonitoring** was kept within the timeline set out in the convention. Post-hospitalisation patients were generally monitored shorter (12.3 days on average) than pre-hospitalisation patients (mean 16.6 days), confirming the idea that pre-hospitalisation patients were more at risk for deterioration. This is an interesting point as in the convention the duration of remote monitoring could be up to 3 weeks longer in the post-hospitalisation trajectory. What is also interesting is that patients in the pre-hospitalization phase should fill out remotely at least a daily survey (without telemetry). To decide if a patient should receive telemetry, the convention refers to the risk stratification. If there are 'clear' risk factors, the patient should receive telemetry (at least measurement of saturation). In case there are no 'clear' risk factors, monitoring can be started without telemetry devices based on the **daily survey**. When deterioration in physical condition is observed **telemetry** should be started. It is doubted if the assessment could be made and if assessing the physical condition based on the daily survey alone is sufficient to detect deterioration i.e. in COVID-19 there was the phenomenon of 'silent hypoxia' in which the patient feels well while (s)he was desaturating. In the post-hospitalisation trajectory, next to risk stratification, the emphasis lays on the one hand on monitoring the recovery process in the weeks following discharge from the hospital and, on the other hand, on the follow up and monitoring of the long-term consequences of the COVID-19 disease. The treating physician can decide that monitoring can be done without telemetry. Otherwise, at least oxygen saturation, breathing frequency, temperature, and heart rate should be monitored. Activity level and sleep can be optionally monitored. Daily structured questionnaires should be filled out. As described in the convention the emphasis in post-hospitalisation monitoring is also on objectification of re-activation and rehabilitation, health-related quality of life and persistent complaints. This refers rather to long-COVID symptoms, and it should be questioned when telemonitoring post discharge is useful? How long should it last? And when should telemonitoring be changed to a form of telecounseling or telerehabilitation?

Across the projects, different subjective and objective parameters are monitored. The **frequency of measurement differed.** Projects integrated a daily survey asking about fatigue, dyspnoea, well-being, etc. and asked objective measurements (often 3 times a day) such as saturation, temperature, heart rate, etc. It appears that deterioration in oxygen saturation was often seen as the primordial parameter to follow up closely as in the studied wave of SARS-CoV-2 infections, silent hypoxia (patient is hypoxic although feeling well) was common and seen by the healthcare professionals as a prognostic parameter for deterioration and (potential) hospitalisation. In congruence with the convention, telemetry devices

consisted at least of a saturation measure and often a thermometer was foreseen. Measuring temperature was important to detect plausible sur-infection.

No validated scales were available to set the alarm **thresholds**. Moreover, healthcare professionals indicate that thresholds had to be individualized, otherwise too many 'false' alarms would be generated leading to alarm tiredness. It remains unclear which cut-off values of parameters are safe or which thresholds are clinically relevant. If an alarm was 'false' or not was not registered systematically. Solely in the independent stand-alone monitoring center **a logbook** of the alarms and actions was kept in their own system. Therefore it is not possible to verify if adequate actions were performed for the generated alarms (quality of RPM), if there should be faster action, or if another action was more feasible?

We observed a variety in type and amount of **personnel in the telemonitoring teams** from an istand-alone monitoring center, to a RRT team, to a one person monitoring (i.e. physician-specialist, quality manager). It remains unclear which healthcare professionals are the most appropriate and what level of qualifications are required. It was seen that most of the healthcare professionals in the telemonitoring team and even in the group of healthcare providers performed these tasks in addition to their regular work. As most telemonitoring projects were hospital-led, it can be questioned if the aims of the convention 'to reduce strain on hospital resurces by freeing up beds' can be adequately met considering the hospital staff that is involved. Only in a few projects, one healthcare professional was relieved from other tasks during a certain amount of time. If telemonitoring is done by primary care providers or a stand-alone monitoring center, this could be the case. However, telemonitoring requires time to get familiar and experienced with, increasing workload on GPs (who are already under a lot pressure during COVID-19) and it is illustrated that GPs are not eager to be involved. It remains unclear if hospital-led projects are superior to primary care led telemonitoring, or if a combination of both should be looked for.

A diversity in **telemetry devices** applied in RPM for patients with COVID-19, from very basic devices (e.g. basic cheap thermometer) to more advanced semi-connected multi-parameter measuring devices (e.g. docking station in V1 CC@H kit) was observed. As stated in the convention, the applied telemetry devices had to be medically approved, but the question remains whether basic (cheap) devices work as well as more developed (expensive) devices. Most telemetry devices were not connected, and the measured variable had to be read by the patient, a relative, an informal caregiver, or an ambulatory care nurse and manually inserted in the app through a tablet, laptop or smartphone. It is also unclear how much precision/accuracy is needed for the measuring devices (e.g. how important it is to know if heart rate is around 67 or 84 beats per minute), as most telemonitoring teams indicate they look at 'a trend of deterioration' in the received measured patient data. How this trend should be defined is unclear. The parameter providing the most technical errors was the manually or automated measurement of breathing frequency. For other projects that are not in the NIHDI convention (such as SafeLink), the use of devices is left to the discretion of the patients. The patient uses his own device if he has one, without any verification of the validity of the measurements (apart legal CE certification).

The convention listed **24/7 remote monitoring** of a patient. Most telemetry devices used in these projects were not connected and measurement had to be done manually. Therefore, registration frequency was mainly done on agreed time-points. The patient could call a telephone number (connecting to the telemonitoring team, the unit nurse, the ED, etc.) at any time. The patient could perform more measurements than requested by the telemonitoring team e.g. when feeling sick during the night, but projects indicated that these inserted parameters were not automatically checked. As the time-point of measurement differs, and no automated alarms are pushed, patient data in this example will only be verified the next morning. In most projects, the dashboard is not continuously projected and alarms are not pushed to the cellphone or email of the healthcare professional. It is questioned if continuous and automated transfer of parameters is needed or if agreed time-points are sufficient. Moreover, it is questioned if alarms should be pushed 24/7 or if someone should be verifying the dashboard 24/7. And who this should be? It is unclear who should answer the telephone, and whether this person has gained sufficient experience.

The convention stated a platform should provide the capacity to monitor at **least 200 patients simultaneously**. It is inherent to the platforms they can monitor many patients, even much more than 200. Some manufacturers even indicate to be able to monitor the Belgian population if necessary. The real limitation in terms of capacity lays in the workforce i.e. staffing of the telemonitoring team (full time equivalents, number of staff, experience of staff, etc.) and other actors involved in the collaboration framework (logistics, technical difficulties, etc.). Secondary factors that influence the number of patients in remote care are e.g. process efficiency (action with each alarm? Who should do what? Which communication strategy?), and integration of monitoring data directly in the patient record. In our study, only a very small number of COVID patients was included in telemonitoring. Next to risk and symptom stratification, it is seen that other factors influenced the inclusion such as digital literacy, the responsibility a patient can take, mother tongue, educational level, the fact that it is a relatively new technology and an unknown disease, etc. The highest number of patients simultaneously monitored during one day mentioned in our study was around 35. It is clear that strategies to scale up telemonitoring in the future should be developed. It is important to take into account staff, process facilitation, and financing, in addition to structure.

The fact that it was a new disease with a relatively unknown disease progression, together with a relatively new technology might also influence the need for **a therapeutic relationship** for both the patient and the healthcare professional. Patients could have been anxious and unsure, and in need of reassurance by the telemonitoring team, the physician or the GP. The physician and/or GP could be unsure about the progression of the disease and whether the patient would call in case of deterioration. Especially in the pre-hospitalisation phase, in more acute patients, clinical decision-making based on the clinical view of the patient was stated to be important. The treating physician (at ED) had to make a decision on whether to hospitalise the patient or send the patient home with(out) telemonitoring. No therapeutic relationship with the in-hospital physician was built. These physicians were more reluctant to implement telemonitoring. Maybe a GP, who has a strong therapeutic relationship, could be more suitable to include a patient in telemonitoring? Or the ED physician could consult the GP at inclusion? Therefore, most projects chose to learn from the more 'stable' post-hosp patients, to get familiar with the process flow of telemonitoring. In the popular press, projects stated to save up 1 to 2.5 hospitalisation days with telemonitoring. This assumption (as no control group is available) is mainly related to the post-hosp trajectory. Looking at the data it is assumed that saving on hospital days is related to the fact that patients could be sent home with oxygen (both in pre-hosp and post-hosp). In regular circumstances, the physician would keep the patient in the hospital as long as oxygen therapy is needed. Note that medical physicians were often reluctant to send a patient home with oxygen, but in case it was necessary to free up a bed, telemonitoring gave physician and patients a kind of secure. In the pre-hospitalisation trajectory, in absence of a control group, it is even more difficult to estimate the saved hospital days. The fact that groups of healthcare providers reach for the for them quite intense telemonitoring (as no supplementary workforce was foreseen) indicates there are probably advantages although they are not clearly defined yet.

All **characteristics of the telemonitoring interventions have consequences for the workforce needed** (and consequently for an appropriate reimbursement of the telemonitoring team). Many (unnecessary) alerts require more workforce to react on them, but is a reaction always needed? (Too) few alerts require less workforce, but may cause adverse patient events. Integration across care lines involves more collaborators, but does this also improve patient outcomes? It is seen that setting up telemonitoring and telemonitoring efficiency is influenced by different factors such as organisation and collaboration within a hospital, former experience in telemonitoring, the driving force i.e. initiator, motivation of the healthcare professionals, learning from each other, etc. The pilot projects were all created bottom-up and also across projects, they should aim to to learn from each other to gain valuable insights on the future use of telemonitoring, possibly also for other target groups.

The **integration of service data** with existing patient administration systems was generally poor, and it was not feasible to arrange data sharing between and within sectors in the time available. Combinations of demographics, clinical readings, patient experience and outcome data (e.g. hospital and ICU admissions or readmissions, ED attendances, mortality rates and patient satisfaction measures) were collected. The need to act

quickly at the start of the pandemic meant that there was little time to carefully plan data collection as well as a register and/or logbook alarms and performed activities. There was a lack of published data to support the design of the remote monitoring models. Moreover, due to the informed consents, we encountered difficulties in collecting individualized data and patient characteristics as we could only request aggregated data. We were confronted with difficulties in data collection and a very low response rate. Few projects had fully **integrated their patient record with the telemonitoring platform**, indicating data had to be searched in the individualized patient files based on patient characteristic identification. This also indicates that other relevant patient data (former hospitalisations, medication, comorbidities, etc.) cannot be consulted by the telemonitoring team, or responsible physician or GP, at a glance. Moreover, data collection outside the apps could be cumbersome, and it was challenging to integrate data from apps into their existing patient administration systems. In the project integrating hospital setting with primary care, an app was implemented in the patient records of the healthcare providers involved in telemonitoring.

Regarding the collection of patient data, the NIHDI refers to the GDPR legal framework. It is seen that since 2011[8], not much changed regarding the legal framework for eHealth in Belgium. In the recently published book by S. Callens[11], the rights and duties of patients, care givers, and care organisations are described. With the development of eHealth many questions are still raised on responsibility of the government (Europe, Belgium, NIHDI?), responsibility of actors involved, documents to be signed (for what? By whom?) e.g. which kind of informed consent (dynamic, oral, written,etc.), informed consent for data use in research, informed consent for the use of videoconsultations, consent for the use of teleconsultation, data provided to a stand-alone monitoring center, etc.

The breakdown of the projects in the characteristics described in this chapter indicates the different combinations possible in the process of telemonitoring. Choices were made relative to aims, patient inclusion, monitoring of parameters, telemetry devices, duration and frequency of monitoring, staffing, responsibility, outcomes, etc. More research is needed to find the 'winning' combination and the most optimal combination might be influenced by the general healthcare organization in the country, and therefore might be not the most optimal for other countries. By the lack of control groups, no randomized controlled trial could be set up or evaluated. Therefore, no firm conclusions can be drawn.

6 CONCLUSIONS

Due to the changing context of COVID-19 and the rapid development of telemonitoring, no study site had been able to identify an appropriate group to use as a comparator at the time of the study and consequently these models were not able to establish control groups to compare effectiveness. It was therefore not possible to make an evaluation of the projects, or statements on effectiveness. COVID-19 was an unknown disease, and clinical presentation of the patients at an ED, and GPs changed across the waves of the pandemic and with the different virus mutations (e.g. delta, omicron) and vaccination rates. Everyone started with limited knowledge on COVID-19 and developed telemonitoring to the best of their knowledge and in function of their organization and infrastructure; this might have caused the large heterogeneity we encountered. The impact of remote home monitoring on patient outcomes and their cost-effectiveness should be assessed through the use of more standardized data collection and appropriate comparators.

Telemonitoring in patients with COVID-19 has been used frequently in Belgium, inside or outside the convention. It appeared to be a feasible intervention to which healthcare professionals reach for once the available hospital resources decrease. The intervention is feasible to develop and implement and seems to be generally well-accepted by healthcare professionals and patients. However, there is a large heterogeneity in telemonitoring characteristics, patient characteristics and outcomes. Also, based on this description, it is unclear to which extend telemonitoring in COVID-19 patients meets all the aims of the convention i.e. avoiding ED-visits, hospital (re)admissions, shortening length of hospital stay or reducing mortality, or patient aims such as reducing mortality, reducing hospital (re)admissions, etc. Or should it be questioned if one aim does not exclude the other? Healthcare professionals involved in these projects perceive the projects especially useful to free up hospital beds and in case decisions have to be taken on whom to hospitalise or not. Moreover, telemonitoring was often initiated bottom-up to comply with patients' needs such as anxiety, the fact that patients were alone in the hospital isolated from family members, patients often considered hospitalisation as the endpoint of COVID-19.

There is a clear need for carefully designed randomized controlled trials to select the most efficient characteristics, to evaluate effectiveness of RPM, to evaluate cost-effectiveness, etc. Also, much more insight is needed regarding which patient group benefits most from telemonitoring, which characteristics of a telemonitoring intervention are essential, which telemonitoring devices are needed, how the telemonitoring intervention should be carried out and by whom, etc. In absence of randomized controlled trials, no claims on savings should be made. COVID-19 is considered as a driving force for groups of healthcare providers learn to set up telemonitoring and bring it into practice for other diseases in the future.

CHAPTER 3 – PERCEPTIONS OF THE ACTORS INVOLVED IN COVID-19 RPM

This section describes the qualitative evaluation of remote patient monitoring (RPM) in patients with COVID-19 during the third wave in Belgium. This included interviews with key actors involved in twelve RPM projects (i.e. the projects that participated in the pilot evaluation of the National Institute for Health and Disability Insurance (NIHDI)), i.e. patients, telemonitoring (TM) teams, ambulatory care nurses and general practitioners (GPs).

1 KEY POINTS

Methods

- Qualitative data collection consisted of 17 individual online interviews with patients, 10 online focus groups with telemonitoring teams, 16 individual interviews with GPs and 4 with ambulatory care nurses.
- Data collection and data analysis were conducted simultaneously and interactively.
- Interviews were transcribed verbatim, and NVivo was used for managing and analysing the data.
- The QUAGOL (Qualitative Analysis Guide of Leuven) method was used to guide the data analysis process.

Findings from patient interviews

- Overall, patients had a positive experience with RPM if the delivery of the intervention matched their needs and expectations.
- For patients in the post-hospital trajectory, this positive experience was largely based on three factors, i.e. being at home sooner, the user-friendliness of RPM and feeling supported (in their individual needs) by the RPM team.
- RPM had a reassuring effect and created a sense of safety because patients could observe their parameters and knew that a (medical) team was also observing their status.
- Receiving feedback about their status and communication with the team were important determinants for a positive experience, which from the patient's perspective underscores the importance of human contact in addition to the technological side of RPM.

- The majority of patients stated that they received sufficient information about RPM, while others indicated that the information was too brief or confusing.
- Some patients–expected that the intervention would decrease the burden on GPs and could cause savings for the healthcare system.
- Although the patients found the RPM systems easy to use, some experienced technical difficulties, which were usually rapidly resolved. Technical difficulties did not result in a negative experience with RPM.
- Negative experience with RPM was linked to having too many alerts or found that some of the questions they had to answer during their follow-up were not relevant for their actual condition.
- Some patients experienced additional needs for information, follow-up and care not associated with COVID-19, but with other medical conditions.
- Overall, patients perceived RPM as a helpful intervention that enabled them to be at home while feeling safe.

Findings from focus groups with telemonitoring teams

- All participants in the focus groups believed in the concept of RPM (regardless of whether or not they were involved in the implementation decision) and perceived it as a valuable intervention for the management of patients with COVID-19.
- TM teams stated that as a disease, COVID-19 created a specific context of anxiety and insecurity in healthcare professionals. This anxiety and insecurity related to actions needed in the care for individual patients, but also to worries about a potential collapse of the healthcare system.
- The implementation of RPM pilot projects was seen by the teams as a solution for the high hospitalisation burden, and as a way to provide care for patients who are not hospitalised but potentially at risk for acute deterioration (silent hypoxia was a concern). RPM provided a sense of safety and control for healthcare professionals who experienced uncertainty about COVID-19 as a new and little-known disease.
- Teams also experienced that their follow-up was a reassurance for patients as it addressed their anxiety related to the disease and its potential consequences. However, several teams observed that some patients demonstrated a need for interaction regardless of the COVID-19 illness experience, which was interpreted as a need for psychosocial support. A key theme was the burden of RPM on teams, which they had underestimated in the conception of the projects. The burden was attributed to the different tasks to be performed (often by different professionals), their coordination, logistical management and the time required to follow up patients. Interviewees thought that the current funding model did not allow for optimal staffing to carry out all the tasks which limited the coverage capacity of RPM projects. This limited capacity was perceived as an important barrier to recruitment, resulting in a more selective inclusion of patients in the projects.
- Another major theme was the reflection about data in RPM, from different perspectives: obtaining the right data, having reliable measurements, managing data, and communicating/integrating data. Teams had different views on what data was best for RPM, ranging from relying solely on objective ‘hard’ parameters to integrating ‘daily life experiences’ of patients in the follow-up.
- Most teams encountered some problems with telemetry which resulted in false alarms. In some cases, adaptations were made to change the threshold levels either for all patients or for individual patients to reduce the number of alarms.
- Some teams were also able to integrate their RPM data in their own electronic patient records which was a facilitator; other relied on external systems with no link to the patient records which was experienced as a barrier. Finally, teams agreed that integration of

data between hospital and home care is an important factor for the future and a requirement for collaboration between hospital, general practitioners and ambulatory nurses.

- A last theme was the collaboration with primary care, particularly in relation to medical responsibility in RPM and how this could be shared. Teams who had a structural partnership with general practitioners and ambulatory care nurses experienced a positive collaboration and defined a shared responsibility in the follow-up of patients. Collaboration was absent for the remaining teams and questions about the responsibility were prevalent.
- The COVID-pandemic was a strong catalyst for the implementation of the projects. Some teams had already initiated the implementation before the launch of the NIHDI convention for RPM projects. Throughout the pandemic they experienced an evolution in knowledge about the disease, which also influenced how the management of the disease was organised.
- Although the overall experience was positive, the current state of RPM systems and their integration in healthcare and society was not deemed ready for scaling up. Key opportunities were investing in data infrastructures, funding systems, and defining role responsibility (primary versus secondary care) and integration in healthcare systems (across levels).

Findings from interviews with GPs

- While all general practitioners had a positive attitude towards RPM, they had mixed positive and negative experiences.
- In general, they believed that RPM contributed to a sense of safety and had a reassuring effect on patients.
- They also reported how the trust between the general practitioner and the patient influenced the start and the effectiveness of RPM. GPs wanted to be involved in the care for their patients and they experienced that patients also expected them to be involved. Having knowledge of the patient's personality, medical history and social situation was seen as important in the follow-up of at-risk patients.
- For most practices, RPM resulted in a higher workload because of administration, interruptions by alerts, and time needed for follow-up. This was also true for the NIHDI projects, although they collaborated with nurses who were able to manage the workload for the follow-up.
- Most GPs believed that investments are needed before RPM can be integrated in their daily practices on a larger scale.

Findings from nurses

- Ambulatory nurses had a positive attitude towards RPM overall and believed that the concept will have an important role in the future.
- The majority believed that their presence and RPM had mostly reassuring effects on patients. However, they observed diverse reactions of patients in relation to RPM. Younger and independent patients did not need follow-up by ambulatory nurses, while older and socially isolated patients requested more assistance than initially planned.
- The ambulatory nurses did not always have the possibility to decide on the frequency of the visits. Some of them thought that the impact on the more isolated or older patients could have been increased if they had been able to decide on the frequency.
- For most ambulatory nurses, supporting patients and providing good quality care was a main driver for participating in the RPM projects.
- Nurses believed that the capacity and organisation of the nursing team was important for the implementation. In most cases, having several trained and dedicated nurses was seen as the ideal situation for the delivery of RPM.

- Nurses reported that existing partnerships, collaboration and good communication between the hospital and TM teams was important for their success.
- The most important barrier was having no access to RPM systems or data.
- Nurses believed that the experience that they gained from this project would help them prepare for new RPM projects in the future.

Conclusions

- Overall, patients' and professionals' attitudes towards RPM tend to be positive.
- RPM is seen as a solution in dealing with the challenges of the COVID-19 pandemic.

2 AIM AND RESEARCH QUESTIONS

The **overall aim** was to understand how patients with COVID-19, and how Telemonitoring teams, GPs and ambulatory care nurses experienced RPM in relation to patients' illness, health and care needs, and in relation to the delivery of care. By combining the perspectives of the different actors, we also aimed to derive the key factors that contributed to successful implementation of RPM.

- We defined the following research question for **patients** with COVID-19.
  - How do they experience RPM in relation to their 'illness experience' and health and care needs?
- We defined the following research question for the **Telemonitoring teams, GPs and ambulatory care nurses**
  - How do they experience RPM in relation to the perceived quality of care they provided, perceived patient needs, and anticipated patient and health system outcomes?
- We defined following sub-questions that are related to the **implementation of RPM in the context of COVID-19**:
  - Which determinants contributed to or hindered the perceived success of RPM?
  - Which adaptations were made to RPM to overcome the perceived difficulties?
  - Which are the opportunities to improve RPM?

3 METHOD

3.1 Design of the qualitative evaluation

A qualitative research approach consistent with the **developmental evaluation paradigm** was adopted. The ethics committee of the Erasme Hospital approved this study (protocol number: P2021/257 / B4062021000134). We used a pragmatic orientation, i.e. 'seeking practical and useful insights to inform action, as it focusses on a practical understanding about concrete, real-world issues'. [12] This method allowed us to understand and describe the strengths, weaknesses, facilitators and barriers associated with RPM from a point of view that informs clinical practice and supports the implementation. Data sources and analyses allowed us to integrate the different system levels (patient, care process, technical, and organisational level) from an ecological perspective. {Kok, 2008 #9} An **emergent design** was used to adapt the qualitative inquiry (e.g. improve the interview guide) as new insights emerge, with the aim of improving the quality and efficiency of the evaluation. [13]

The main purpose was to capture and understand all experiences with RPM for COVID-19 as perceived by all relevant end-users. In line with the idea of developmental research, [14] we aimed for rich data and an in-depth understanding as to inform the further development and future improvement of RPM as a potentially effective and efficient intervention. We further aimed for an understanding of implementation factors relevant for COVID-19 RPM in the Belgian context.

This evaluation adopted an **open, inductive approach** where participants were asked to respond to broad open questions on their experiences first and foremost. Gradually, the interviewers explored potentially relevant angles and topics not spontaneously discussed by participants. For this, an interview guide was developed to contain additional open exploratory questions based on an integration of the four system levels regarding RPM, and Flottorp's comprehensive overview of determinants for implementation in practice. {Flottorp, 2013 #4}

3.2 Sampling of participants

All the participants in this qualitative evaluation were selected from twelve projects that implemented RPM as part of the NIHDI pilot evaluation. These projects have been described in chapter 2. The sampling strategies are outlined below for each of the four participant groups.

3.2.1 Interviews with patients

We aimed to recruit 24 patients (two per project) as to obtain a sample of twelve patients who had used RPM at home prior to a hospital admission, or without being hospitalised at all (i.e. pre-hospital), and twelve patients who used TM after hospital discharge (i.e. post-hospital). Patients were eligible for an interview if they had experience with either pre-hospital or post-hospital RPM and were included in one of the twelve NIHDI RPM projects.

We aimed to perform 75% of the interviews in the Dutch language area and 25% in the French language area. This corresponds to the representation of projects in the Dutch and French speaking part of the country.

Because the research team did not have direct access to patient data for recruitment, RPM project coordinators were asked to contact patients via e-mail to invite them to participate in individual online interviews. The e-mail contained information about the study and a link to a brief online survey where they could register for participation. In the brief survey, patients were also asked to complete some background information that could aid the purposive selection of participants. Background information included the RPM project team responsible for RPM, gender, age, level of education, duration of RPM, hospital admission or readmission, admission to intensive care, type of RPM (pre-hospital versus post-hospital), and the degree to which RPM met their expectations (VAS-scale 0 – 100). A recruitment matrix was constructed with this information to aid the selection of patients.

However, the initial strategy did not result in the desired number of participants. Projects were contacted again and were asked to consider alternative recruitment strategies. These strategies included sending a reminder via e-mail, sending an invitation to participate by post, or contacting

patients by telephone. Eleven out of twelve TM projects participated in the recruitment of patients (Table 22). Because there were fewer candidate participants than desired, purposive selection was not possible, thus resulting in a convenient sample of seventeen patients (thirteen in the Dutch and four in the French language area). In function of the participants' preference, fourteen interviews were online, three per telephone. Participants received a gift certificate of 25 euro to thank them for their participation. Recruitment was situated between July and November 2021.

Table 22 – Overview of patient recruitment strategies

Project [1]	Primary recruitment strategy	Secondary recruitment strategy	Number of participants
1	E-mail invitation	Telephone by Telemonitoring team	3
2	E-mail invitation	Telephone by Telemonitoring team Letter by post Message in TM system	0
3	E-mail invitation	Reminder e-mail	3
4	E-mail invitation	-	0
5	Did not participate	-	0
6	E-mail invitation	Letter by post	0
7	E-mail invitation	Letter by post	2
8	E-mail invitation	-	3
9	E-mail invitation	Telephone by Telemonitoring team	2
10	E-mail invitation	-	1
11	E-mail invitation	-	2
12	E-mail invitation	-	1
TOTAL			17

[1] *Project numbers refer to the different NIHDI RPM projects.*

3.2.2 *Interviews with Telemonitoring teams*

We aimed to recruit the twelve Telemonitoring teams for focus group discussions with each team participating with four to six participants per focus group discussion. The organisation of the focus groups was discussed with the coordinators in order to create the most optimal conditions (date, place and participants) and obtain rich data about the project. The participation of the project teams was discussed either during a site visit or via e-mail and telephone. We aimed to include participants who were involved in the day-to-day workings of the team, the follow-up of the patients, who were responsible for project coordination or project support (e.g. ICT), etc. However, the final selection of participants was determined by the teams themselves. Teams could choose between online or on-site interviews. Nine projects participated in a focus group (eight in Dutch and one in French) with a total of 36 individual participants across groups. In addition, we had one individual interview with the coordinator of the TM project (in French). See Table 23 for an overview per project. Teams were recruited between July and October 2021.

Table 23 – Overview of the recruitment of telemonitoring teams

Project [1]	Recruitment strategies	Number of participants per focus group	Type of interview
1	Site visit E-mail invitation	6	On-site
2	Site visit E-mail invitation Telephone invitation	5	Online
3	Site visit E-mail invitation Telephone invitation	2	Online
4	E-mail invitation	2	Online
5	E-mail invitation Telephone invitation	Did not participate	-

6	E-mail invitation	2	Online
7	E-mail invitation Telephone invitation	4	Online
8	E-mail invitation	8	On-site
9	Site visit E-mail invitation	4	On-site
10	Site visit E-mail invitation Telephone invitation	Did not participate	-
11	Site visit E-mail invitation Telephone invitation	3	Online
12	Site visit E-mail invitation Telephone invitation	1	On-site

[1] *Project numbers refer to the different NIHDI RPM projects.*

3.2.3 Interviews with GPs

We planned to recruit 24 GPs for participation in four online focus group discussions (three in Dutch and one in French). We contacted the Telemonitoring teams to identify professionals who were repeatedly involved in cases where RPM for COVID-19 was used, as to obtain sufficiently rich experiences. We aimed for a relevant diversity of characteristics (e.g. working alone or in team practices/care organisations) and cases (with positive and negative RPM experiences). Two Telemonitoring teams provided contact information of general practitioners, who were sent an email by the research team. The email contained information about the study and an invitation to participate.

However, the initial strategy did not result in the desired number of participants, and new strategies were designed. These included sending e-mail invitations via regional clusters of general practices ('huisartsenkringen' and 'Cercles des médecins généralistes'), personal e-mail invitations to GPs if they were located in the geographical area of the hospital responsible for the TM project, invitations via the newsletter of Domus Medica (the Flemish Society for General Practitioners/Family Physicians), an invitation via social media of the Belgian Healthcare Knowledge Center (Twitter, and website), using the snowballing by asking patients who were interviewed for the contact information of their GP, and by using the network of the research team. Lastly, it was also decided that GPs with experience in RPM in patients with COVID-19, but not associated with the National Institute for Health and Disability Insurance (NIHDI) RPM projects, could also participate. GPs participating in a similar RPM project (not within convention), i.e. SafeLink (via the Réseau Santé Wallon, a regional hub for transmission of individual health data), were also contacted. To further stimulate participation, individual interviews were performed and participants could opt for a short version of the interview (fifteen minutes), and a financial remuneration (50 euro) was offered. GPs were recruited between September and December 2021.

Overall, three GPs with experience from two RPM NIHDI projects were recruited, three general practitioners were recruited from the SafeLink project, and ten general practitioners had developed their own RPM project. Thus, total of sixteen individual interviews were performed (nine in Dutch and seven in French; five were online and eleven were via telephone).

3.2.4 Interviews with ambulatory care nurses

We aimed to recruit 24 ambulatory care nurses for four online focus group discussions (three in Dutch and one in French). We contacted the Telemonitoring teams to identify ambulatory care nurses who were repeatedly involved in cases where COVID-19 RPM was used, as to obtain sufficiently rich experiences. We aimed for a relevant diversity of characteristics (e.g. working alone or in team practices/care organisations) and cases (with positive and negative RPM stories/experiences). Only four RPM projects had a formal collaboration with organisations for ambulatory care nurses, who were sent an invitation email by the research team. The email contained information about the study and an invitation to participate. Representatives of the organisations facilitated the communication with the

individual nurses to plan the interviews. Nurses could choose between online or on-site interviews. A total of four focus groups (three in Dutch and one in French) with a total of twelve participants, and one individual interview (in Dutch) were performed. See Table 24 for an overview per project. Nurses were recruited between September and October 2021.

Because we also wanted to capture the potential experiences of self-employed nurses, we asked two societies for ambulatory care nurses (i.e. 'de Vlaamse Beroepsvereniging voor Zelfstandige Verpleegkundigen' and 'Onze Thuisverpleging vzw' to publish an invitation to participate in interviews (in a closed group on social media). This did not result in new interviews.

Table 24 – Overview of the recruitment of ambulatory care nurses

Project[1]	Nursing organisation[2]	Number of participants in the focus group	Type of interview
1	1	2	Online
2	2	5	Online
8	3	2	On-site
	4	1	Online
12	5	5	Online

[1] Project numbers refer to the different NIHDI RPM projects; [2] Nursing organisation numbers refer to five organisation that provided ambulatory nursing care in collaboration with four of the twelve NIHDI RPM projects.

3.3 Interview plan

A combination of individual interviews and focus group interviews was used for the data collection. Individual interviews were carried out by a single researcher, whereas two researchers (one moderator and one observer) were present for focus group interviews; all researchers had previous experience in qualitative research.

Interview guides for the actors in French and Dutch were developed by the KU Leuven/UC Louvain research team in collaboration with KCE researchers and can be found in Appendix 2. A literature search was performed to identify sensitizing concepts that could inform the development of these interview guides. The interview guides integrated the different system levels for RPM interventions. In this way the interviews addressed point of care experiences, as well as experiences with interprofessional collaborations, organisation dynamics and health system structures.
We used open questions to engage participants in a conversation about their experiences, and we used more active and probing questions to explore meaning and examples in the 'story' of the participant. Several reports were made after each interview:

- A methodological report containing the interviewer's ideas on the quality of the interview and any events or circumstances that could have affected the interview quality.
- A descriptive report containing a description of the interviewee(s) and contextual characteristics.
- A report containing important themes and new insights/hypotheses related to the research questions.

These reports were used by the research team to discuss the initial interviews for patients and for each of the different types of healthcare professionals. Insights from these reports were used to evaluate the interview guides and update these with emergent insights, in order to optimise the quality of the following interviews. The interview guides were also slightly adapted in accordance with the advice of the ethical committee. Furthermore, the reports provided important information that was integrated in the data analyses.

3.4 Data analysis

Data collection and data analysis were conducted simultaneously and interactively (the initial steps of the analysis process were started during the interviewing phase; coding was performed after all interviews were completed). [15, 16] Interviews were transcribed verbatim, and NVivo was used for managing and analysing the data. The QUAGOL (Qualitative Analysis Guide of Leuven) method was used to guide the data analysis process. {Dierckx de Casterlé, 2012 #7} The strengths of this guide lie in its case-oriented approach (instead of a 'line-by-line coding'), its forward–backward dynamics (using the constant comparative method) and its team approach (at least two researchers per interview and regular peer reviews). The analysis consisted of two parts: 1) a thorough preparation of the coding process, and 2) the actual coding using qualitative data analysis software. The QUAGOL (designed for grounded theory analysis) was adapted for the purpose of thematic content analysis to include the following: reading interviews; drafting descriptive, methodological and content reports; developing conceptual schemes and coding lists; linking fragments to the codes using NVivo and description of the themes. {Dierckx de Casterlé, 2021 #8} An inductive coding scheme was used. However, we also used Flottorp's comprehensive overview of determinants for implementation in practice to organise the results pertaining to implementation. {Flottorp, 2013 #4}

Box 1 – Overview of main determinants for implementation in practice

Factors related to the RPM intervention: These factors include the evidence about RPM, how it is delivered in clinical practice, and the behaviour that is needed from healthcare professionals for the delivery of RPM.

Factors related to the Telemonitoring team: These factors include knowledge and skill of healthcare professionals, attitudes towards RPM, and behaviour of healthcare professionals related to the implementation of RPM.

Factors related to the patient receiving RPM: These factors include, needs, beliefs, preferences motivation, and behaviour of patients.

Factors related to professional interactions: These factors include communication between healthcare professionals, team processes, and referral processes (e.g. between care settings)

Factors related to incentives and resources: These factors include the availability of resources, (non)financial incentives or disincentives, information systems, quality and safety systems, continuing education systems, and assistance for clinicians.

Factors related to capacity for organisational change: These factors include mandated authority, leadership, strength of supporters and opponents, internal regulations, rules and policies, perceived priority of change, monitoring and feedback, and assistance for organisational changes.

Social, political and legal factors related to RPM and its delivery: These factors include economic constraints on budget, contracts, legislation, funder piorities, liability, influential people, corruption, and political stability.

A full analysis including Nvivo coding was performed for the interviews with the Telemonitoring teams and the nurses. However, for the interviews with patients and GPs, the analysis was limited to case and cross-case analysis, hence no Nvivo coding was done. After discussing the initial coding of the data from the patients and the GPs it was decided that coding in NVivo would not generate more insights than those from the case analysis and cross-case analysis. The reason for this was that interviews of patients and GPs provided less 'rich' materials for analysis. Therefore, NVivo coding was not likely to provide an added value to the existing conceptual coding schemes and coding lists based on the case and cross-case reports, which were thus used for the analysis.

3.5 Methodological quality

We used several strategies to enhance the quality of the qualitative evaluation. The research team documented the research process with reports and field notes. Triangulation was achieved by interviewing different end-users, using different data collection methods and through the involvement of different researchers in the analysis of the interviews. We used member checking during the interviews to verify the responses. Initially, the interview transcripts were discussed (peer review) within the research team during weekly meetings to support the interpretation of the data. In a later stage, the interpretation of the data was discussed within the research team during weekly meetings. A qualitative researcher of the KCE participated in the meetings. The research teams at KU Leuven and UCL worked closely together. The interview guide was drafted collaboratively, and the analysis was performed by both teams. This allowed us to create uniform codes and further understand relevant regional differences.

Important note on the interpretation of the results

It should be noted that the depth of the analysis is different for the interviews with the different actors. Our results show that patients were keen to get their message through and reflected information that was highly specific to the individual and personal views and context of the participant. This means that we had to focus on 'larger messages' throughout the interviews, which also means that there are less details reported in the results section of the patients. This was also the case, but to a lesser extent, for other interviewees. If appropriate, we tried to give examples about how interviewees had different experiences, focusing on examples that were likely to illustrate the point. However, these examples should not be considered as proof for a causal relation between a projects' characteristic and a specific experience. We were also careful to give examples that did not enabled the (re)identification of individual patients or professionals. Lastly, for interviews with GPs and ambulatory care nurses, it was easier to define and potentially link context elements to experiences. When appropriate, these have been described. Overall, it should be noted that this qualitative evaluation does not constitute an evaluation of the RPM projects, nor do the results imply (causal) relationships between characteristics of projects and RPM and experiences related to impact and implementation.

4 FINDINGS

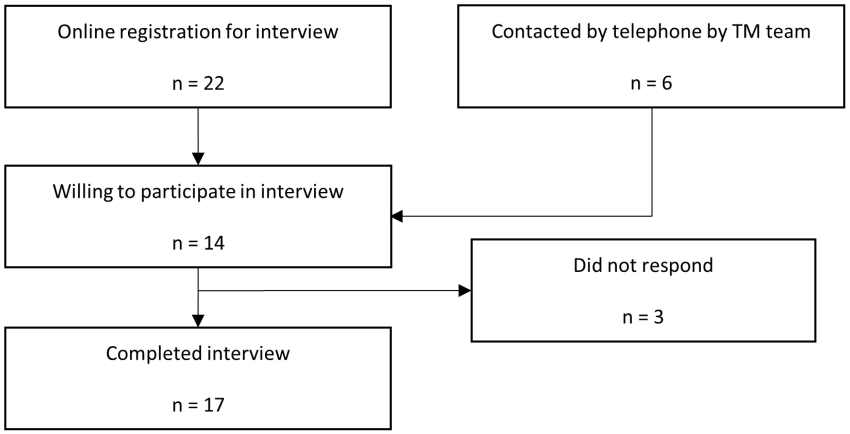
The following section reports findings at the level of the different types of participants: 1) patients, 2) Telemonitoring teams, 3) general practitioners, 4) ambulatory care nurses.

4.1 Findings from interviews with patients

4.1.1 Description of patients

We used the combination of different strategies to recruit patients from RPM projects. A flow-chart of patient inclusion is visualized in Figure 14. As a result, 17 individual patients agreed to individual semi-structured interviews from August to November 2021. As seen in Table 22, 17 patients were included across 8 projects.

Figure 13 – Flowchart of patient recruitment



The duration of the interviews was 33 minutes on average and ranged between 18 and 64 minutes.

Table 25 provides a description of the sample. There was an equal gender distribution, the majority of participants were aged between 45 and 64 years, and all but one patient lived together with a partner and/or child. Two patients had used RPM at home without being hospitalised (pre-hospital RPM), and the remaining patients received post-hospital RPM. Five patients were admitted to the intensive care unit because of COVID-19 during their hospitalisation. The average duration of RPM was two weeks and varied between three days and two months. On average, RPM met the expectations of patients with a median score of 85 out of 100; the range in scores was 50 to 100. At the time of the interview, nine patients indicated that they were fully recovered from COVID-19.

Table 25 – Characteristics of interviewed patients

Characteristic,	Patients, n = 17
Post-hospital RPM	15
Pre-hospital RPM	2
Female	8
Age	
25 – 44	1
45 – 64	13
65 – 74	1
75 - 84	2
Educational level	
Lower secondary education	1
High school	7
University	9
Living alone	1
Multimorbidity	8
Time in hospital	
Not applicable	2
< 1 week	4
≥ 1 – <2 weeks	6
≥ 2 – <3 weeks	2
≥ 3 weeks	3
Admission to intensive care	5
Duration of TM	
< 1 week	3
≥ 1 – <2 weeks	6
≥ 2 – <3 weeks	3
≥ 3 weeks	5
Expectations met by TM (0 – 100)	
50 – 59	1 (6)
60 – 69	3 (18)
70 – 79	1 (6)
80 – 89	4 (24)
90 - 100	8 (47)
Follow-up by professionals outside of TM team *	
GP	10 (59)
Physical therapist	3 (18)
Ambulatory care nurse	5 (29)
Medical specialist	3 (18)

** These refer to with healthcare professionals outside the follow-up of the NIHDI projects and were not related to RPM. These constituted regular care contacts*

4.1.2 *Experiences related to quality of care, patient needs and patient and health system outcomes*

Three themes were identified in the patient interviews related to (1) feeling secure, (2) relation to patients' needs, (3) effect on burden of health care

RPM made patients feel secure

The large majority of patients felt reassured by receiving RPM. The need for reassurance was driven by anxiety for the consequences of COVID-19. Patients were anxious because of the stories they heard in the media, because they had already experienced severe symptoms, or because they knew a person who experienced severe symptoms. Several patients said they expected to die. RPM presented to them during hospitalisation for remote monitoring made them feel secure.

The reassuring effect was enacted through several mechanisms. An important factor was **knowing that a telemonitoring team was monitoring (and observing) their status**, and that the team would intervene if there was a problem; or that the patient could call the team.

> *"Omdat het mij effectief wel gerustgesteld heeft dat de opvolging er is, ook voor mezelf om te weten van: "Ik ben nog ok, alle parameters zijn ok." Zelfs moest daar een parameter wat minder goed zijn dat er die*

opvolging is en dat er eigenlijk ook een alarm afgaat bij degene die die doet de opvolging" - Patient 04

No patient reported a negative event that was not monitored by the telemonitoring team, i.e. if they recorded an abnormal parameter in the RPM system, they e.g. received a message to monitor it again or were contacted by the team. In some projects, patients received feedback that everything was 'normal' (e.g. by seeing a green screen in the app when they had submitted their parameters) and this was found helpful. In other projects this was not the case and patients expressed that they did not know what values for the parameters were good.

The reassuring effect was also impacted by '**being at home'** in comparison to being in the hospital. Patients experienced that RPM was able to 'provide the same care as being in the hospital', but without the isolation they experienced in the hospital (note that hospitals did not allow visitors on patient wards).

The perceived value of RPM on reassurance appeared also to be dependent on **individual characteristics**. For example, patients who expressed a high sense of self-care and independence were neutral towards the effect of RPM on their life. They stated that they were capable of monitoring their own health status (e.g. determine when a vital sign was abnormal) and would find help if this was needed. One of the patients interviewed expressed a low sense of self-care and independence and had a negative experience with RPM which resulted in an increased feeling of anxiety. This patient presented him/herselve to the ED as severe symptoms were experienced and the patient expected to be hospitalised. However, the hospital only admitted patients with COVID-19 if they required intensive care (during that time of the pandemic), and the patient indicated to be discharged home with RPM "against his/her will".

These examples illustrate an important determinant for the effect of RPM, i.e. how RPM interacts with individual patient needs. The interaction between RPM and individual patient needs is detailed in the next section.

The value of RPM depended on the interaction with individual patient needs

the overall perceived value of RPM for the individual patients depended on how well the intervention interacted with individual needs.

An important patient need **was interaction with healthcare professionals**, which could be the TM team or the GP; the GP was in these cases not involved with RPM. This need was observed in both pre-hospital and post-hospital patients and across projects. However, there were differences on how this need was met across the projects. For example, in one project the TM team contacted patients spontaneously which was valued by patients. In this same project, the GP also contacted pre-hospital patients which was also valued by patients. Interaction was particularly important in the pre-hosp phase because patients felt isolated due to quarantine measures.

In other projects patients received a telephone call by the RPM team when an 'abnormal' parameter was observed. Receiving a telephone call by the TM team when alarms were generated, gave patients the opportunity to "tell their story". Patients valued that healthcare professionals were available to listen to them. However, this meant that patients who were recovering without generating alarms had no contact with the TM teams, because several teams only performed actions when an alarm was triggered (based on the principle of 'no news is good news'). Some of these patients missed this interaction with and feedback from the TM team. Examples include a need to have confirmation that parameters were seen by the RPM team, and having unanswered questions that could be related or not, to COVID-19. Overall, patients did not contact the TM team themselves even if they had questions. In some patients, this was remedied by calling their GP, which replaced the need for interaction with the TM team. Overall, **communication** with healthcare providers whether or not taking up an active role in RPM was perceived as important to deal with potential anxiety and reassurance.

Patients felt that the **daily questionnaire** they had to answer was not always relevant or that they would have liked to give the TM team other information which they felt was more important. For example, patients had to indicate if they were nauseous but they found it more relevant if the TM team would

ask about their physical functioning, their appetite and weight. One patient perceived some questions as stressful.

> *« Une ou deux questions comme je vous ai dit, que je recevais et auxquelles je devais répondre en fin de journée […] Il y avait deux ou trois questions comme ça et je me disais: "alala j'espère que je n'aurai pas ça". – Patient 09*

Several patients discussed their **need for information about RPM**. While for some patients the information they received in the hospital was sufficient, this was not the case for all patients. Patients stated that they were not able to retain the information they received in the hospital. While patients in the post-hospital traject received RPM information about the intervention at the moment they were (partially) recovered from severe symptoms, patients in the pre-hospital traject were informed about RPM at the time of diagnosis and experiencing more acute symptoms. Patients did not consider that 'the appropriate moment'. However, patients who did not retain or understand the RPM information when recruited in the project were able to figure out how the system worked based on the information materials they had received from the hospital.

Patients expected that RPM reduced burden on the healthcare system

The majority of patients expected that RPM had a positive impact on the healthcare system. This was mostly for two reasons. First, **patients believed that they were discharged home sooner**, e.g. being discharged while still receiving oxygen therapy. Second, patients also believed that participating in these projects would help healthcare professionals learn how to optimise or change the delivery of care.

> *"J'avais l'impression qu'on était au début de l'expérience et cette expérience était très rapidement vouée à être proposée à toutes les autres personnes donc j'ai pris ça comme sans une raison particulière, mais parce que l'expérience débutait quoi!" - Patient 02*

Some patients believed that RPM could reduce the burden on GPs or result in lower healthcare costs.

Other patients were neutral towards the effect of TM on the healthcare system.

4.1.3 Experiences related to implementation: barriers and facilitators for success

Six themes related to implementation of RPM were identified in the interviews with patients; Five themes were related to the RPM intervention and one theme was related to the TM team.

4.1.3.1 Factors related to the RPM intervention

RPM required access to a smartphone, tablet or a computer

Participation in RPM required patients to have access to a recent smartphone, tablet or computer. In several projects, patients could also use a computer when they did not have access through a smartphone. Patients did not express a preference for using a particular device (e.g. smartphone) to access the RPM system.

Instructions by TM teams were clear according to patients

The majority of patients indicated that the instructions that they received about the RPM system were sufficiently clear and they appreciated when they were able to practice the RPM application on their smartphone in-hospital. Several patients additionally indicated that the RPM team addressed all their questions or repeated instructions when they were home; which was considered a facilitator as well. Instructions by the GP and ambulatory care nurse helped also to use the RPM system.

However, several patients found the instructions not sufficient, too brief or confusing. This meant that patients were not certain when to register their parameters or had to figure out for themselves how to work with the RPM system. One patient who received the instructions in the ED stated that instructions should not be given when someone is too ill to concentrate and take in the information.

RPM systems are user friendly

In general, the RPM systems were considered user-friendly:

> *« Het was net precies zoals wanneer je een berichtje stuurt. Zo eenvoudig is het. Ge moest juist maar ingeven, ja, "Zoveel, mijn bloeddruk is zoveel", ge moest het juist maar intikken. Dus dat was vrij eenvoudig. » Patient 03*

This was relevant for both the telemetry devices (hardware) and app (software). Patients found the interface of the RPM app simple and intuitive. Having the software installed in the hospital contributed to the experience of a user-friendly technology. However, some patients observed that not everyone would be able to use it, e.g. older persons who do not know how to work with apps on their smartphone.

Most technical issues could be solved easily by the helpdesk or TM teams

Half of the patients reported experiencing (small) problems with the RPM system. These were small technical difficulties with the software in patients who were recruited at the start of the projects. For example, in one project the ambulatory care nurse installed the RPM app on the patients phone the day after hospital discharge. This was the first time the nurse had to perform the installation and did not succeed in the installation. The ICT department of the hospital was able to work with the patient to install the app on the phone. Or in another project, there was no button to submit the answers. This was also resolved after a few days by the ICT department of the hospital. Some patients also experienced problems with telemetry equipment, e.g. thermometers that did not detect the body temperature correctly or patches to monitor the respiratory rate that were misplaced. While the TM team was generally available to help patients with these problems, patients also indicated it took too much time before the system worked properly. For one patient, the system also generated too many alarms because the thermometer systematically recorded low temperature values, which created a negative perception of the RPM system.

Flexibility in registration of measurements

RPM required patients to manually enter a standard set of parameters at fixed times during a day. However, not all patients experienced this as relevant or appropriate. One patient reported this as a barrier because it limited daily plans and routines. Some patients indicated that the standard set of parameters were not suitable or not comprehensive enough for them or felt that they could not register important information.

> *"[…] maar als je het een nadeel zou kunnen noemen dat je het moet voor een bepaald uur moet doorgeven hé. Ja, ze moeten dat voor dat uur weten, laat ons zeggen ten laatste voor de middag, maar ik was toch thuis, ik kon toch nergens heen." Patient 08*

4.1.3.2 Factors related to the telemonitoring team

TM teams were flexible to deal with challenges

Several patients commented on the responsiveness of the TM team. Positive experiences with responsiveness of the team and their follow-up on parameters stimulated further use of the system by patients. This also meant that the follow-up was adapted as the course and symptoms of COVID-19 changed; the ability to make such adaptations was valued by patients. Quickly responding to and resolving technical issues supported the use of the RPM system. One patient stated that the TM team switched immediately to the regular telephone to ensure remote monitoring of parameters when the Wi-Fi connection did not function well.

> *« Mais c'est parce que…ce n'est pas toujours évident d'avoir internet, donc …le wifi etc correctement. Alors parfois quand on ne se voyait plus du tout, alors elle [the hospital physician] me téléphonait et alors elle m'entendait. […] ça me fait du bien, parce que donc elle m'écoute, elle me conseille.» - Patient 09*

4.2 Findings from interviews with Telemonitoring teams

4.2.1 Description of sample

Ten out of twelve telemonitoring teams were interviewed (Table 23). There was one individual interview and nine focus group discussions. The two non-participating teams had initially agreed to participate in the focus groups, but it was not possible to organise the interview for the team within the timeline of the project.

The sample size of the focus groups varied between two and eight. The total sample size was 37 participants, including thirteen medical doctors, twelve nurses, and twelve other staff members (i.e. project coordinators, ICT, managers)(see Table 26). The duration of the interviews varied between 52 and 100 minutes. The median duration was 85 minutes. Interview were performed between August and October 2021.

A description of the RPM projects and teams is detailed in Chapter 2.

Table 26 - Composition of focus groups with telemonitoring teams

Project	Medical doctor	Nurse	Other staff	Sample size
RPM1	1	3	2	6
RPM2	1	0	4	5
RPM3	0	0	2	2
RPM4	2	0	0	2
RPM5	-	-	-	-
RPM6	0	2	0	2
RPM7	2	1	1	4
RPM8	3	4	1	8
RPM9	1	1	2	4
RPM10	-	-	-	-
RPM11	2	1	0	3
RPM12	1	0	0	0

4.2.2 Experiences related to quality of care, patient needs and patient and healthcare system outcomes

Seven themes were identified in the interviews with Telemonitoring teams.

RPM reassured healthcare professionals

RPM was experienced as reassurance on several levels. First, at the patient level, healthcare professionals felt less uncertain when they could monitor at a distance the patient's recovery process. They were confronted with a new disease and the prognosis was uncertain. For example, they worried about the occurrence of silent hypoxaemia (in which the patient subjectively feels good, while desaturating). The RPM system enabled them to detect (potential) problems and to react quickly when necessary. RPM reduced the responsible physicians' uncertainty through the monitoring of objective (parameters) and subjective (e.g., well-being, quality of life) data to inform their decisions. In addition, the RPM system allowed for rapid detection and reaction if the patient's condition worsened and if necessary, on the basis of the data, the RPM projects could correctly refer patients to the ED

> *"En het is ook een ontlasting voor ons, want ik voel me als huisarts ook geruster. Die patiënten worden opgevolgd, die saturatie wordt gedaan, en als die bellen, de zorgcentrale bijvoorbeeld belt, die patiënt belt u zelf niet meer als hij verontrust is, maar zij pikken het op en gij kunt gericht gaan inspelen." – RPM project 08*

Second, some projects benefitted from the support of primary care providers at the patient's home, which also reduced the uncertainty experienced by the Telemonitoring team. Data about the person of the patient, how he or she felt or about his or her environment were felt to be relevant in addition to the data obtained by RPM.

> *"Moi j'aime ce garde-fou des infirmières, je ne m'en passerais pas. Je pense que c'est.j'étais très bien avec les télé-consultations, mais pour tous les projets d'avenir, je ne me passerais pas de l'infirmière à domicile qui m'a apporté une grosse plus-value. En confirmant ou en allant contre moi entre guillemets en me disant : "ah tu sais il n'est pas si bien que ça." Mais moi le patient m'a montré une belle image de lui*

sur la vidéo, alors que en réalité ça n'allait pas si bien que ça." - RPM Project 12

Third, on a more general level, it also reassured physicians of the hospital's management capacity to handle critical moments of the pandemic

"On est arrivé à un moment où il nous restait trois places d'hospitalisation COVID et on avait plus les moyens de créer d'autres secteurs ; où on s'est posé la question et après ? ou est-ce qu'on met les patients ? Qu'est-ce qu'on…comment on fait ? C'était un vrai stress, une vraie inquiétude. […] Ça (RPM) nous a permis nous en interne de finalement répartir les ressources un petit peu plus équitablement." - RPM project 11

RPM reassured patients

All teams believed that RPM reassured patients as it addressed their anxiety and uncertainty about COVID-19. Several teams observed that patients were anxious because of the potential lethal consequences of COVID-19. They also attributed this to the negative stories in the media. Telemonitoring teams believed that patients were reassured because they knew that they were being monitored, and that if there was a problem, the team would contact them.

"Le...ça leur a apporté une sécurité. Ça leur a apporté une sécurité alors que...ils ont eu des symptômes très angoissants, de dyspnée, pour certains ont été dans un état de détresse respiratoire sévère où ils se sont....pour employer leur terme...tous, se sentir mourir. Ils avaient cette sécurité que si leurs paramètres n'étaient pas bons, ils savaient que ça envoyait une alarme et qu'ils étaient contacté immédiatement." – RPM project 12

"Zeker ook met alles wat er in de media verteld werd, ongerust waren en dat ook aangaven dat ze heel blij waren dat ze opgevolgd waren" - RPM project 03

"Ik denk uit de ervaring dat de patiënten vooral veel geruster waren. Uh van 'oke, ik ga naar huis, maar ik word nog opgevolgd, als er iets is, ik word nog opgebeld als het effectief nodig is'. Uhm en ik denk vooral die geruststelling dat ook allez heeft meegeholpen in hun proces thuis met genezen nog verder te doen" – RPM project 09

Some Telemonitoring teams also noted that **communicating with patients was important**, i.e. patients had to feel that healthcare professionals were involved in their care . Informing patients about the safe range of parameter values also contributed to this effect, according to some interviewees.

"Ik denk voor mensen die het gevoel hebben van 'oké, er zit daar iemand die dit opvolgt en die heeft een stem en die kan ik bellen', euhm dat dat wel belangrijk is. Euhm, zeker voor die oudere populatie, absoluut. […] een oudere mens heeft nog altijd graag iemand die dat in mensentaal vertaalt en af en toe wat uitleg geeft. Ik denk dat het wel belangrijk is dat je dat inderdaad, alé nog altijd ergens, alé een ja een menselijke inleving aangeeft." – RPM project 04

Patients valued individualised care and having contact with the Telemonitoring team

Several teams **adapted their RPM follow-up to the needs and preferences of patients**. These included changing the duration and frequency of the monitoring, preferring telephone or text messages to video calls, and setting individual "alert thresholds". This last point was also important for the Telemonitoring teams, limiting the number of inappropriate calls to the patient, as the thresholds were not adapted to the patient's situation (for example, a patient with COPD).

Some Telemonitoring teams **offered more comprehensive assistance by providing guidance** on lifestyle (e.g. diet, hydration, positioning, exercise, rest) and on the use of medication (e.g. dosage). Patients received a lot of information before they were discharged from hospital. Later, at home, they sometimes needed clarification, for example, about the medicines they could take.

"Mevrouw je mag zeker Dafalgan nemen, en liever geen Neurofen, dat is toch al een beetje... Zo die dingen dat haal je er wel nog uit omdat dat zo dadelijk veel informatie is. En dan als ze thuis zijn dan hebben ze zo wat rust in de omgeving, en dan vertellen ze u wat en dan kun je

dat er wel weer mooi uitfilteren en dan is dat heel veel, dat is heel gemakkelijk voor die mensen om dat dan weer, neen mevrouw, we doen het zo, dat is het best en dat is nochtans volgens het voorschrift van de arts hoor" – RPM project 01

This guidance was **tailored to the specific situation of the patient**, for example in the case of pregnant women. The Telemonitoring teams were also able, in many cases, to offer support, giving patients the possibility to ask questions (e.g. about their symptoms and the evolution of the disease) or to ask for advice or information (e.g. about administrative procedures).

Several Telemonitoring teams observed that some patients **demonstrated additional needs for personal contact and emotional suppor**t. For example, they noted that some patients called the RPM team on their own or prolonged the conversation when the Telemonitoring team called them. They reported that some patients also informed them about the progress of their disease or told them stories about their daily life. While the team recognised that this was important for patients, they also reflected that this was not their main function or role. In some cases, this resulted in some frustration because they felt that they did not always have the time to listen, and that these conversations further increased the burden on the team.

"Maar zelfs nu, als ge wordt opgeroepen, en nog een keer alle patiënten moet opbellen, en elke patiënt een kwartier aan de lijn... Dan ja, het was echt moeilijk om te combineren vandaag."- RPM project 01

Patients with low digital skills, higher age and foreign language were less likely to be included

To be included in an intervention such as RPM, patients must comply with clinical criteria such as presenting symptoms of COVID-19 or having risk factors to deteriorate after in-hospital stay for COVID-19. Besides these clinical criteria however, RPM was only proposed to a selected group of patients. Patients who did not have the right skills such as language and digital skills or did not have the right equipment (connected smartphone or tablet) were excluded from plausible participation in the projects. Some patients living in the more remote areas of Wallonia did not have effective mobile phone or internet coverage and therefore RPM as planned through connected platforms was not always possible.

"Et ben on s'assurait toujours que ça, vous voyez par exemple ça c'était dans les critères d'exclusion qu'on n'a pas négligés, c'est euh s'assurer que le patient ou […] un aidant proche puisse avoir un smartphone ou un objet connecté mais qui puisse avoir tout le temps de la connexion. "- RPM project 10

Moreover, patients had to have the capacity to use the devices, and the RPM system. For these reasons, most of the RPM projects included a low number of patients with a geriatric profile or who were not fluent in Dutch or French. Several projects noted that this latter group was the largest demographic group of patients who presented to the hospital with COVID-19. Furthermore, it was suggested that fewer older people could be included in the pre-hospital RPM trajectory because there was less time in the ED to explain how the devices worked. They considered that ED was not a good setting for recruitment of older people.

"Ik denk niet dat er veel oudere mensen, ik ken het nu niet vanbuiten, maar ik denk niet dat wij prehospitaal veel oudere mensen hebben geïncludeerd eigenlijk. Dat zal echt wel een minderheid geweest zijn. Na de hospitalisatie misschien wel, maar dan heb je wel meer tijd om alles uit te leggen, die bij te staan. Op spoed heb je toch, denk ik, iets minder tijd om uw uitleg te doen" – RPM project 07

"Wij zijn nog een stuk later eigenlijk gestart dan [naam], waardoor dat wij ook zeer weinig inclusies hadden. Plus wij zitten ook met een specifieke patiëntengroep. Zeker de ambulante patiëntengroep die bij ons naar huis gegaan is, is toch gebleken dat, zeker qua taal, dat dat een grote problematiek was. Da's één van de grote oorzaken eigenlijk waarom dat er zo weinig geïncludeerd geweest zijn." – RPM project 06

Language was also experienced as barrier for RPM. Exceptions were projects in which applications were developed in multiple languages (usually Dutch, French and English). However, language remained a barrier, as health professionals also needed to be proficient in the other language and communication was important for initial instructions and optimal follow-up.

"Ze moeten voldoende capaciteit hebben om Nederlands te begrijpen, waarin dat de app bestaat hé, die kon ook in het Frans en in het Engels gezet worden, maar als mensen niet snappen waarover het gaat, werkt het niet" – RPM project 04

Additional workload for the Telemonitoring team

RPM put a significant burden on the Telemonitoring team members. The investment required in terms of human resources for a comprehensive RPM follow-up was significant. The projects developed different strategies to cope with this burden. However, this resulted in an increased workload for the healthcare professionals involved in the RPM tasks and a limited the capacity in terms of the number of patients followed

"Wij hebben wel na verloop van tijd omdat het echt te veel werd, dus afhankelijk, zijn enkel de mensen van [anoniem gemaakt] gestart met de opvolging en de opstart van de patiënten. Na verloop van tijd hebben we ook de hoofdverpleegkundigen van de cohortafdeling ingeschakeld omdat die toch al volledig ingepakt was en euhm, op de afdeling aanwezig was." – RPM project 03

Tasks related to patient recruitment and follow-up were in many cases added to the daily activities of team members, hence increasing their workload considerably. For those involved, participation in the RPM project meant that in addition to the work related to the care of hospitalized patients, there was also the follow-up of patients at home. So there was no additional staff hired, which increased the workload, and limited the capacity needed to scale up the RPM project.

"Dus je moet het een beetje zo zien: dat het bijkomend werk is, je hebt wel een nauwere opvolging van de patiënt. Hij pakt wel geen bed meer in, maar je gaat hem wel opvolgen" – RPM project 07

In some cases, other work was side-lined (e.g. academic) or other actors have been trained to support the activity (e.g. for administrative tasks) or the Telemonitoring team members involved indicated to work a lot of additional hours.

Impact of RPM on hospital admissions

The teams believed that the RPM projects reduced the pressure on the hospitals mainly through 1) freeing up beds by shortening hospital stays and reducing avoidable hospitalisations due to COVID-19, 2) increasing the hospitals' capacity to cope with new COVID-19 admissions and 3) allowing the hospitals' usual activity to be maintained as far as possible.

"En waar ze dan twijfelden van gaan we ze opnemen of niet, ja en die werden dan eigenlijk geïncludeerd. En dan was het duidelijk, dan konden we ze naar huis laten gaan. Dus we hebben, qua instroom toch wel wat kunnen opvangen. We hebben een snellere uitstroom kunnen doen." – RPM project 02

"Bij ons heeft dat echt het verschil gemaakt tussen een vijfde en een zesde verdiep opstarten, en een zesde verdiep opstarten dat was bijna een ballast van het ziekenhuis, want dan nog eens twee niet-Covid afdelingen dicht." – RPM project 08

Learning experience and knowledge about RPM

Multiple Telemonitoring teams defined the project as a learning experience. The context of COVID-19 enabled hospitals to experiment with new models of care, which could also be useful for the management of other diseases. Participants experienced an increase in their know-how and skills in relation to RPM. However, initially this required a change of mindset on the part of physicians and nurses who had never provided remote care before.

"Die soms de neiging hebben om van hun patiënt thuis ook een ziekenhuispatiënt te maken, dus daar willen we dan ook veel aandacht aan besteden. Maar dus, dat is wat dat jullie dan moeten leren, dus en wat dat we allemaal moeten leren denk ik. Wat dat we ook allemaal aan het leren zijn." – RPM project 01

The learning experience was observed in different areas. For organisations, it was an opportunity to test a model for other disease management (e.g. chronic diseases management) and identify areas for support, improvement, and investment. At the process level, short-term improvements were noted because Telemonitoring teams learned to optimise their project based on

daily experiences. At this level, it was considered important to have a sufficient number of patients in the project. Projects noted the importance of creating a routine to facilitate the learning experience.

> *"Dat was wel ja, zeer tijdsintensief inderdaad. Maar ja, die routine na vijftig patiënten... De eerste patiënt, dat heeft waarschijnlijk het allerlangst geduurd, maar na de vijftigste, de 55ste patiënt, dat is natuurlijk ja, dat ging wel vrij vlot. Dus inderdaad, routine moet erin zitten." – RPM project 08*

Medical doctors reported learning to know more about the disease because of the feedback through the RPM data. For example, as their knowledge progressed, they felt safer sending patients home, for example with oxygen.

> *"En door eigenlijk gestandaardiseerde vragenlijsten voor te leggen op periodieke momenten, kreeg je die input van de patiënten die ge anders nooit krijgt als die gewoon thuis zitten en niet opgevolgd worden, waardoor dat ge nieuwe inzichten krijgt. En met die nieuwe inzichten konden, kon de behandelende arts veel sneller gaan reageren en inderdaad die zuurstoftherapie of medicatie of dergelijke meer. En dat gaat ge nooit krijgen met een nieuwe ziekte of een nieuw ziektebeeld als ge dat niet op die manier opvolgt." – RPM project 02*

Several teams discussed how the project enabled them to experiment with RPM technology and learned what worked or what was problematic. For example, respiratory frequency measured by the patient him or herself was not reliable. This led some teams to test sensors to try to capture this parameter in a more reliable way.

4.2.3 Experiences related to implementation: barriers and facilitators for success

Eleven themes related to barriers and facilitators to the implementation of RPM were identified in the interviews with the Telemonitoring teams. Three themes were related to the RPM intervention, two to the Telemonitoring team, two to professional interactions, two to incentives and resources, and one to organisational change and social, political and legal factors.

4.2.3.1 Factors related to the RPM intervention

Informing patients is key to patient recruitment and adherence

Informing patients was important for the recruitment and facilitated patients' adherence during the follow-up. Teams felt that taking time to inform patients about the project facilitated the recruitment. This was important because health care professionals experienced that patient were anxious about the outcomes of the disease. Having time to provide information had a reassuring effect and motivated patients to participate in the project. However, this was experienced differently by teams who recruited patients in the ED in comparison to teams who recruited patients on COVID-19 wards. For example, one team explained that recruitment was influenced by the context and gave the example of their ED. They felt that they did not always have the time to inform patients. Furthermore, they stated that starting a patient with RPM was more time consuming than admitting a patient to the hospital. In comparison, patients on a COVID-19 unit have 'nothing to do but wait'. This makes the context of post-hospital RPM easier to inform patients about RPM.

Teams also felt that patients needed information about what they would experience and what was expected from them. Informing patients about what to expect during follow-up was important to help patients cope with the uncertainty (RPM is an unknown intervention to patients) and ensure that they were adherent during the follow-up. Teams stated that they expected patients to be responsible for their own follow-up, which meant that patients had to be informed about this responsibility.

> *"un attachement tout particulier au fait que le patient soit responsable de sa propre prise en charge, on lui explique bien, et que quand il sorte il ait tout compris pour qu'il soit totalement euh déstresser sur le fait de dire on vous fait peut-être sortir un peu plus tôt de l'hôpital mais au final vous avez une prise en charge qui est plus longue avec un suivi plus long." RPM Project 11*

Quality of data was an important challenge

All Telemonitoring teams agreed that quality of data was a key factor, but they differed in what they found important. Quality of the data was described as having two dimensions, i.e. the type of data needed for follow-up, and the reliability of the measurements. While some teams positioned objective data (e.g. temperature) as key to their follow-up, others valued more subjective general health and well-being data. Objective data was valued because some Telemonitoring teams stated that they did not always trust the answers of patients. For example, oxygen saturation was preferred over perceived breathlessness by some.

> *"Enerzijds is dat mensen worden dat moe, als je die vragenlijst een keer moet invullen, maar ja elke dag dan doe je dat niet meer. Twee, heel veel van de informatie waarnaar je vraagt in je vragenlijsten kan je eigenlijk afleiden uit je parameters en is subjectief. En als je dan moet kiezen tussen de antwoorden van de vragenlijsten of de parameters, dan ga je de parameters gebruiken, want die zijn objectief." - RPM Project 04*

Telemonitoring teams systematically reported errors in the measurement of the respiratory rates, and several teams reported problems with thermometers. Teams had different ways of dealing with such errors, including sending a nurse to the patient's home to verify the measurement, or relying on experienced staff to filter the information. For example, by calling a patient an experienced nurse could assess the respiratory status and if the measurement in the RPM system was correct.

> *"want de ene mensen meten zelf, maar we hebben wel gemerkt dat we heel vaak de verpleegkundigen moesten langs sturen he, voor een correcte meting. De ademhalingsfrequentie was een heel mooi voorbeeld waar dat wij heel veel uit geleerd hebben. Mensen die dat zelf moeten meten die ademen mee met de... Zo dat was razend hoog en dan zeiden wij van oei, is alles wel in orde? Ah ja, ik adem elke keer dat ik mijn..." - RPM Project 08*

Some projects also observed hardware problems with thermometers. Technology partners were available to support teams with hardware problems, e.g. by analysing if there were problems in the system and replacing malfunctioning RPM equipment. There was consensus that measurement of data should be easy and intuitively.

The logistic management of projects was challenging

The logistic management of the project was a challenge and required the cooperation with different hospital support services and primary care partners. Projects reported that the logistic organisations were a challenge because of the contagious character of COVID-19. This was experienced differently by projects. For example, one project recruited patients on a COVID-19 ward but per hospital policy only healthcare professionals involved in the care of patients were allowed on the ward; the person responsible for recruitment was not part of this team. In another project, the recruiting team found that they lost a lot of time adhering to infection prevention measures. In the projects, patients had to return to their 'box' with the RPM system. A challenge was organising a system for the safe delivery of this 'contaminated box' in the hospital, decontaminating the RPM equipment and returning these to the RPM team for the next patient. Teams that collaborated with ambulatory care nurses experienced an additional challenge as RPM systems also was exchanged between partners. These examples demonstrate that collaboration and communication with other units and primary care partners was important for the delivery.

> *"Ik denk dat het digitale nog de minste uitdaging was, tenzij dan die zuurstofsaturatiemeters, dat was ook wel nog een uitdaging, maar het was voornamelijk, hoe organiseren we dat zorgpad? Hoe zorgen we ervoor dat die saturatiemeters toch bij de patiënt komen en nadien ook terugkomen? En dat die gedesinfecteerd geraken, terug klaargestoomd worden om opnieuw ingezet te worden. Hoe volgen we de patiënt op, hoe gaan we met de eerste lijn communiceren, dat waren de grote uitdagingen." - RPM Project 02*

4.2.3.2 Factors related to the telemonitoring team

Prior experiences with RPM facilitated implementation

Teams who had prior experience with RPM experienced this as a facilitator because they were able to integrate the project in existing RPM structures and processes.

> *"Daar hadden we voorsprong denk ik, en dat is ook heel specifiek aan onze benadering omdat we dat instrument als ik het zo mag zeggen al hadden en daar heel vertrouwd mee zijn." - RPM Project 01*

Prior experience with RPM included having a team with experience, having an own ICT-RPM platform or integrating RPM follow-up in their electronic patient records, and having a vision on TM for future healthcare delivery. This allowed teams to adopt and adjust the project in function of emerging needs, and resulted in a positive experience with the implementation. For example, teams with their own RPM platform were able to change or individualise the questions that patients had to answer during follow-up. Positive experiences were a motivator to also implement RPM in patients with COVID-19. Some project teams did not have experience with RP, but with other forms of remote healthcare. For example, a project had a positive experience with 'hospital at home', which helped the medical coordinator in their decision to implement RPM for patients with COVID-19.

> *"ça les perturbait beaucoup de ne pas maîtriser chaque heure finalement d'évolution du patient euh à domicile. Donc euh, moi ça m'a moins perturbé parce que euh…ben je m'occupe déjà des patients en hospitalisations à domicile, donc ça veut dire que j'ai déjà des patients en charge que je ne vois pas tous*

One project team explicitly stated that having no experience or resources was a barrier to performing RPM as desired. In this project, RPM was implemented without investing in the project and the team members had to perform RPM on top of their daily function. They stated that they missed experience and were never able to build experience because they had not sufficient time for RPM on top of their daily function.

Teams were motivated to implement RPM

Motivation of the team was a facilitator that can drive the implementation of the RPM. This was evident at two levels. First, motivation of the coordinator who initiated the implementation was the driving factor in multiple projects. The choice for implementation was often initiated by a healthcare professional or team, i.e. there was a bottom-up implementation. This means that without these people, most of the projects would not have existed. For example, this was evidenced by several projects that had initiated their own RPM as a solution for the care gaps they observed in the follow-up of COVID-19 patients. This was the case for a project that already had an established RPM programme for patients with heart failure, but also for two projects who had no prior experience. It appeared that the personal motivation of the project initiators were the driving factor; the implementation drivers were healthcare professionals and not hospital management. These projects had recruited by pre-hospital and post-hospital patients.

> *"de...responsables du projet...ont passé énormément de temps personnel, y compris en congé, etc. Je pense que...quand on se lance dans un projet...si on ne s'investit pas personnellement, ça ne peut pas fonctionner." - RPM*

Second, a motivated team to provide RPM was seen as crucial. Teams stated that RPM was more than monitoring parameters.

> *"De technologie is één, maar het engagement van het team is zeker ook niet te onderschatten." - RPM Project 09*

4.2.3.3 Factors related to interprofessional interactions

Collaboration within hospital and with primary care is needed for RPM

Telemonitoring teams had different views on, and experiences with collaborating within the hospital and with primary care professionals. Collaboration within Telemonitoring teams was evident in all projects as there were no one-man team. Trust and communication were important determinants. Team members had to rely on each other. For example, multiple teams worked with nurses who monitored the RPM parameters on

a daily basis. The medical doctors were dependent on the nurses to inform them which patients needed medical follow-up. However, in some project the medical doctors monitored all patients with abnormal parameters.

> *"Team member 1: Ik vond dat super, ik had daar eigenlijk niet zo veel schrik van omdat [Person's name] wel duidelijk gezegd heeft bij welke waarden dat het wel alarmerend is en niet alarmerends is. [Person's name] was ook altijd bereikbaar. Als we twijfelden, we mochten haar ook altijd aanspreken. Nee, dat was heel positief. Ja. […] Team member 2: Dat is ook een van de redenen waarom ik met hun twee wou samenwerken, omdat we dagelijks samenwerken. Omdat ik weet dat dat vertrouwen er is, terwijl als je met een nieuw team begint moet je dat vertrouwen eerst nog creëren. Dat was een reden waarom ik niet met zo'n meldkamersysteem van externe verpleegkundigen wou werken." – RPM Project 07*

Collaboration outside the team but within the hospital was also an important implementation determinant in some projects. Team members noted the collaboration between different units to facilitate recruitment. For example, recruitment of patients was usually organised on the units of the medical doctors directly involved in the project, e.g. recruitment on COVID-19 wards by the coordinating medical doctor (a pneumologist); however, this was not the case for all projects. Some projects managed to recruit patients on multiple wards, e.g. both COVID-19 wards and the EDED. Furthermore, in some projects, follow-up was shared between units to make the workload more feasible. One team noted a barrier in the collaboration between units. They reported tensions when medical follow-up was taken over by another medical doctor. This means that some doctors may be cautious to allow their patients to be monitored using RPM if another doctor or team is responsible for RPM. For example, while some teams collaborated with an external RPM service managed by nurses (in the primary care setting), other teams stated that they did not want to work with such external partners. Trust (or lack of) was the important underlying factor for this decision.

> *"Maar dat was in het begin ook niet zo eenvoudig he. Ik bedoel, dat is iets van oei, opeens gaat iemand, want als je de context aanvoelt van "mijn" patiënt gaan opvolgen, "mijn" patiënt in zoverre dat dat bestaat, maar in de geesten van vele artsen is dat nog altijd wel zo. Dus dat heeft wel wat tijd en wat duiding gevergd om dat, om over die drempel te gaan." - RPM Project 01*

The collaboration with primary care was also discussed by the projects' team members. While this was generally recognised as important, and several projects initiated communication with GPs, multiple teams reported that GPs were not involved in the follow-up of patients. They noted that the work pressure on GPs was very high during the project and that GPs entrusted them with the follow-up. It was argued that having an integrated platform that can be accessed by all healthcare professionals would have aided the collaboration between Telemonitoring teams and GPs.

Access to data is needed for collaboration and continuity of care

Having access to RPM data was considered an essential element to ensure continuity of care and information. Access referred to two elements: access for health professionals (mostly GPs), and access to data in electronic patient records (in comparison to external servers). Access to the RPM data for GPs was an important element throughout the focus group discussions, especially where collaboration with GPs was explicitly part of the project. Such access was considered necessary to ensure adequate follow-up by all GPs and to facilitate collaboration. Teams that had a partnership with ambulatory care nurses mentioned that access for these professionals was also important. One Telemonitoring team decided to restrict access to their system for external partners. For them, this was related to responsibility.

> *"Het is wel zo, als een patiënt slecht was, dat we soms het advies gaven: Vraag dat uw huisarts komt of ga ernaartoe. Als we geen opname geïndiceerd waren, dat wel. Maar ja, dat is wij die met de patiënt afspraken van: Bel naar uw huisarts of doe het nu zo. Als de huisarts dan wou, dan kon die wel kijken. Als die een patiënt bij hem kreeg die onwel was. Want als die niet kunnen gaan kijken, helemaal niet, ja dan hebben die niks, maar in het geval als er iemand slecht zou worden en niet bij ons komt en die voorbij de huisarts ging, dan kon ze dat ook bekijken, de parameters. Bijkomend is nog dat dat over een speciale populatie gaat, die toch in isolatie zit op dat moment. Dat is*

allemaal toch niet zo evident voor de huisarts om dat even tussendoor te gaan bekijken hoe het met die patiënt is." – RPM project 07

4.2.3.4 Factors related to incentives and resources

Dedicated teams are needed for RPM

Having a dedicated team was a facilitator for the implementation of RPM, and team size and experience were important implementation determinants. This was because of the many different tasks involved, including recruitment, informing patients, monitoring RPM parameters, medical supervision, communication with patients during follow-up, collaboration with primary care, project management and coordination, ICT support and logistics management. This necessitated the involvement of different healthcare professionals. Teams agreed that one person is not sufficient to run the project.

Furthermore, the project teams reported that they had underestimated the work that was needed and stressed the importance of tasks not related to patient follow-up, including coordination and communication with patients during follow-up. Even larger projects with multiple healthcare professionals felt understaffed. Teams explained that staffing Telemonitoring teams was challenging. This is because of several reasons. First, the many different tasks require expertise from more than one professional. Second, the case-load in the project was not high enough to dedicate a 'full time' professional to the project and fluctuated throughout the course of the project. Third, RPM requires continuity in the follow-up. For example, teams who relied on one or two persons for the project reported that they found it difficult to take a holiday because without them the project would stop, or reported that they worked on the project in their free time. Projects who were able to integrate themselves in existing Telemonitoring teams did not report these challenges.

"Maar ge moet inderdaad in al die processen een team voorzien in het ziekenhuis die dat daar dedicated mee bezig is. Waar dat dan ook ja, een zeven op zeven continuïteit, zeker voor de follow-up is." - RPM Project 02

"Er is altijd iemand de coördinator, die eigenlijk de parameters moest opvolgen, maar niet iedereen van ons was even vertrouwd met het systeem. Dus ik denk als het misschien onder minder mensen was verdeeld, op een andere manier, dat het misschien toch beter was geweest naar haalbaarheid voor iedereen om zeker te zijn dat alles goed opgevolgd werd." - RPM Project 07

"Omdat zij ook de telemonitoring van de hartfalen-patiënten doen, hebben we dat deel er eigenlijk bij laten doen. Zij waren gekend met het principe van de telemonitoring en dat is dan ja- zij wisten- weten heel goed wanneer ze een arts moeten contacteren, uh wanneer het nodig is, wanneer aan de hand van de vragen wat de patiënten er in konden zetten, wanneer moeten we eens bellen of het nog gaat of niet gaat. Uh die kunnen daar wel goed op anticiperen en uh wisten wel goed hoe ze dat moesten doen." – RPM Project 09

NIHDI funding was not sufficient to support implementation

Telemonitoring teams agreed that the NIHDI remuneration was not sufficient to fund the personnel that was needed to deliver RPM. The funding did not account for time investments related to coordination, project management, and communication with patients by the Telemonitoring team. This meant that hospitals had to invest in the projects. Examples include hiring additional staff, developing the ICT infrastructure and RPM platform, buy equipment. However, in some cases the RPM systems were made available for free by the technology partners. Nonetheless, the lack of funding resulted in projects that were operated by teams who performed RPM tasks on top of their regular work. As a result, projects recruited less patients than desired and in some projects only a small number of patients. Lastly, teams also noted that hospitals lost 'income' because patients were discharged home sooner. Overall, funding was considered an important barrier for future scaling up but the high burden on the hospitals, the motivation of healthcare professionals to deliver quality of care, and the vision of hospital regarding RPM as future intervention were important factors to overcome this barrier during the pandemic.

"En eigenlijk ja, de financiering de we gehad hebben is een beetje op de telemetrie, op de techniciteit van ja, een opvolging zonder telemetrie of met telemetrie, maar het is toch echt de technische benadering. Maar de tijd die ge daarin steekt van ja, heel regelmatig naar de gegevens te gaan kijken, zeven dagen op zeven, te communiceren, vragen op te lossen, misschien ook iemand anders een advies te vragen, feedback te geven aan de huisarts. Ja, dat zit eigenlijk niet vervat in die vergoeding." - RPM Project 02

4.2.3.5 Factors related to capacity for organizational change

Management support facilitated the implementation

For projects that were initiated in-hospital, support and vision from hospital management facilitated the implementation through investing in resources (staffing, ICT). Teams who had prior experiences with RPM reported strong management support and experienced those hospitals were more eager to invest in both staffing and equipment. For example, a coordinator was hired in one project, and nurse was hired to support recruitment of patients in another project. Another example is investing in the development of a RPM platform that was managed by the hospital without the need of outside technological partners. This enabled them to implement the project as designed or to adapt RPM to increase the feasibility of its implementation.

"Maar wat dat we vanuit de directie wel altijd gedaan hebben, is het feit dat we dat platform al hadden, het digitale platform, dat we al ervaring hadden met extra-muros zorgpaden, is door het feit dat we vanuit het ziekenhuis beslist hebben dat we daarin gaan investeren. Dat we wel zien dat dat de toekomst is voor de gezondheidszorg." - RPM Project 02

A second and third determinant as experienced by the Telemonitoring teams were the innovation culture within the hospital, and the freedom and trust given to the Telemonitoring teams. This was observed in teams who did not have prior experience. Although these teams also reported a positive experience with the implementation, they received less material support than teams with a history and strategic vision about RPM at a higher management level. For example, latter teams experienced that they had the freedom to experiment with RPM and autonomy to organise the project. However, they missed the investment in resources to deliver RPM as desired. There was one negative case that expressed a lack of support by management. This project aimed to recruit patients in both the ED and COVID-19 wards. However, the team responsible for RPM felt that this project was not a priority for the hospital and expressed a lack of support. For example, two nurses had to recruit patients during their day-to-day activities: one in the ED and one on the COVID-19 ward. However, there was no dedicated 'project time' and the nurses were only able to recruit a small number of patients

"Die COVID heeft zodanig veel energie van alles en iedereen eigenlijk gevergd, ja... Dat project lag eigenlijk een klein beetje in de schaduw op sommige momenten. Dat is opgestart geweest, dat is toen even in de spotlight gezet geweest, maar dat is heel snel terug verdwenen in de schaduw van andere" – RPM Project 06

4.2.3.6 Social, political and legal factors related to RPM and its delivery

Uncertainty about medical responsibility related to RPM

Medical responsibility was a complex theme throughout the interviews, and Telemonitoring teams differed on their views on the roles of patients, medical specialists, general practitioners and nurses. Teams generally indicated that patients were responsible for seeking help when needed, e.g. patients had to sign an informed consent for this purpose. However, teams also observed problems with this responsibility as many projects reported problems with accurate observations of vital parameters if patients do not trust data that is not accurate, they are less likely to take appropriate action. Responsibility was generally also attributed to supervising medical doctors in the hospital.

"Au niveau légal rien n'est clair. Donc a priori, là en l'occurrence comme c'est moi qui faisais les télé-consultations et qui recevais les alarmes, j'ai jugé que c'était moi. J'ai d'ailleurs fait moi rajouter une clause dans

ma RC professionnelle privée, mais ça non plus ce n'était pas prévu. Donc moi j'ai une assurance à visée médicale qui s'y connaît bien, mais ils ont tout de même fait des yeux tout ronds quand je leur ai demandé d'ajouter cette clause." –RPM Project 12

However, doubts arose as to which medical specialist was the main responsible person, and several projects also defined responsibilities for the nurses in their team. An important underlying factor was a trust relationship between the nurses and medical doctors in the RPM team to ensure the follow-up. Not all teams agreed on sharing responsibility with primary care professionals. Teams collaborating with general practitioners in the follow-up had an open view on sharing responsibility. Other projects however, stated that they were primarily responsible for follow-up and that GPs were not systematically involved.

4.2.4 Experiences related to adaptations

The majority of teams faced challenges that prompted them to make adaptations to the project. These changes were related to operational challenges. The major problems that teams encountered were associated with 1) staffing levels (too low to recruit the desired number of patients), 2) quality of data (accuracy of data and alarms generated by the RPM system that were not always clinically relevant), 3) administrative burden in the project, and 4) logistic management of the project.

These problems prompted the following changes: 1) increases of staffing levels for the team, 2) replacing malfunctioning hardware in collaboration with individualisation of thresholds for certain patients and changing procedures to (4) decrease burden of administration and 5) optimize logistic management of the project. Examples of adaptations are presented in Table 27.

Table 27 – Examples of adaptations

Challenge	Number of projects	Adaptation
Low recruitment	2	More staff was recruited to help with recruiting and informing patients in the project. This was initially performed by nurses from the intensive care units, but the burden of the project was too high for them. Existing staff, e.g. head nurses, were asked to recruit patients on the units after half a year. This was not the original plan, but the workload was too high for the team. The head nurses received training to recruit the patients.
Quality of data: accuracy of the data and alarms	5	The number of questions were reduced to reduce the burden on patients. Some questions were also adapted. Thresholds for generating alarms based on RPM data were altered to deal with the large number of alarms. Changing the visualisation of the RPM data in their system, e.g. display of temperature curves to better monitor evolution. There were problems with thermometers that systematically reported measures that were too low. This generated many alerts in the RPM system. The team changed the thresholds for alerts and thermometers were replaced. This team also changed their measurement of respiratory rates and started using a patch to measure respiratory rates.
Administration	1	Administrative procedures, which were needed to recruit a patient and start the follow-up, were to lengthy and burdensome for GPs, and this was shortened.
Logistic management	1	Nurses were required to pick up RPM equipment from the hospital to deliver these to patients and bring it back. This was changed so that nurses also had equipment in their organisation.

4.2.5 Experiences related to opportunities

All the teams saw opportunities for improvement. These were related to three major categories: 1) design and capabilities of RPM systems, 2) communication and integration of RPM data in electronic patient records (across the different levels of care), and 3) project design for specific target populations.

System improvements were related to the interfaces used, communication within the team and with patients, and the types of (objective) measurements for parameters. Integration of data in electronic patient records was considered the most important opportunity for improvement. Team members perceived a need for 1) integrating data in the electronic patient records of the Telemonitoring teams, 2) communicating and integrating data between the electronic patient records of Telemonitoring teams, general practitioners and ambulatory care nurses. There was a fear that many RPM systems would co-exist in the healthcare system, and a need for a unified system that can communicate with the different electronic patient records was felt necessary. Teams believed that the government had an important role in defining and facilitating such a structure. One team suggested that a single RPM platform was needed. Ambulatory care nurses were perceived as an opportunity to reach and coach patients who do not have the 'ideal profile' for RPM, such as older patients or patients with no or limited digital skills.

> *"Moi j'aime ce garde-fou des infirmières, je ne m'en passerais pas. Je pense que c'est..j'étais très bien avec les télé-consultations, mais pour tous les projets d'avenir, je ne me passerais pas de l'infirmière à domicile qui m'a apporté une grosse plus-value. En confirmant ou en allant contre moi entre guillemets en me disant : "ah tu sais il n'est pas si bien que ça." Mais moi le patient m'a montré une belle image de lui sur la vidéo, alors que en réalité ça n'allait pas si bien que ça." - RPM Project 12*

Teams also felt that ambulatory care nurses could facilitate the measurement and input of parameters in the RPM system (which was already the case in some projects).

Challenge	Number of projects	Opportunity
Design and capabilities of current RPM systems	6	RPM system could benefit from more communication modules, e.g. leaving notes for colleagues in the system. This would improve the collaboration and communication and ensure continuity of care. Videoconferencing would improve communication with patients. Seeing patients is expected to give more information (i.e. concerning clinical status) than hearing patients. Add reminders to RPM system so that they can see when patients and RPM parameters need to be monitored. Developing medical devices that are both reliable and have a user-friendly interface, e.g. like the current sport watches. They see a potential for integrating sensors; and the use non-obtrusive measurements. Use instruction videos about the disease and RPM project to increase uptake of the intervention.
Communication and Integration of RPM data in electronic patient records	3	There are currently no bridges between the different systems of health professionals and organisations, which is needed. The RPM system should be integrated in the electronic patient records and all healthcare professionals involved in the follow-up should have access. It should be linked to existing platforms and not as its own platform. This would greatly increase the accessibility. Having multiple platforms running is a burden and not efficient for the implementation. RPM should also be modular and adaptable to different diseases. They warn against a new RPM system for each disease. A generic platform/system is needed that can be adapted to patients. One RPM team went further and suggested that RPM should not be linked to specific hospitals. The follow-up could be provided by a specialised center with nurses that communicate the data to the responsible medical doctors. However, not every team was positive about this concept. Medical doctors in particular found it important that they know and trust the nurses in the RPM team. A framework is needed that defines data access and integration of data in patient records. This was seen as a task for the government.
Project design for specific target populations	1	Use nurses to visit older patients receiving remote monitoring. This would have enabled the project to also recruit patients with a geriatric profile and ensure a safe discharge home. They also suggested to collaborate with nursing homes for follow-up of nursing home residents. The team felt that patients from nursing homes were sent to hospitals because the nursing home could not manage the follow-up. They experienced a lot of admissions from nursing homes. The RPM project could have supported the nursing home staff and decrease their workload by taking over some of the remote care, and support the staff in decision-making. Participation in projects could be improved when 'the public' knew about RPM as intervention. They suggested more media exposure.
Potential of RPM in near future	6	Several teams suggested (and expected) to use RPM for other diseases, i.e. diabetes mellitus, chronic obstructive pulmonary disease, and cardiac diseases.

4.3 Findings from interviews with GPs

4.3.1 Description of sample

Seventeen GPs were willing to participate and sixteen of these were interviewed between October and November 2021. One practitioner who initially agreed to participate could not be reached for an interview. The duration of the interviews varied between 9 and 35 minutes. The median duration was 21 minutes. Interviews were performed between October and November 2021.

Four general practitioners had experience with two of the NIHDI RPM projects. Three practitioners had experience with SafeLink, an RPM platform developed for the follow up of COVID-19 patients by GPs in Wallonia and Brussels. The remaining participants had initiated and self-developed an RPM intervention in their own practice. All but one worked in group practices. General practitioners' exposure to RPM ranged from experience in one to 152 patients. Most practitioners were not able to recollect the exact number of patients seen in follow-up, but the median was around five patients.

4.3.2 Description of GPs' role

RPM interventions developed through the NIHDI convention - These projects included in the NIDHI convention have already been fully described in other chapters of this report. What is relevant to the role of GPs, is that decisions on the technology used, the RPM procedures and structures employed, and the parameters to be monitored were largely taken by the Telemonitoring teams and with little involvement of GPs for the most part. In addition, the collaborators of these projects took care of the daily RPM routines and logistics (providing measurement equipment, installation of the application, access to a help desk etc.), as well as the provision of information and support for the patients during the follow-up. Commonly, GPs were informed of patients' inclusion in the RPM projects, which was most often at the time of hospital discharge- and were consulted if problems arose.

In one project, the GP also had the role of initiating RPM as a prehospital intervention and including patients via an interface. Here, the logistical aspects and actual monitoring were carried out by a central care dispatch center which managed the alerts generated by the system in the first instance. The GP was contacted if it was verified that the patient had deviant parameters. Prior to this, the professionals at the central care unit carried out the necessary checks to ensure that the patient's situation required the intervention of the GP.

RPM through SafeLink - The SafeLink technological platform, developed under the initiative of the Collège de Médecine Générale et SSMG, is connected to regional e-health hubs (RSW and Abrumet) and made available to GPs for the remote monitoring of patients with COVID-19. The system allows for the communication of parameters, and answers to standardised questionnaires completed by the patients. The GP is responsible for the patient, receives the information and alert notifications generated by the system. It is the GPs responsibility to check the quality of the data transmitted, to ensure that alerts are justified, and to offer necessary treatment and care. The registration of the patient on the platform, the information and instructions provided to the patient are also within the responsibility of the GP. Parameters monitored depend on the devices available to the patients.

Self-developed RPM interventions - Telephone or video-conferencing consultations were mostly used in self-developed RPM interventions. Many GPs organised telephone follow-ups of patients who tested positive for COVID-19. This was considered to be the most efficient, or even the only possible way to provide accessible care to their patient populations. In addition, it required no installation to be done and no added technical or connectivity issues. The telephone was also used to follow up on patients living in areas that were less well served or without sufficient access to the Internet. Some GPs also used video conferencing software if the patient was comfortable with this option. Patient follow-ups were more or less structured, took place at regular time intervals and evolved during the pandemic. The parameters measured depended on the capacity and devices available to the patient (pulse oximeter, thermometer, blood pressure monitor, etc.).

4.3.3 *Experiences related to quality of care, patient needs and patient and health system outcomes*

Five themes were identified in the interviews with GPs.

RPM enabled GPs to inform and communicate with patients about their disease and its management

GPs indicated that patients needed information on 1) the follow-up and what was expected from them (e.g., when to contact he GP and in case of which problem or deviant parameters) and 2) COVID-19 in general and general regulations on quarantine or isolation. Communication between patients and their GP was an important determinant of success. The information that GPs gave to patients also had to evolve in view of changes in knowledge, policies and procedures. According to the GPs, this information should always be based on current the scientific knowledge). GPs noted different information needs as patients' questions related to variable topics such as instructions for RPM, COVID-19 symptoms and symptom progression, management of symptoms, feedback on COVID-19 progression and recovery, safety and quarantine procedures.

Patients valued personal contacts with their GP

GPs indicated that patients valued and expected to receive follow-up by their GP. GPs explained how patients trusted them and they perceived it as their responsibility to follow-up on patients' disease trajectory. This was illustrated by a case where several patients dropped out of a NIHDI project because they preferred follow-up from their GP. Some GPs explained the importance of the personal relationship with the patient based on trust. GPs felt they were the key point of contact with the healthcare system for their patients and that patients trusted them to decide if RPM was appropriate for them.

> *"Een huisarts is dan in feite een vertrouwenspersoon die hen een beetje de weg kan leiden naar behandelopties en die zaken. Dat is toch wel een meerwaarde die wij kunnen bieden dan als huisarts." - GP 13*

In this context, the GPs were able to, on the one hand, discuss different treatment alternatives and to guide patients in the follow-up of the disease. On the other hand, they were able to give psychological support to patients who were isolated, were anxious, had psychological problems, or who had a particularly complicated family situation.

Patients were reassured and felt safe

GPs expressed how patients were reassured by the follow-up they provided. According to the GPs, the patients became aware that through the monitoring of the parameters, the GP was really involved. This made some patients feel more secure because they felt that they were cared for and not left to their own devices. GPs felt that communication with their patients was an important determinant for RPM's reassuring effects. The reassurance that GPs were able to provide also depended on the patient's personal situation and degree of anxiety.

RPM affected GPs' burden and workload

GPs experienced the COVID-19 pandemic as particularly challenging, i.e. in relation to having to follow up on many patients with limited resources and thus needing to reinvent their practice. Some GPs mentioned how they felt exhausted, stressed and anxious.
RPM provided GPs with a means to deal with the workload and burden resulting from the COVID-19 pandemic. For instance, RPM provided an alternative to home visits and consultations and gave GPs a sense of control over the situation although the workload remained high.
For several reasons, GPs associated RPM with an even higher workload, although experiences and opinions differed. Some general practitioners who collaborated with the NIHDI projects reported a high administrative burden. They were asked to complete background information on the patients to be recruited in prehospital RPM pathway but did not have time for this. Also, some GPs explained how several telephone contacts with the Telemonitoring team were required in order to provide and verify all the information relevant to the patient's follow-up.
GPs outside the NIHDI projects experienced an increased burden because of the very large number of patients with COVID-19 who had to be seen in follow-up. GPs recounted that, during periods when RPM almost completely replaced face-to-face contacts with patients, the reorganisation of their

practice and implementation of the RPM system had also taken considerable time. Several GPs reported that the workload was related to the number of alerts.

"J'ai eu des tas d'alertes rouges parce que les gens s'étaient trompés, ils avaient mis la fréquence respiratoire dans la fréquence cardiaque et donc ben oui avec 12 de battements cardiaques par minutes effectivement on avait une alerte tout de suite. Alors quand on les appelait on nous disait : Ah ben oui je me suis trompé de case." - GP 02

One GP who had used the SafeLink platform for instance, explained how RPM had led to many telephone calls in order to deal with false alarms and incoming questions. At times, this GP felt he was always on the telephone or on a video-conference platform, even at night. Patients also had many questions, thus adding to the GP 'workload.

> *"Dat ze nogal veel praktische vragen.... Iemand die vrij vragen aan de telefoon stelt - ja wacht ik heb nóg een vraag. Ja ik heb nog een vraag. En die patiënt dit, en die patiënt dat. En dat bleef maar duren en op het moment heb je daar eigenlijk ja. Denk je van ik wil hier wat hulp hebben en het geeft mij precies nog wat meer werk" - GP 01*

A few GPs felt they had saved time, for example because RPM reduced the time they used to spend on the road to do home visits. GPs who collaborated with one of the NIHDI projects relied on a TM service organised by the dedicated Telemonitoring team. This team was responsible for monitoring the parameters and alarms, and -if indicated- they contacted the GP for medical follow-up. This system decreased the workload of GPs.

GPs were reassured

GPs found RPM reassuring as it provided them with information about the disease progression of their patients. The information allowed them to detect problematic situations and to refer to the ED when necessary. In the context of the unpredictability of the course of COVID-19, RPM offered an alternative for monitoring patients. According to several GPs, RPM allowed them to intensify the follow-up of parameters and to have more frequent contact with patients as to better identify inflection points in the patient's evolution. In the case of the general practitioners involved in NIHDI RPM projects, this was possible through the intervention of the monitoring service and the ambulatory care nurses. GPs perceived that RPM had also made it possible to anticipate complications and monitor the appropriateness of treatment. Through repeated measurement of parameters, GPs felt able to give more objective follow-up instructions (e.g. the saturation values at which a patient would have to contact their GP). This also contributed to the GPs' feeling of security.

4.3.4 Experiences related to implementation: barriers and facilitators for successful RPM

Eight themes were identified in the interviews with GPs. Three themes were related to the RPM intervention, one theme related to the patients receiving RPM, and two themes were related to incentives and resources, and to social, political and legal factors related to RPM and its delivery.

4.3.4.1 Factors related to the RPM intervention

Selection of patients with the right profile was not always easy

GPs experienced difficulties in selecting 'the right patient' for RPM. They felt there were two general criteria: 1) the clinical need for follow-up (i.e. the risk profile), and 2) the acceptability of TM as intervention for individual patients (i.e. the compliance profile).

GPs generally agreed that monitoring all patients with Covid-19 was not needed nor feasible. They made a selection based on published criteria (e.g. using a decision flowchart) or based on clinical judgement. They targeted patients they considered at risk for deterioration or hospitalisation. Several GPs stated that they missed formal guidance for the selection of patients, and that selection criteria also changed as more information about the disease became public.

GPs involved in the NIDHI projects observed that not all patients found RPM acceptable. They recounted that the concept of RPM was mistrusted by some patients and that patients preferred 'face-to-face' follow-up by their GP. Some patients were not used to handling devices or filling in

questionnaires; they were suspicious and would have preferred the GP or someone else to do it for them. Some patients did not feel comfortable with technology in general, or with having to measure parameters on a regular basis. According to the GPs, mistrust in RPM resulted in dropout of some patients.

> *"Donc les patients qui ont refusé, ce sont des patients qui soit se méfiaient de...qui avaient peur d'une non-confidentialité des données. Malgré les explications qu'on a données sur le fait que c'était sécurisé, etc, ils avaient quand même peur." -GP 08*

The therapeutic relationship facilitated follow-up

GPs felt that knowing their patients (both their personality and medical history) was a key facilitator for the success of RPM. They felt that they had a key position in the RPM trajectory, although views about what their role was differed between GPs.

GPs who implemented their own RPM system felt that follow-up of patients was a key role for them. They referred to the importance of knowing their patients when interpreting their answers or parameters. They also found it beneficial to understand the context of patients when needing to guide their interpretation and management of COVID-19. GPs further indicated that patients expected them to be involved in their care.

> *"D'abord...il y a deux raisons. D'abord, c'est que on peut, connaissant les patients, on peut savoir un peu le crédit qu'on peut apporter à leur évaluation. Et euh...donc euh voilà. Il y en a qui exagère toujours un petit peu, il y en a qui sont plutôt rassurants…Donc ça, euh le fait de connaître les patients ça aide quand même un peu." - GP 16*

> *"J'ai des patients, je savais que quand je leur disais, ou que le tracing leur disait, qu'ils étaient COVID positifs, leur vie d'effondrait, quoi. Pour des raisons qui ne sont pas toujours médicales, mais parce que c'était des indépendants, qui allaient devoir fermer pendant quinze jours. Euh…parce que euh...parce qu'ils avaient un mari, un enfant ou autre, immunodéprimé à la maison et qu'ils se sentaient super coupables... " - GP 15*

GPs who participated in the NIHDI projects had a somewhat different view on their roles. They wanted to be responsible for recruiting patients in the pre-hospital trajectory, but trusted the nurses to follow these patients on a daily basis. They did refer to the importance of staying connected with patients in addition to regular RPM follow-up because patients valued this relationship and they felt responsible for the patients' quality of care.

Flexibility essential for tailoring follow-up

GPs who had their own RPM system stressed how its flexibility was important as to adjust follow-up in function of patient needs and their own or the team's capacities. The frequency and duration of the follow-up was adapted to the patient's situation and condition. Thus, there could be several contacts per day, only one contact per day, one contact every 48 hours, etc. This frequency was determined according to 1) the symptoms and their evolution, 2) the social or psychological situation of the person, 3) the person's state of anxiety, 4) the need for advice or guidance, 5) the need for obtaining information to complement the parameters, and 6) the need for treatment adjustments.

In SafeLink, the rhythm of follow-up was determined by the GPs in advance, while initiatives were put in place to facilitate the patient's contact with the GP or a member of the team. For example, one practice had activated a specific telephone number, while others were reachable 24 hours a day, every day of the week through the organisation of a duty service. Some GPs allowed the patients to contact them if they wished to be seen in consultation or during a home visit. The duration of the follow-up was adjusted to the patient's needs and the end of the follow-up was decided by mutual agreement with the patient. GPs believed that all these variations in the delivery of RPM were crucial and that such flexibility supported successful implementation of RPM. Some RPM platforms allowed the alert thresholds to be set individually, depending on the patient, which was particularly appreciated by the GPs.

4.3.4.2 *Factors related to the patient receiving RPM*

Patients needed knowledge and skills to participate in RPM

GPs indicated that patients needed education and support to be able to participate in RPM interventions. Patients were expected to have a sufficient understanding of the values measured during RPM. This included information on the symptoms they needed to observe, the interpretation of the RPM parameters, when to seek help and how to perform a reliable measurement.

This was related to engaging patients in their role of 'participants' in RPM. Patients needed to know what to expect from the GP and what the patients' role was.

Some patients had difficulties in expressing their symptoms clearly due to a lack of vocabulary and needed help of their GP. Others had technical difficulties because they knew how to use their smartphone but not all its functionalities, for example how to start a video call in WhatsApp. Some GPs explained that it was not easy for some patients for example to find a carotid and measure pulses. This could be aggravated by the patient's state of anxiety.

> *"Donc je me souviens d'un moment avec une dame je lui explique : voilà, vous sentez bien la pulsation ? Oui, okey. Vous allez les compter et on va mesurer sur 30''. Et allez, je dis : allez y compter, et puis après 30 secondes je lui dis : voilà, vous avez combien ? Vous avez compté combien ? Ben 30 secondes qu'elle me dit. Oui mais vos pulsations ? Ah ben, moi j'ai compté les secondes" - GP 05*

In some RPM platforms, patients had to register their parameters online, and they had to understand the abbreviations used for the different parameters. For example, where it was marked SaO2, 'oxygen saturation rate' had to be added, and patients did not know what this abbreviation (SaO2) meant. According to GPs', better results would have been obtained if the GPs had been able to explain and show all this in consultations, rather than over the phone. Some patients had more difficulties with typing in the RPM platforms, and when they did not use a comma or a full stop this caused coding errors (e.g temperature equal to 378°C).

> *"Ça ce sont des patients qui ont du mal à mettre un point ou une virgule" - GP 08*

4.3.4.3 *Factors related to incentives and resources*

Access to RPM equipment was limited for some patients

Materials needed for the implementation of RPM were not always available. Some patients had all the instruments needed for RPM in their homes. However, not all patients had access to thermometers or pulse oximeters because they were not affordable, or they could not be purchased as they were out of stock. At certain times during the pandemic, patients had not been able to buy or rent pulse oximeters. Some GP practices had a small stock of pulse oximeters, which they were able to loan to some patients. However, the quantity was not sufficient to provide instruments to all patients. Several GPs mentioned that for those who did not have a device for measuring their parameters, monitoring on the basis of heart rate was advised. In some cases, the GP had to explain to people how to take this measurement over the phone.

> *"Ceux qui n'avaient aucun appareil de mesure, ce que je suivais c'était la fréquence cardiaque. Et donc je leur expliquais comme la prendre. Donc comment compter au niveau du cou en regardant leur montre etc., et de me dire un petit peu où ils en étaient" - GP 07*

Others explained how they assessed breathlessness in the absence of a measuring device.

RPM required sufficient capacity in practices and could challenge organisational structures

GPs experienced the human resources available as crucial for the implementation of RPM. Some GPs managed the follow-up on their own, but others experienced the need for administrative support or support from nurses for monitoring of parameters or home visits. The burden of RPM was

considered very high and team capacity was considered important. Some suggested that multidisciplinary practices were a facilitating factor or even necessary factor to organise the follow-up.

> *"(...) maar als je geen team hebt kan je niet doen wat wij gedaan hebben. Je kan niet een verpleegster om de hoek gaan vragen of zij wil gaan opbellen. Je hebt teams nodig die elkaar kennen, die op elkaar ingespeeld zijn, dat vraagt jaren werk om elkaar te leren vertrouwen en te helpen door het leven en elkaars problemen en kleine kantjes te leren kennen en dat te durven zeggen, misschien feedback te durven geven" - GP 03*

In some multidisciplinary teams the follow-up activities were shared among the team members, which allowed for greater efficiency. Some GPs working in multidisciplinary teams, through this experience, discovered the advantages of a RPM system which they thought should remain part of the new practice organisation. Other types of practices developed other strategies such as, for example, the integration of RPM into the GPs diary. Good organisation and the delegation of certain tasks to other professionals was crucial for remote monitoring. One GP who worked alone explained that he had received help from other colleagues because he could not visit patients at home due to his advanced age.

> *"euh...quand il fallait vraiment aller voir le médecin...euh le patient, certains confrères alors y allaient à ma place. Donc on a eu là une euh...une entraide. Qui a été quand même exceptionnelle." - GP 04*

The GPs in the NIHDI projects relied on the collaboration and partnership with ambulatory care nurses, who provided regular follow-up. However, one of the GPs involved in this project added that it would be necessary to think about how to build an efficient structure within the practice to follow the patients through all the stages of the RPM trajectory. Another added that as a mono-disciplinary general practice, they lacked sufficient staff, the help of other professionals (administrative, nursing, practice assistants...) to support the RPM activities. Beyond efficiency, it was a question of quality of care.

> *"Wij huisartsen, wij zijn in deze periode veel minder bereikbaar geweest, we moeten daar ook nog aan werken. Maar zij konden eigenlijk sneller terecht bij [one of the NIHDI projects], de verpleegkundige, die hen dan eigenlijk te woord stond. Dus dat is, daar zag ik ook het nut van de verpleegkundigen, ik zou dat eigenlijk beter in mijn eigen praktijk ook hebben, dat ze eigenlijk daar als tussenpersoon eerst sneller terecht kan." - GP 14*

4.3.4.4 Social, political and legal factors related to RPM and its delivery

Remuneration of RPM was not sufficient

GPs felt that the current remuneration by NIHDI was not adapted to the work that was needed for RPM. Although teleconsultations can be billed, the time that was needed for administration and monitoring parameters was not compensated. However, this experience was different for GPs based on the type of their practice. GPs in community centers could rely on nurses to assist in RPM. However, not every GP was convinced that this was the right structure for their practice, or that they would benefit from it in relation to RPM. Centers recognised as integrated associations in Wallonia were seen as having benefited from regional funding for these activities.

GPs who used SafeLink were able to bill 5 services in the framework of the NIHDI nomenclature. However, this was not enough to cover the activity when the system (in this case SafeLink) asked to call the patient back 3 times a day.

> *"Alors je ne pense pas qu'on soit forcements complètement géniaux mais je pense que tout un travail mérite salaire et si les recommandations font qu'on doit travailler à un certain rythme ben c'est un peu logique que le salaire suive ce qui nous ai demandé." - GP 16*

Uncertainty about legal framework in relation to medical accountability

GPs were uncertain or did not know how current legal frameworks applied to RPM. The GPs shared a number of uncertainties related to the medico-legal responsibility in relation to RPM. There were also concerns about the (lack of) continuity of monitoring, e.g. the impossibility to be available 24 hours at all days.

> *"Ge hebt de groep waar [one of the NIHDI projects] al zei van oké, we bellen die op en die gaan naar het ziekenhuis. En ge hebt die grijze zone, en de huisarts was eigenlijk verantwoordelijk voor die grijze zone, van wat doen we ermee" - GP 14*

4.3.5 Experiences related to adaptations

Only one adaptation was discussed in an interview with a GP from one of the NIHDI projects. In this case, the GPs in the practice had to complete a lot of administrative information about patients they had recruited. This included background sociodemographic and medical information. This procedure was changed to reduce the burden on the general practitioner.

4.3.6 Experiences related to opportunities

GPs also saw opportunities for improving the communication with patients, e.g. the integration of videoconferencing tools in medical records. For them, the RPM system should offer the possibility of using video as well as recording the exchange to keep a record of the consultation.

The future widespread use of RPM in the context of chronic disease monitoring seemed inevitable for the majority of GPs, regardless of their personal affinity with the technology. According to the participants, this evolution could allow a closer follow-up of patients with chronic diseases without necessarily replacing contacts.

> *"Vraiment, la saine alternance entre le distanciel et le présentiel. Pour moi, il faut…oui, il faut continuer de voir les gens. Je...ça me paraît important que le...le télé-suivi existe, mais garder en tête qu'il n'est pas la panacée." - GP 07*

According to one of the GPs, the shortening of hospital stays means that primary care is more and more confronted with the follow-up of patients with serious pathologies. RPM could strengthen the capacity of primary care to adapt to these changes. Several participants mentioned the worsening shortage of staff and the existence of "medical deserts" with insufficient GPs in a certain region. In both cases, RPM was seen as a means to support the emergence of new models of interprofessional collaboration between GPs and other professionals. GPs also noted that if this system were to be developed, it would have to consider that there are areas that are less well served in terms of 4G or internet networks.

During the pandemic, some GPs made themselves available on a continuous basis, as to monitor parameters and answer questions. This availability was justified by the exceptional context of COVID-19. To make RPM sustainable however, they felt the system would have to rely on an intermediate structure of care providers between the patient and the GP. This structure would have to be responsible for monitoring the parameters and checking the quality of the information transmitted by the patient. In their view, members of this structure would then contact the GP when it would be considered necessary to intervene with the patient. They thought this type of service could be linked to other existing services or organised within general practices with additional staff.

Finally, the GPs believed that RPM could benefit from increased familiarity of the concept with the public. They thought, information campaigns addressed to patients and GPs could increase the acceptability of RPM by potential users (via the health insurance agencies for example).

4.4 Findings from interviews with ambulatory care nurses

4.4.1 Description of sample

A total of twelve nurses participated in four focus group discussions and one individual interview between September and October 2021 (see Table 24). These nurses collaborated with four of the NIHDI RPM projects. The duration of the interviews was on average 56 minutes and ranged between 49 and 83 minutes. The interviews were performed between September and October 2021. All the nurses had collaborated with a single RPM team and there was a formal partnership in the project for the follow-up of patients with COVID-19. Only two nurses were self-employed as the remaining worked as employees in an organisation for ambulatory nursing care.

4.4.2 Description of the role of ambulatory care nurses

Most often, nurses had a logistical and technical support role in registration of the parameters. The nurses intervened on call when the Telemonitoring teams observed deviant or missing data. Some teams also provided nursing care to patients and routinely measured patient parameters.

Normally, the Telemonitoring team would inform the manager or coordinator of the ambulatory nursing team of the patient being discharged or his or her inclusion in the RPM project. A minimal amount of information about the patient was transmitted at this time by telephone or by a messaging system, such as the requested number of visits by the ambulatory care nurses, specific care needed and type of parameters to measure. Participants reported that they received insufficient information about the medical history and the duration of contagiousness needed to understand the patient's whole situation (i.e. other chronic conditions). Within the nursing teams, the coordinator or the manager organised home care according to the rounds and the nurses available that day. Organisations tried to work with a dedicated team of nurses, but this was not always possible. Nurse organisations defined the Telemonitoring teams on the basis of their existing teams but tacking into account criteria of geographical reach, flexibility or previous experiences with innovation projects.

The first visit usually happened on the same day at the patient's home for the installation or the first connection of the devices with the application. For the next visits, the frequency of visits was either predetermined by the procedure of the RPM project (e.g. visits on day 1, 7 and 10 if the patient had no problems) or prescribed by the physician responsible for other care that the patient required (e.g. care supporting ADL activities, injections, wound care). Other visits could also be arranged when the patient had technical issues (e.g. connectivity issues between the devices and the smartphone). On these occasions, ambulatory care nurses also re-explained the instructions for using the system and gave tips and tricks.

When alarming values or changes in the patient's situation were observed, the ambulatory care nurses informed the RPM team. In the other way, when an alarm due to deviant values was observed by the Telemonitoring team or when the patient did not enter the parameters, they contacted the ambulatory care nurses and asked them to check the situation. A nurse then went to the patient's home to check parameters and health status and provided feedback to the RPM team.

4.4.3 Experiences related to quality of care, patient needs and patient and healthcare system outcomes

Four themes were identified in the interviews with ambulatory care nurses.

Not all the patients were eligible for RPM

Nurses observed that not all patients who could benefit from RPM were included because of several obstacles, e.g. not every patient had a smartphone, or mastered the language sufficiently, or had internet access. One team reported that patients staying temporarily in Belgium did not always have a valid phone number to download the application. According to one team, someone who was very ill did not have the energy to measure his or her parameters and answer the questionnaires. Nurses also expected that it might be more difficult for older persons to understand the benefit of RPM compared to hospitalisation.

"Een 80-jarige denk ik dat dat voor hen bijzaak gaat zijn, dat ze misschien ook niet gaan het inzicht hebben van wat geeft dat als voordelen tussen ziekenhuis en thuis. Misschien gaat dat moeilijk zijn om hen dat inzicht te geven, denk ik." - Nursing team 1

Organising safe care at home was a concern

Nurses were challenged by circumstances when patients were in isolation. Isolation and hygiene measures had to be rigorously applied. Nurses reported that they had the necessary protective equipment, but putting it on required time. Before coming into contact with the patient in his/her home, the ambulatory care nurses had to put on protective equipment (gown, gloves, mask...) in a "clean zone", which was not always available within the house. Therefore, this "clean zone" was sometimes created outside the house, which could lead to privacy issues:

"Ja, maar ik wou nog één ding toevoegen, want uhm bij de mensen, vooral bij de COVID-patiënten, als je binnen kwam moest je echt volledig omgekleed zijn om beschermd te zijn tegen de aandoening en dat was voor mij echt het moeilijkste. Want je moest eerst voor de deur van de mensen proberen te omkleden, soms is dat echt op straat en iedereen ziet dat, sommige mensen weten zelfs niet dat die patiënt COVID heeft en door die voor de deur te omkleden, weet iedereen dat die patiënt of die mensen die daar wonen COVID heeft." - Nursing team 02

The nurses also had to deal with interactions with other family members who lived in the same area and with the awareness that these people had for hygiene measures. This made the task more complicated. In some cases, they had to dress in the street or in the common areas of the building. Some patients were embarrassed because of this lack of privacy and asked the ambulatory care nurses to change into their protective gear in the living space. Because of these hygiene measures, it was also necessary to adapt the way of working, e.g. nurses were used to working with their tablet to register observations but these could not be taken in the patient's house because of possible contamination of the equipment. Once the care was finalised, they had to think about how to apply the quarantine hygiene procedures.

"Ja vooral omdat je van COVID dan ook wel euh van COVID-patiënt naar u gewone patiënt op de ronde gaat. Het is niet dat het COVID-ronde was dat wij deden. Dus euh inderdaad dat vraagt dan wat denkwerk he. Uw auto, uw sleutels, uw handrem." - Nursing team 01

Nurses aimed to see patients with COVID-19 at the end of their rounds to minimise transmission risk, but this was not always possible.

Interactions with cohabitant family members were sometimes difficult, because of the lack of awareness that these people had for hygiene measures. This made the task more complicated

Different patient needs required different follow-up

According to the ambulatory care nurses, the need for patient support depended on several factors. This included the severity of illness and symptoms, health literacy, technological skills and other care needs. For those patients with less severe forms of the disease who were able to manage the technical aspects of monitoring independently, the added value of home nursing support was limited and some declined to receive follow-up (as they perceived this was not needed for them). On the other hand, older patients and socially isolated patients valued the continued follow-up and a proportion of patients requested more follow-up than once daily as defined in the protocol.

"Bij sommigen zou dat compleet fout gelopen zijn he, daar moogt ge gerust in zijn. Dat zou niet opgevolgd zijn, die zouden niet geweten hebben of ze correct bezig waren bij een aantal zaken. Dus het is ergens gewoon die houvast, zo dat tussenstuk tussen volledig alleen thuis zijn maar toch nog ondersteund worden" - Nursing team 03

Two nursing teams were able to answer positively to the requests for increased follow-up of patients.

"Je pense qu'en fait, par rapport à la COVID, tout le monde ne l'a pas eu de la même façon non plus. On n'a pas été touché de la même façon donc je pense qu'il faut faire du cas par cas. Et c'est vrai qu'il y a des gens où on allait qu'une fois par jour et c'était très bien comme ça, mais il y en avait peut-être d'autres qui auraient mérités deux ou trois passages, quoi. Mais ce n'était pas toujours possible." - Nursing team 05

However, one team noted that they were limited in what they could do by the doctor's prescription, in which duration and frequency of follow-up is described and on which the payment depends. Therefore, the ambulatory care nurses felt that they did not have the authority to make changes in the planned care.:

"Dat geeft toch een echt fijn vertrouwensgevoel als de patiënt voelt van oke die bellen hier makkelijk en dat ziekenhuis belt hier terug en die weten eigenlijk alles over ons ziek zijn en dat wordt gevolgd. Eigenlijk is dat wel een goed gevoel he. Zo zou het ook moeten kunnen bij die oudere geriatrische patiënten […] Wat dat we deden op dag 1 en dag 7 gaat misschien meer moeten op dag 3 en op dag 1, he allee. Korter op de bal misschien." - Nursing team 01

Participants stated that, in general, patients were stable at hospital discharge and the need for support by ambulatory care nurses decreased as their condition improved and as they became more familiar with the RPM. Where possible, ambulatory care nurses adapted the number of home visits based on the following patient needs:

- The need to verify parameters (e.g. patients forgetting to measure or transmit data, or when dangerously outside the agreed range);
- The need for support and reinsurance of patients and their relatives;
- The need for other nursing care (e.g. wound care, diabetes monitoring, among others);
- The need for information (e.g. physical activity and COVID-19);
- The need to test the devices which were not working well;
- The need for extra social support (e.g. asking neighbours when the patient is too ill to buy food) or help for translation.

Reassuring patients that they are safe

Ambulatory care nurses felt that their presence and the technology helped patients to overcome their anxiety and doubts and was a reassurance. Face-to-face contact seemed particularly important for patients who were alone, isolated or had more severe forms of the disease. Nurses believed that their presence gave patients a sense of safety. The personal contact of the ambulatory care nurses with the patients was complementary to the follow-up done by the RPM team. In general, the RPM provided a sense of security at a distance for patients but for many isolated patients it was not sufficient to reduce anxiety, as experienced by the ambulatory care nurses.

"De angst die er natuurlijk in zit bij de mensen, dat is. En ja die onmacht he. Dat ze (***). Dat ze eigenlijk niets kunnen doen he. Hele fitte mensen, heel sportieve mensen die eigenlijk zelf de trap en de trap af, en die buiten adem waren he. Die dan echt voor hunzelf moesten zeggen van goh mens toch. Ja. Een klein beetje ja. Een beetje morele steun eigenlijk ook bieden. Niet enkel die parameteropvolging maar effectief echt luisteren naar hun gevoelens, naar hun verhaal eigenlijk." - Nursing team 04

For some patients, the ambulatory care nurse's visit was the only contact with an outsider at emotionally difficult times due to contact restrictions. In addition, the nurses also helped the patients to make sense of the measurement results and symptoms during this recovery process. For example, when the ambulatory care nurse arrived, a patient was very worried because the last measured saturation value was low. The nurse asked the patient about the activity he/she performed before the measurement and reassured the patient that the effort made just before the measurement could explain the alarm for the low oxygen saturation. This reduced the patient's anxiety about the "bad" result. Emotional support and listening contributed to the relief of anxiety. The feeling of having meant something to the patient, of having been able to reassure them, of having

been able to help is important for the ambulatory care nurses. This was seen as a source of job satisfaction.

> *"Omdat, ge betekent iets voor hen, want gij alleen moogt gaan en gij alleen kunt hun geruststellen en ge zijt echt wel een houvast voor die mensen. En dat geeft u uit uw beroep die voldoening van uw werk, ook wel. Niet dat ge daarbij stilstaat, "Ah morgen komen die misschien als patiënt bij ons" ofzo, dat niet, maar ge hebt die kunnen helpen. En dat was eigenlijk- vond ik wel voldoende." – Nursing team 03*

4.4.4 Experiences related to implementation: barriers and facilitator for success

Four themes were identified in the interviews with the ambulatory care nurses. One theme was related to the RPM intervention, to the professional interactions, to incentives and resources and to the social, political and legal factors related to RPM and its delivery.

4.4.4.1 Factors related to the RPM intervention

No access to RPM data (and other clinical information on patients) was a barrier

Nurses did not have access to the RPM system. For some of them, this was not experienced as a barrier because their main task was installing and initiating the RPM at the patient's home. When teams perceived their task beyond installing and initiating, having no access to the RPM data was perceived as a barrier. They reported missing important information about the patients, e.g. medical history, contagiousness status and RPM parameters or not being able to register the parameters in time, as is illustrated in the case of one project, in which nurses observed RPM parameters for patients who could not use the app themselves. However, because nurses had no access to the system, they could only register the parameters at the end of their shift. As a result, the Telemonitoring team did not receive the parameters in time. The system was designed to report missing parameters when these were not put in the system in the morning, and reminders were sent while the parameters had been measured.

4.4.4.2 Factors related to professional interactions

Good collaboration and communication with RPM partners

Nurses experienced a good collaboration with Telemonitoring teams, which was based on trust between the teams, partnerships between organisations, and was experienced as supporting for nurses. Trust and communication were important determinants for a good collaboration, and this was specifically appreciated in case of problems, by two ambulatory nursing teams. Nurses experienced that they could contact their partners for help and experienced that they always received help. Having a number of dedicated contact persons and experiencing that you will be helped, facilitated the communication. Furthermore, nurses found it important that teams knew each other.

Two nursing teams had existing collaborations with the hospitals of the Telemonitoring teams. This was an important determinant for their participation in the project and resulted in an efficient collaboration.

> *"Ja, wij deden de COVID-testen aan huis he. En wij gingen veel vaak gingen we naar het ziekenhuis, wij lopen daar wekelijks binnen en wij kennen die mensen en wij kennen het labo en wij kennen die mensen die daarmee bezig waren en dat kwam zo ter sprake. En dan is, dan hebben wij dat ook aan onze directie verteld als ze gingen dat eventueel implementeren. En dan die hoofverpleger hè was daar ook bij betrokken en we waren aan het babbelen toen en dan hebben we echt wel gezegd van oké dat zou wel tof zijn. En dan zijn wij echt wel uitgenodigd via, allee dat is via de directie dan gegaan denk ik." - Nursing team 01*

> *"Euh dan gaan ze dat bijvoorbeeld. Ze kennen ons bijvoorbeeld bij naam. Als ze dan een idee lopen in het ziekenhuis dan gaan ze zeggen van ah oke we kennen daar mensen in het [nursing team 1]. Die vraag komt dan wel niet rechtstreeks bij ons, maar bij de directie. Maar is wel voortgevloeid van het feit van we kennen die mensen, wij zien die mensen vaak." - Nursing team 01*

4.4.4.3 Factors related to incentives and resources

Dedicated nursing teams facilitated the implementation

Nursing teams found that working with dedicated nurses beneficial because it facilitated training and building experience with the project and RPM equipment. Working with a smaller dedicated team of nurses was considered efficient by the nursing team as not all nurses are sufficiently proficient to work with the system.

> *"Wij zijn met uh heel veel verpleegkundigen. […] Maar wij hebben natuurlijk geprobeerd uhm binnen het project van het telemonitoring om zo weinig mogelijk verschillende mensen te betrekken. Uh gezien de opleiding en de kennis van toestellen toch wel noodzakelijk was." - Nursing team 02*

Apart from external training, nurses also acknowledged the importance of learning through experience and by discussing problems with their colleagues. However, it was not always possible to organise dedicated RPM rounds because of the distance between patients. This meant that sometimes additional nurses with less experience had to be involved. In that case, one nursing team explained that it helped them to have a dedicated contact person in the team to coordinate with the RPM team at the project level. This enabled them to collaborate with each other efficiently.

> *"Ik denk dat het heel goed is van het, was, een aanspreekingspunt. Wij waren het aanspreekpunt. Wij kennen ook de verdeling binnen onze organisatie dus we weten zeer gemakkelijk naar wie dat we wat moeten delegeren waardoor dat we eigenlijk daar nergens op gebotst zijn van dat werkt niet of." - Nursing team 01*

4.4.4.4 Social, political and legal factors related to RPM and its delivery

Nomenclature is not adapted to tasks for nurses in RPM projects

Current NIHDI nomenclature is not adapted to the tasks that nurses performed in the RPM project. Nomenclature is based on regular care visits and some nurse interventions, but measuring parameters is not part of them. Nurses also had to perform time-consuming logistic activities that are not sufficiently compensated under current reimbursement practice. Nurses were dependent on prescriptions of medical doctors, which restricted the range of activities they could perform.

> *"Maar we hebben eigenlijk de specifieke thuisverpleegkundige nomenclatuur in het kader van covid gebruikt om onze bezoeken aan de patiënt eigenlijk te kunnen factureren aan het RIZIV. Uhm en daarvoor hebben we natuurlijk altijd een voorschrift nodig van een arts om dat te kunnen factureren." - Nursing team 02*

Nurses felt that a different funding scheme was needed as billing patients per visit would be too expensive. However, funding was not an important motivator for implementation. Nurses implemented the project because they felt responsible for delivering good care.

4.4.5 Experiences related to adaptations

Only a few adaptations were observed by nurses. One nursing team had to change the logistic organisation, i.e. nurses had to collect the RPM equipment from the hospital and deliver it to patients. They changed this and the nursing team kept a stock of RPM equipment to be able to work more efficiently. One nursing team had a patient with a 'foreign' cell phone. The RPM app was not available in the app store for that patient. The RPM team changed the license so that the app was available worldwide. Nurses had to change the organisation of their rounds because some patients were in isolation. However, this was not really perceived as a barrier for the project.

4.4.6 Experiences related to opportunities

Nurses believed in the potential to add other monitoring equipment, e.g. blood pressure, for remote monitoring of other diseases. They see a lot of potential for monitoring patients with a chronic disease, e.g. diabetes, heart failure. They also saw an opportunity to use the RPM system to communicate with patients, nurses, general practitioners and hospitals. They envisioned an integrated system with access of all persons involved in the follow-up. They also believed that there was potential to also include more older persons in the projects. A different organisation of the follow-up would be needed where nurses would visit patients daily or multiple times a day.

5 DISCUSSION

This chapter presented results from interviews with patients, Telemonitoring teams, GPs, and ambulatory care nurses. We aimed to understand how RPM was experienced in relation to the patients' illness experience, needs, care delivered and received, and outcomes. We also explored what factors contributed to, or hindered the implementation of the projects, what adaptations were made and what could be improved in future projects of RPM.

To fully understand the findings, it should be noted that the COVID-pandemic was characterised by uncertainty and anxiety for both patients and healthcare professionals. Patients who contracted COVID-19 were fearful of serious symptoms and even dying. At the same time, healthcare professionals were faced with an unknown disease they could potentially contract themselves as well, and with a progression that was difficult to predict; silent hypoxia was a fear that was often cited in interviews. The pandemic challenged the capacity of hospitals but pushed primary care professionals to their limits at the same time. The RPM projects were initiated in this context and the RPM intervention was an attempt to manage the burden of COVID-19 on the healthcare system.

An important observation was that RPM was designed, implemented and delivered from the perspective of hospitals, in all but one of the twelve projects. This means that in most projects, there was no dedicated or systematic role for GPs or ambulatory care nurses. Projects had notified GPs that a RPM project would be implemented, and most Telemonitoring teams tried to notify GPs once a patient was included in the project by stating this in the discharge letter. While a few Telemonitoring teams contacted GPs directly to discuss patients, the majority only advised patients to visit their GP. Only four Telemonitoring teams collaborated with ambulatory care nurses to support patients with the installation and use of the RPM system; nursing teams had a different function or contribution in the projects. One project defined itself as an integrated care project that organised a collaboration between hospitals, GPs and ambulatory care nurses. In this project, each professional had a defined role, and they considered their collaboration a success factor of the project. Their collaboration enabled

them to deal with the informational, clinical and organisational continuity of care.

Overall, it is very likely that RPM reduced the anxiety and uncertainty of patients and healthcare professionals, i.e. RPM worked reassuringly. Knowing that healthcare professionals were actively monitoring the RPM parameters and seeing that individual parameters were good, contributed to this effect. However, the value of RPM was dependent on how the intervention interacted with the individual needs and preferences of patients. Patient needs and expectations were diverse and were related to information about COVID-19, instructions for RPM, management of comorbidities, nursing care, and psychosocial support. Frequent communication with patients was seen as important to support patients in their needs. There was no consensus on the ideal mode of communication, and patient preferences regarding communication also differed. Another important determinant for the experienced value of RPM, was how Telemonitoring teams interacted with the expectations and information needs of patients towards the system, how patients were involved in the decision of starting RPM. The use of RPM was further facilitated by user-friendly RPM systems.

Several factors can facilitate the implementation. From the patients' point of view, implementation starts with the eligibility of patients. Therefore, presenting the RPM to the patient and checking whether the design of the RPM is likely to be in line with the patients physical, emotional, psychosocial (health literacy, digital literacy) and social needs, is hugely important. Second, collaboration between providers and between organisations seems key. RPM was considered a team effort by all, and trust between team members was seen as important. Cultivating partnerships between hospitals (Telemonitoring teams) and nursing organisations was considered key for their collaboration. Third, both Telemonitoring teams and ambulatory care nurses stressed the importance of communication, which was important in the organisation of the follow-up. Fourth, some projects reported good collaborations with GPs; but collaboration was absent for most RPM projects. GPs generally wanted to be involved in RPM as they believe they are the key point of contact for their patients; this was also echoed by several patients. Other key factors for implementation are the attitudes and vision of individuals, teams and organisations towards RPM. Several teams demonstrated a strong belief in RPM and were supported by their management through investing more resources in the project. Ambulatory care nurses also felt supported by their organisations for the delivery of the project.

On the other hand, the implementation of RPM was challenging for several reasons. The burden of operating RPM systems on both Telemonitoring teams and GPs was high in comparison to the available resources. RPM was perceived as a complex pathway that requires the expertise and effort of multiple healthcare professionals and services. These include a project coordinator, a medical supervisor, a Telemonitoring team for the recruitment, instructing patients and follow-up of patients, ICT and logistic support, GPs, and -in some projects- ambulatory care nurses. Recruitment was a concern across projects. Older patients, those with a geriatric profile or less able to use the technology and non-native speakers were systematically excluded from RPM, raising concerns about care inequality. This was attributed to the design of the projects' RPM interventions, having limited resources, and the context of the pandemic. Several projects collaborated with ambulatory care nurses which helped them recruit older patients. Ambulatory care nurses visited patients at home to teach and support them with the use of the RPM system. This also allowed nurses to investigate and deliver care for other needs.

Collaboration between hospital-based Telemonitoring teams and primary care professionals is imperative for a significant group of patients. However, most Telemonitoring teams had none to limited interaction with the GPs or ambulatory care nurses. RPM systems allowed Telemonitoring teams in hospitals to implement and deliver the intervention, but in projects in which primary care was actively involved, it was seen that GPs and ambulatory care nurses wanted to be part of the system. Furthermore, many patients expect that their GP is involved in their care. Access to the RPM system was experienced as a minimal requirement for collaboration across levels of care but this was not the case in all projects. RPM systems were mostly developed as standalone platforms, and the lack of integration and communication of data with the electronic patient records of different healthcare professionals across levels of care was an important barrier.

Consequently, the interoperability of RPM platforms with existing electronic patient files and regional/federal hubs across levels of care is a requirement for a systemwide implementation, along with working “as a team” with the patient residing in his or her home environment. This also refers to the integration of RPM pathways, for patients other than COVID-19 patients e.g. in patients with diabetes and heart failure. Therefore, formal partnerships were considered important for good collaboration and communication between RPM partners. This may suggest that implementation needs to be facilitated at a local, e.g. city or care zone, level.

The results of this qualitative inquiry uncovered three important questions or concerns in the views of participants. First, how should TM be organised? In the NIHDI projects, RPM was mainly organised at the level of hospitals, with the exception of one project. Hospital teams have the technological expertise and specialist knowledge about the acute care episode while GPs and ambulatory care nurses have a very good knowledge of the home situation, and vice versa. Perceptions of patients and GPs may question if hospital-based RPM is the right level of to organise RPM. Our data also questions if RPM can completely replace human contact. Our data suggest that patients, GPs and ambulatory care nurses seem to value personal contacts more than Telemonitoring teams. Furthermore, current RPM practices under evaluation demonstrated fragmentation in care across disciplines and care levels, shown by the lack of informational continuity. Although it is clear that a team approach is needed, the role definitions and responsibilities are unclear. This raises several other questions about how to organise continuity of care, and data and information transfers between levels of care and different information systems; and lastly how to define a financing system to support the tasks and work of all healthcare professionals involved in the pathway, taking into account ‘invisible’ tasks, such as coordination of providers and logistic issues.

Second, what is considered good quality data for RPM, or what data is needed to monitor and intervene appropriately? Every participant agreed that good (i.e. reliable) data is important for RPM. However, there was no consensus about what constitutes good data. Differences related to the role of patients in reporting data, the type of measurements (self-reported versus automated) and the type of data (symptoms or experiences versus objective ‘hard’ data). Moreover, in this specific ‘new’ pathology and in a changing context little valid risk stratification scales were available putting a higher priority on ‘clinical view’ of the patient to estimate disease progression.
Third, an overall observation was the question whether the ‘right’ patients were included in the projects. Most projects had none or few readmissions among the RPM patients, and several patients who were interviewed by our team indicated that they had no (medical) need for the intervention.

Strengths and limitations

The qualitative evaluation has several strengths. Several forms of triangulation were introduced which contributed to a multi-perspective exploration of RPM and its potential and challenges in caring for COVID-19 patients at home. Different stakeholders were interviewed to investigate the experiences from different points of view, and using different data collection methods. Interviews were performed and analysed by a team of researchers with experience in qualitative research. Furthermore, initial reports from interviews were discussed in team which allowed us to improve gradually the quality of the interview guide as well as the data analysis. A systematic approach using the QUAGOL methodology and the TICD checklist of implementation determinants {Flottorp, 2013 #4} helped to improve the depth and rigour of the analysis process. The QUAGOL methodology included a team approach to discuss the initial findings, coding schemes, interpretation of codes and integrating results in main findings. A qualitative researcher of the KCE also participated in the discussions of the analysis and results.

There were also some limitations. We were not able to triangulate our data systematically with the parallel KCE full report about the evaluation of the RPM projects and literature review because of the chronology of the parallel subprojects. Local programme theories for the different study settings have not been developed because of the large heterogeneity of the RPM projects. As a consequence, some context information on the specific RPM projects was missing (e.g. we interviewed patients on experiences, but without having objective details on the exact RPM technologies used for the patient at the time) or could not be linked to specific findings. We were not able to interview patients from all projects (only eight of the twelve), and all but two

patients had experience with *post*-hospital RPM. As pre-hospital RPM was also not an option in several projects, the findings therefore apply primarily to post-hospital RPM. In addition, some patients –especially those who had been most seriously ill- were not able to remember everything, potentially leading to a recall-bias.. Furthermore, we believe it is likely that patients who responded had a positive attitude towards the RPM projects, potentially resulting in a self-selection bias. We were able to interview one negative case (a person who was really dissatisfied with RPM), but important experiences may be missing from our sample. Not all projects participated in the interviews with the Telemonitoring team (ten of the twelve), and not all team members who participated could be present at the time of the interviews. This entails some risk that individual experiences were missed. Focus group discussions were not feasible with GPs, and only a few GPs that were interviewed had experience with one of the NIHDI projects. We therefore interviewed GPs who implemented their own RPM project to help us understand the context of RPM for GPs. However, these interviews were shorter in duration, and while some contained rich data, other interviews were necessarily superficial. Likewise, we were not able to recruit the desired number of ambulatory care nurses. However, GPs were only systematically involved in one project and nurses in only four projects. Consequently, our sampling reflects the characteristics of the projects under evaluation. Overall, this means that theoretical sampling was not possible and that it was difficult to explore variation and depth of some experiences, which meant that we were not able to achieve saturation for most of the themes. Nonetheless, some experiences were consistent within and between groups of participants (e.g. reassurance of RPM), which strengthened the credibility of the main findings.

6 CONCLUSION

Overall, patients' and professionals' attitudes towards RPM tend to be positive, and RPM is seen as a solution in dealing with the challenges of the COVID-19 pandemic. RPM offers reassurance for both patients and healthcare professionals and may decrease the utilisation of hospital beds. However, older patients and non-native speakers are often excluded by the RPM projects' staff, thus limiting their reach. Personal communication and flexibility in RPM procedures can cultivate a positive experience with patients because individual needs are more often met this way.

RPM implementation is facilitated by motivated teams of dedicated healthcare professionals, management support, user-friendly RPM systems, prior experience with RPM for other purposes, and partnerships between primary and secondary care (with good communication between partners). Hindering factors for the implementation of RPM are the high burden on Telemonitoring teams, insufficient resources, lack of financial remuneration of all tasks needed for RPM, technical problems with RPM systems, challenging logistic management of TM projects, lack of access to RPM data for all relevant stakeholders, lacking integration of RPM data in electronic patient records, doubts on quality of data derived from RPM systems, and professionals' limited knowledge of legal frameworks relevant for RPM.

Overall, healthcare professionals perceive RPM as valuable and believe that the concept will have its place in healthcare systems. However, they also believe that current RPM practice is challenged by too many barriers, and that the sustainability of RPM implementation is low.

Key challenges for the future will be: carefully considering where to embed RPM systems in healthcare and which professionals are best placed to lead RPM delivery which is also probably disease specific, connecting RPM platforms to electronic patient records of all healthcare professionals, adapting nomenclature to the multidisciplinary nature of RPM and all necessary tasks, facilitating collaboration and communication between potential RPM partners (who historically have worked in isolation), redesigning RPM systems to facilitate recruitment of older persons and

persons who experience a language or socio-economic barrier for participating in RPM.

CHAPTER 4 – REVIEW OF THE COVID-19 RPM LITERATURE

1 KEY POINTS

Methods

- **We searched in several sources and ways since many COVID-19 studies are not yet in the traditional databases.**
- **We searched also for ongoing trials**
- **All references retrieved were imported into Endnote and deduplicated. One researcher assessed title and/or abstract on inclusion criteria. Full texts were obtained for all eventual relevant articles.**

Results

- **By 15/12/21, we identified 164 projects (160 centers and 241 documents) from across the world on RPM in patients with COVID-19, covering 248 431 patients.**
- **96 projects concerned only COVID-19 patients that were not yet hospitalized, 32 projects concerned only patients after hospitalization, 34 projects concerned both pre- and posthospitalizations trajectories and in 2 projects it was unclear if it concerned pre- and/or posthosp**
- **All projects were observational studies; some studies made a kind of comparison, but with a variety of kind; seven projects applied a matched-control design.**
- **No randomized comparative trials were found yet (closing date of searches 15/12/21), but some are on the way.**
- **We encountered a large heterogeneity across studies in patient populations, monitored parameters, monitoring modes, involved healthcare professionals, intervention dose and modes, prohibiting combining studies and making overall**

conclusions on effects/effectivity of telemonitoring in patients with COVID-19.

- The mean length of telemonitoring in prehosp studies varied from 3.5 to 21.8 days, with a median of 10 days and in posthosp studies it varied from 3.1 to 90 days, with a median of 13.6 days.
- The projects showed a large variety in outcomes and the way that they were measured, such as process outcomes, clinical outcomes, economical outcomes and experiences of healthcare professionals and patients.
- There is large variance in all outcome measures across studies.
- There is a large variety in number of ED-visits across the prehosp projects and there is no convincing evidence that RPM prehosp leads to less or more ED-visits.
- There is no convincing evidence that RPM posthosp leads to less or more ED-visits.
- There is no convincing evidence that RPM prehosp leads to less or more hospital admissions.
- There is no convincing evidence that RPM posthosp is associated with less or more hospital readmissions.
- Mortality in RPM prehosp is in general low and there is weak evidence that shows that RPM is associated with lower mortality than non-RPM.
- Mortality in RPM posthosp is in general low and there is no evidence that RPM is associated with lower or higher mortality than non-RPM.
- There is no convincing evidence that RPM posthosp shortens previous hospital length of stay.
- Many publications make claims in favor of RPM for avoiding ED-visits, hospital admissions, shortening length of hospital stay and reducing costs. But the scientific base for these claims is doubtful.
- Patients are in general positive about RPM; it gives them a feeling of reassurance. However, in all studies only part of the patients responded to the satisfaction questionnaires.
- Seven projects demonstrated that RPM is feasible in oncology patients with COVID-19. RPM is appreciated by patients and gives them reassurance and from the study of Mayo Cancer Clinic Center there is some evidence that RPM in cancer patients with COVID-19 might lead to reduced ED-visits, hospital admissions, and shortened length of hospital stay.
- Three studies demonstrated that RPM is feasible for children with COVID-19.
- Five studies demonstrated that RPM is feasible for pregnant/postpartum women with COVID-19.
- In general, although there is no convincing evidence that RPM is effective in reducing hospital strains, it is seen as a meaningful intervention by healthcare professionals and appreciated by patients and gives them reassurance.
- There is a dearth of good quality economic studies on costs (savings) of RPM. In absence of reliable data on comparative effectiveness, it is not possible to calculate an incremental cost-effectiveness ratio.

Conclusions

- More research is needed on the (added) value of all individual intervention components and combinations of them.
- In absence of randomized controlled trials, claims on savings by COVID-19 RPM should be interpreted with care

2 BACKGROUND

Remote patient monitoring (RPM) or telemonitoring has been used in the past decade for several patient groups, including patients with respiratory diseases and cardiac diseases (KCE-study No xx) and showed promising results.[17-25] Therefore it could be argued that such remote monitoring strategies and devices could also be of use when applied to patients with COVID-19, staying at home or in a residential care setting, both in a pre-hospital and post-hospital admission phase. The aim of applying the intervention can be twofold i.e. when the monitoring strategy early warns for deterioration and immediate action can be taken, potential hospital admissions could be avoided (pre-hospital admission phase) while it could be envisioned to discharge patients earlier from hospital, when adequate signalling is assured (post-hospital admission phase). In both situations, the aim is to optimally use the available hospital beds for COVID-19 patients. The use of telemonitoring and other digital health applications for patients with COVID-19 has already been advocated by several authors.[26-30]

As mentioned in the general introduction, the NIHDI initiated a project concerning telemonitoring for patients with COVID-19 in Belgium and wanted to know more about experiences with this type of remote care. In this chapter the focus is on the experiences, the safety and the effectiveness of telemonitoring in patients with COVID-19, staying at home, as described in the intefrnational literature.

3 METHOD

3.1 Data sources

To find out if telemonitoring has been applied for patients with COVID-19 with the aim to avoid hospital admissions and/or to discharge patients earlier from the hospital and to see if this was feasible and effective, we searched in several sources and ways since many COVID-19 studies are not yet in the traditional databases:

1. the **'traditional' databases**: PUBMED, CINAHL, EMBASE, LISSA and the COCHRANE LIBRARY.
2. Special developed COVID 19 literature databases (https://www.ncbi.nlm.nih.gov/research/coronavirus/ , https://search.bvsalud.org/global-literature-on-novel-coronavirus-2019-ncov/, https://www.cochranelibrary.com/collections/doi/SC000043/full , https://covid-19.ebscomedical.com/ , https://www.covid19reviews.org/index.cfm?cat=3 , https://www.cebm.net/oxford-covid-19-evidence-service/ , https://covid.cadth.ca/
3. **preprint servers** (https://www.biorxiv.org/ , https://arxiv.org/ , https://hal.archives-ouvertes.fr/ , https://preprints.jmir.org/ , https://www.medrxiv.org/)
4. **trial-registers** (https://clinicaltrials.gov/ , https://www.clinicaltrialsregister.eu/ , https://www.who.int/clinical-trials-registry-platform , https://clinicaltrialsdatabase.be/en) to find ongoing trials and contacted authors of these trials.
5. worldwide web with Google advanced
6. citing/cited search of relevant reviews (identified in the above sources, e.g. [31-34]) in Google Scholar by means of Publish or Perish interface.

3.2 Search strategies

Searches were structured around this PICO(T):

- Patients: patients infected with COVID-19 and residing out of the hospital:

  (Covid-19 OR Covid* OR corona OR Sars-Cov2[f]) AND (home OR discharge OR post-hospital)

- Intervention: remote monitoring of clinical status of patients

  Telemonitor OR "remote monitor" OR “remote patient monitoring” OR “remote home monitoring” OR "hospital at home" OR "virtual visit" OR "virtual round" OR "virtual hospital" OR telehealth OR telemedicine OR smartphone OR wearable OR "mobile health" OR mhealth

- Control: -
- Outcome: -
- Type of study: -

All searches were limited in time, starting from March 2020 till December 2021 (the ‘traditional’ databases were searched on 16/09/21, but a daily search alert from PUBMED was kept until 15/12/21; trial-registers were searched on 16/11/21 and the daily google advanced searches were done until 15/12/21).

Detailed search strategies for each source can be found in Appendix 4.1.

3.3 In- and exclusion criteria

Inclusion criteria were structured around this PICO(T):

- Patients: patients with COVID-19 and residing at home

AND

- Intervention: remote monitoring of clinical status of patients

AND

- Control: regular care

AND

- Outcome:
  - Experiences and satisfaction of patients

    OR
  - Experiences and satisfaction of health care providers

    OR
  - Clinical effectiveness (ED-visits, hospital (re)admission, hospital length of stay, 30 day (after start of monitoring) mortality, early discharge)

    OR
  - Cost/savings of telemonitoring

AND

- Type of study: all

All types of publications (peer reviewed journal articles, pre-print publications, websites, popular press releases, etc.) were included.

[f] Or special developed search filters in database

References were excluded if they

- contained only an opinion without supporting data
- were published in another language than English, French, Dutch or German

3.4 Inclusion process

All references retrieved were imported into Endnote and deduplicated. One researcher assessed title and/or abstract on inclusion criteria. Full-texts were obtained for all eventual relevant articles. One researcher assessed full-texts. The inclusion process is depicted in Table 28.

Table 28 – Inclusion process

About telemonitoring?				
NO ↓	Yes/doubt ↓			
	In (adult) patients with COVID-19 staying at home?			
	NO ↓	Yes/doubt ↓		
		Contains results about experiences of patients, experiences of HCP*, clinical effects?		
		NO ↓	Yes/doubt ↓	
			Written in English, Dutch, French or German?	
			NO ↓	Yes/doubt ↓
		EXCLUSION		INCLUSION

**HCP: Health care practitioners*

3.5 Data-extraction & Analysis

References were categorized according:

- Type of study (review, observational, comparative, match control, randomized trial)
- Country + research team/centers
- Type of patients (pre- or posthospital)
- Type of outcome
- ...

Intervention description:

- Intervention elements
- Platform used
- HCP involved
- Parameters monitored
- ...

Patient population description

- Number
- Pre/posthop
- Inclusion / exclusion criteria
- Age
- Gender
- Risk profile
- Comorbidities
- ....

Outcome/effects description

- ED-visits
- Hospital admission
- Length of hospital stay
- Length of monitoring
- Number of interventions
- Number of alerts
- Patient satisfaction
- HCP satisfaction
- Costs/savings
- ....

Some projects presented their outcomes for a combined group of prehosp and posthop trajectories. In our outcome analysis, we left out all the studies in which data of the pre- and posthosp were not presented separately, except for the patient satisfaction outcome.

No methodological assessment was performed.

Identified previous reviews were used for reference tracking and in the discussion section to compare our results.

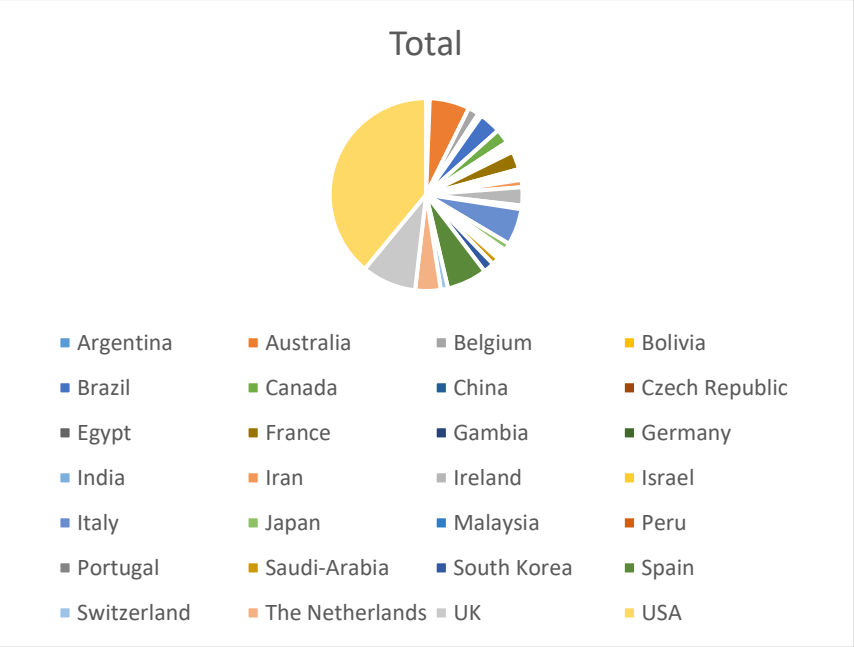
4 RESULTS

4.1 Search results

We identified 164 projects[g], from 160 centers, published in 241 documents, that were analyzed.[1, 3, 4, 31, 35-271]

We found projects from around the world, spread over 28 countries; by large the projects originated in the USA (39%), UK (9%), Australia (7%), Spain (7%) and Italy (6%). Figure 14 shows the % of projects per country.

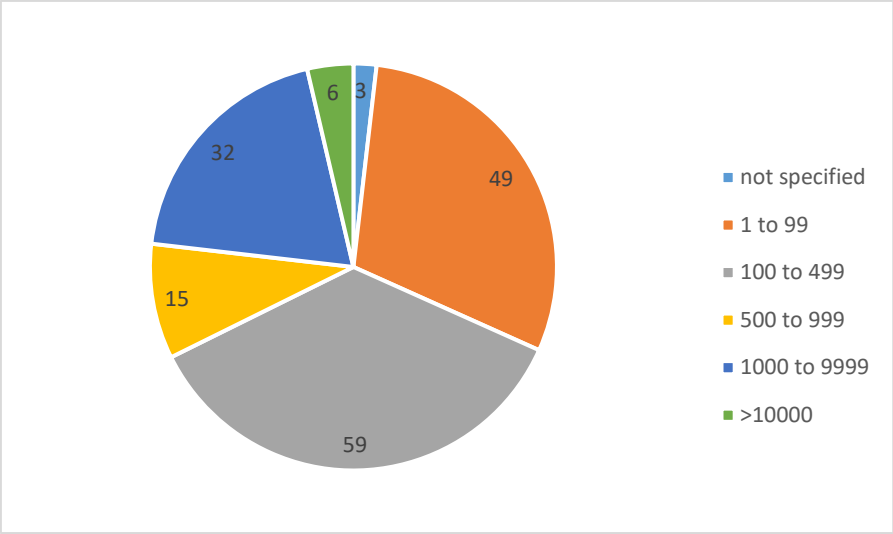
Figure 14 – Number of RPM projects across the world



Research population sizes varied from 10 to 43 103; 30% of the projects were small scale projects with less than 100 patients, but there were also 6 projects[59, 134, 135, 158, 177, 263] with more than 10 000 patients. Overall, the included 164 projects cover 248 431 patients. Figure 15 shows the number of projects according to research population size.

[g] (four centers made separate publications on prehosp/posthosp traject or on different COVID-19 wave and some projects were presented in several publications; in the rest of this results section we keep the 164 projects as unit of analysis and for each of them we assigned a 'principle publication' to refer to them).

Figure 15 – Number of RPM projects according to the number (interval) of patients included in the project



All included projects concern observational studies, with some of them including a kind of comparison arm (e.g. patients that receive telemonitoring in certain area compared to patients from another area and that presumably had not received telemonitoring, or patients with symptoms versus asymptomatic patients, or patients with RPM at home versus patients with RPM in quarantine hotel, or patients receiving low-intensity RPM vs high-intensity RPM, or prehosp RPM versus posthosp RPM) and seven projects[79, 93, 129, 144, 175, 221, 263] applied a matched-control study design in which RPM versus no RPM was compared and in which patient characteristics (such as comorbidities and risk profiles) were taken into account in weighted way. Within these matched-control studies, six [79, 129, 145, 213, 221, 263] concerned the prehosp traject. Three of those matched-control studies [93, 129, 175] concerned patients after hospital discharge.

No randomized trials were identified, in which patients were allocated to telemonitoring or not in a random way. However, searches in trial registers learned that some RCT's are underway (see section 5).

4.2 How do the telemonitoring interventions look like?

Telemonitoring is an interaction between (a) healthcare professional(s) at a certain place and a patient at another remote place, in which a certain number of patient's functioning parameters is assessed and followed up for a certain duration of time. This remote interaction consists of several elements:

- **A patient**, in a certain disease phase with or without comorbidities and with or without risk factors. For this review we included only studies on patients with a proven or suspected infection with COVID-19 and staying at home (we encountered also telemonitoring studies in which patients with COVID-19 were staying in a quarantine hotel, a field hospital, a nursing home and even in a hospital itself). We encountered studies in which patient's disease phase varied from asymptomatic and immediately after suspicion of COVID-19 infection over mild symptomatic to severe disease presentation. Some of the studies (e.g. [51, 111, 147, 173]) included only high risk patients (e.g. aged 65+ and one comorbidity) while others (e.g. [40, 91, 157, 170]) included only low risk patients and others all types of patients. The way and criteria on which the risk was assessed differed and for some the deterioration risk assessment was used to select patients while in others it was used to adapt the intervention to risk profile (e.g. increasing frequency of measuring parameters, additional parameters to follow, adapted alert settings, monitoring by MD instead of RN,…). 96 projects concerned only COVID-19 patients that were not yet hospitalized, 32 projects concerned only patients after hospitalization, 34 projects concerned both pre- and posthospitalizations trajectories and in 2 projects it was unclear if it concerned pre- and/or posthosp.
- Concerning the patients that were followed by RPM after a hospital admission, their mean length of hospital stay was mentioned in 11 studies, it varied from 1.7 to 38 days (median= 6, P25=4, P75=10). The

study with the shortest mean length of stay was Kilaru[261]; the 44 included patients stayed on average 1.7 days in hospital with a standard deviation of 2.6 while the study with the longest mean length of hospital stay was Bernocci et al.[179] in which the 170 patients had a mean length of stay of 38 days with a standard deviation of 22.

- Some studies focused on special populations, such as oncological patients [71, 74, 75, 82, 96, 120, 133, 144-146, 148, 151, 163, 189, 235], children[76, 228, 248], liver transplant patients[249], or pregnant/postpartum women[180, 190, 233, 250, 255] with COVID-19.
- **Aim:** In general, all projects aimed at lowering pressure on hospital resources/capacity, by avoiding ED-visits and hospital (re)admissions and by shortening hospital length of stay. Next to this they aimed at timely upscaling of healthcare interventions in case of possible deterioration, at avoiding deterioration and mortality, at avoiding contamination and viral spread and at reassuring patients.
- **RPM staff**: the projects used healthcare professionals varying from nurses, nurse practitioners, physician assistants, physiotherapists, respiratory specialists, psychologists, social workers, dieticians, medical and nursing students to GPs or medical specialists. Sometimes only a single professional was involved, sometimes a multidisciplinary telemonitoring team. Many projects used volunteers, retired and redeployed health care professionals (e.g.[38, 59, 61, 69, 80, 92, 94, 137, 139, 176, 216, 222, 242]) (Appendix 4.2 gives some more detail on staffing). In addition, administrative and technical staff was added. Only a few papers mention the number or FTE of staff they had. Sometimes a stepped approach was applied: e.g. nurses performing the monitoring, but in case of deterioration of a patient scaled-up to monitoring by a medical specialist. Sometimes a specialized telemonitoring team, external of a hospital was used (e.g. [113, 184]). Most of the RPM projects were hospital based, but some [1, 38, 80, 91, 142, 149, 172, 186, 213, 229, 262] used telemonitoring by primary care professionals. In many projects an already existing RPM-staff and infrastructure that was installed for telemonitoring in other diseases was used and extended.
- **An interaction content** (patient's functioning parameters): we found a large variety in functioning variables that were monitored, e.g. general well-being, fatigue, coughing, diarrhea, smell, mobility, temperature, heart rate, respiratory rate, shortness of breath, oxygen saturation, etc. The parameter that was most often monitored was oxygen-saturation. The way in which these variables were assessed varied from patient self-assessment, assessment by a health care professional (at site or remotely) or by means of a (connected) device. Also alerting cut-offs for each parameter varied. Sometimes the number of monitored variables (and devices) were scaled up or down depending on a patient's condition. Frequency of assessment also varied widely from once per 2 days to 5 times per day to continuously (e.g. [60, 65, 84, 100, 101, 103, 132, 142, 153, 164, 173, 174, 182, 198, 206, 211, 219, 220, 260]) for some parameters and could vary during the course depending of presented symptoms. A nice example of low versus high intensity RPM model is presented by Coffey et al.[184] in Figure 16 below.

Figure 16 – Low intensity versus high intensity care RPM model (Coffey_2021 [184])

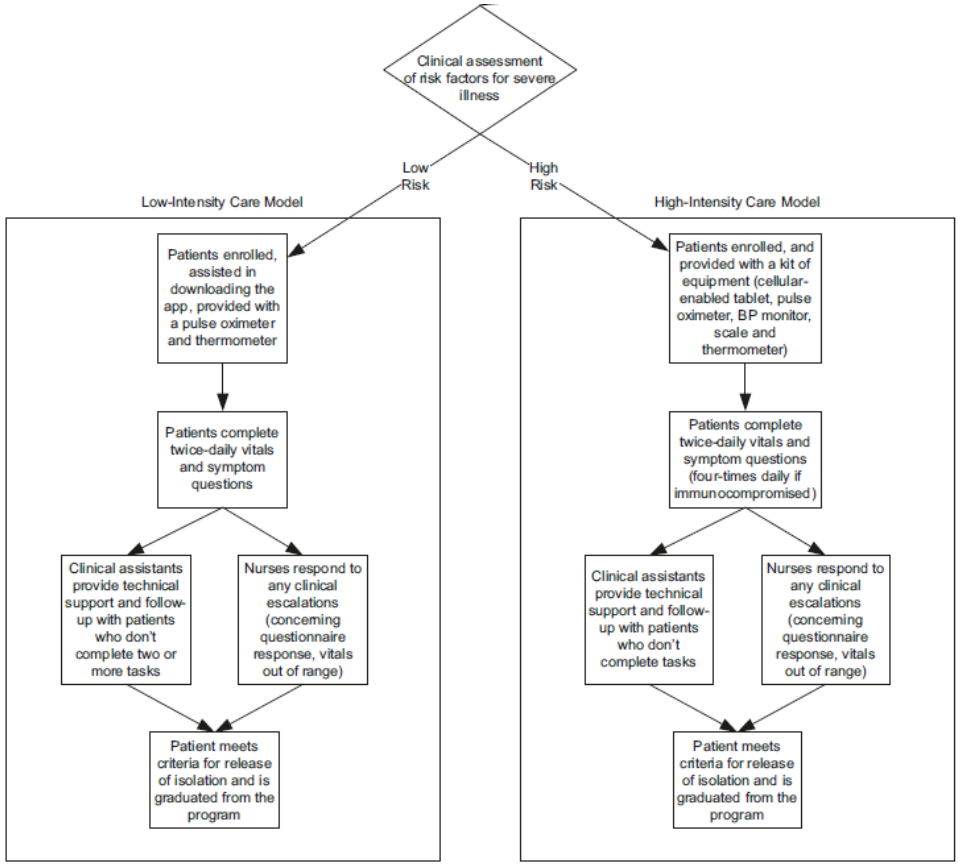


Fig. 1 Clinical workflow for patient identification and eligibility for the COVID-19 RPM care models. Patients at high risk for severe COVID-19 illness were eligible for the high-intensity care model if they had one or more of the following: age >65 years, diabetes, current smoker, BMI >40, chronic liver disease, chronic lung disease, congestive heart failure, active cancer therapy, bone marrow or solid organ transplant, other immunocompromised state, end-stage renal disease. Additionally, patients were eligible if they were hospitalized for COVID-19 without one of these risk factors, but experienced one of the following: hospital length of stay ≥7 days, ICU admission, cardiac complications, need for mechanical ventilation or dialysis, need for oxygen supplementation at discharge, and receipt of remdesivir upon discharge.

And next to the monitoring part of parameters, the interaction content contained a (re)action from the RPM team to the data they received. These (re)actions varied from no (re)action as long as parameters were within the set limits ('no news is good news'), to a reassuring reaction to the patient each time parameters were uploaded to tell them they were received and normal, to an automatically generated signal or a call to patients to reassess a parameter when this was suspicious, to a call to a GP or RN that a parameter was suspicious and further investigation or home visit could be usable, to a call to the patient that (s)he should go to a GP or to the ED for further check-up, to a call to the patient that (s)he should immediately present to the hospital for admission. Sometimes deviating parameters were first discussed within the RPM team and specialist consultants before a reaction was made to the patient. We did not obtain a clear view on what type of interventions were deployed on what types of alerts of which parameters. It is also unclear if all these (re)actions were systematically registered in the systems by the RPM team.

- **An interaction modus:** the interaction modes varied from (different combinations of) telephone audio calls, video calls, text messages, and special created software platforms. In some studies information was send only by patients to healthcare professionals and in other studies the information exchange was bi-direct.
- **An interaction infrastructure** (hardware, software). Hardware needed/used on the patient side concerned a (smart)phone or a kind of computer (PC, tablet) for information exchange, and a number of measuring devices (such as thermometer, saturation-meter, tensio-meter, pulse-meter, etc., either a separate device for each parameter or a single device for a combination of parameters (e.g. smart watch, in-ear device)), that measured automatically, sometimes in a continuous way and that sometimes were connected by WIFI, Bluetooth to the patient's computer or smartphone. On the side of the healthcare professional, an ICT-system to which all parameters information was send and processed, to give healthcare professionals a numerical/graphical insight of patient's functioning; this ICT-system could either be stand-alone or integrated in the electronic patient record of a hospital or a general practitioner.
- **A frequency and duration of RPM**: assessment of patient functioning varied from a few times per week, over once per day, several times per day to 24h/7 continuously or started at high frequency and lowered during the RPM (or intensified based on parameters). The duration of the telemonitoring varied from a single day to several weeks.

PREHOSP

The mean length of telemonitoring in prehosp studies (mentioned in 33 studies) and varied from 3.5 to 21.8 days, with a median of 10 days (P25=8, P75=13.1)). Short (≤ 5days) mean length of telemonitoring was reported in a UK study of Maghrabi et al.[119] (mean 3.5 day, min=0, max=19) in 300 patients of which 158 required oxygen, a Dutch study of Dirikgil et al.[79] (4 days; IQR 3-7]) in 55 patients with a moderate risk profile, and in an USA study of Ryan et al.[149] (4.1 days) in 233 patients with at least 1 risk factor. Long mean length of telemonitoring prehosp (≥15 days) was reported in an UK study of Francis et al.[86] (median of 21 days (range 15–46)), among a mixed low and high risk population of 455 patients, a Czech study of Weinbergerova et al.[171] (mean=18.4; median=14.0; min=0; max= 54) among 105 patients of which 80% had at least 1 comorbidity, an USA study of Aalam et al.[35](mean=21.8 days, median=18, min=1; max=42) in 83 patients, an UK study[86] in 455 patients (median=21, range 15-43) and in an USA study of Steimer et al.[163] (mean=15.7; min=2; max=63) in 26 patients with cancer and COVID-19.

POSTHOSP

The mean length of telemonitoring in posthosp studies (mentioned in 16 studies) varied from 3.1 to 90 days, with a median of 13.6 days (P25=11.8, P75= 20.5) across studies. Short length of telemonitoring (≤5 days) was reported in a small scale USA-study of Heller et al.[97](mean 3.1) in 24 patients and in another USA study of Ye et al.[175] (median=5; IQR 3-7) in 217 patients. Long length of telemonitoring posthosp (≥15 days) was reported by Francis et al.[86] (median=21,

min=15; max=46 days) among 445 patients, by Copeland et al.[70] who report a median of 84 days (IQR:19-119) RPM in 111 patients and by Kohlbrenner et al. [238] who followed 50 patients by RPM for 90 days.

Table 29 – Mean length of telemonitoring

	N studies	min	P25	median	P75	max
Pre hosp	33	3.5	8	10	13.1	21.8
Post hosp	16	3.1	11.8	13.6	20.5	90

- **Initiation of telemonitoring** varied from the day someone was suspected of COVID-19, over the day with first symptoms, or the day of a positive test, or the day of an ED-visit, or the day of worsening of symptoms, or the day of hospital discharge.
- **Side interventions**: Sometimes telemonitoring was combined with a visit at home (by one or more healthcare professionals e.g. [113, 243, 272]),
- **Co-interventions**: In both prehosp and posthosp projects, telemonitoring was sometimes accompanied (e.g.[113, 145, 162, 187, 188, 195, 207, 213, 215, 218, 221, 231, 243, 248, 266, 270]) by other interventions, such as oxygen therapy, antibiotics, antipyretics, anti-coagulants, corticosteroids, hydroxychloroquine, lopinavir/ritonavir, etc. but details about dose, frequency and durations were mostly lacking. Also, many publications did not mention if there were co-interventions yes or no. It was not clear from the publications to what extent these co-interventions influenced the measured outcomes.

In summary, we encountered a large heterogeneity across studies in patient populations, monitored variables, monitoring modes, involved healthcare professionals, interventions dose and modes, prohibiting combining studies and making overall conclusions on effects/effectivity of telemonitoring in patients with COVID-19. Therefore, the next section on outcomes should be read with much caution.

4.3 Outcomes

The projects showed a large variety on outcomes that were measured, such as process outcomes (number of patients that refused RPM (e.g.[52, 93, 130, 158, 163, 181, 187, 201, 209, 261]), number of alerts(e.g.[35, 41, 62, 70, 71, 74, 78, 93, 103, 109, 122, 128, 135, 138, 146, 153, 164, 165, 175, 176, 184-186, 191, 195, 214, 220, 260]), number of interactions and reactions of the RPM team (e.g. [82, 84, 93, 98, 101, 128, 162, 164, 184, 189, 213, 222, 235, 248, 250, 255, 262, 264, 266]), number of technical problems (e.g. [62, 102, 116, 185, 254]XX), clinical outcomes (N of escalations to a GP, number of ED-visits, number of hospital (re)admissions, mortality; see further below), economical outcomes (costs of RPM, hospital days avoided, cost savings) (e.g. [3, 40, 47, 55, 73, 87, 88, 97, 107, 125, 137, 141, 150, 155, 168, 169, 182, 183, 186, 188, 195, 197, 212-214, 251, 261, 266, 271] and experiences of health care professionals (e.g.[40, 49, 50, 61, 63, 65, 82, 87, 99, 103, 121, 142, 150, 160, 170, 180, 182, 183, 191, 197, 199, 210, 240, 246]) and patients (e.g. [37, 40-42, 46, 48-50, 59, 60, 65, 66, 69, 74, 75, 77, 80, 82, 84, 87, 95, 98, 99, 102, 103, 107, 110, 111, 118, 120, 125, 127, 130-132, 135, 137, 141, 142, 146, 150, 155, 160, 161, 163, 168, 173, 175, 178, 179, 182-184, 188, 191, 197, 199, 209, 217, 218, 223, 224, 230, 232, 234, 236, 245, 246, 253, 257, 258, 264]). The time when the aims/outcome measurement(s) was performed was not always (mostly) clear.

Some projects presented their outcomes for a combined group of prehosp and posthop trajectories. In our outcome analysis, we left out all the studies in which the pre- and posthosp are not presented separately, except for the patient satisfaction outcome.

Some projects (e.g. Coffey et al. (Mayo Clinics) [184] and Sitammagari et al. (Atrium Health) [4]) presented separate analyses for low and for high risk patients with substantive differences between them. This means that outcomes presented in other projects where they did not make this differentiation, should be read cautiously.

It is important to make difference between low- and high-risk patients when judging about outcomes as was clearly demonstrated in the multi-site studies of Coffey et al. (Mayo Clinics) [184] and Sitammagari et al. (Atrium Health) [4]. However, also to be taken into account is that low-risk patients received lower intensity intervention. So is the difference in outcomes due to risk-profile or to the intervention-dose?

In the next section we present only clinical outcomes regarding number of ED-visits, (re)hospitalizations and mortality.

4.4 ED-visits

The number of ED-visits was presented in 54 studies in pre-hospitalization patients, and in 13 with post-hospitalization patients.

PREHOSP

In the 54 pre-hosp projects the percentage of telemonitored patients that made an ED-visit varied from 0 to 36%, with a median of 11.2% per study (P25=5.7; P75=19.9). The 0% ED-visits were reported in a small (n=26) Australian study [102] and with no further specification of patient characteristics; the 36% ED-visits were reported in a small (n=77) USA study [154] with confirmed COVID-19 diagnosis. In the two large (>10 000 patients) studies that reported ED-visits in prehosp patients, the Brazilian study of Nascimento et al. [134] reported 19.7% ED-visits in a high-risk population and the USA study of Shaw et al. [158] reported 20.4% ED-visits in confirmed COVID-19 cases with all types of risk-profiles. This large variation could be due to patient characteristics such as risk profile: it is 'normal' that in studies with more higher risk patients, the number of ED-visits is higher. E.g. two publications made a comparison on % of ED-visits in the prehosp group; both studies originate from the Spanish Telea project in Galicia: Rabunal et al.[147] (n= 275 in RPM group and n= 247 in control group) reported on the first COVID-19 wave and found 2.9% ED-visit in the RPM group consisting of high-risk confirmed COVID-19 patients versus 0.8% ED-visits in the comparison group consisting of lower risk confirmed COVID-19 patients that were followed by GPs without RPM; Casariego et al.[62] (n= 1 187 in RPM group versus n=3 197 in control group) reported on the third COVID-19 wave and found 25.9% ED-visits in in the RPM group consisting of high-risk confirmed COVID patients versus 7.1% in the comparison group consisting of lower risk confirmed COVID-19 patients that were followed by GPs without RPM. Both studies found higher % ED-visits in the RPM group than in control- group, but these could be due to the higher risk profile in the RPM group; remarkably is that % ED-visits in the RPM group were much larger in the 3td wave than in the first wave.

Furthermore, it is difficult to interpret if an ED-visit has to be regarded as good or wrong: did RPM fail since it didn't avoid an ED-visit or was it successful because patients were sent timely to the ED and would perhaps send later or not to the ED in case RPM was not applied?

Four projects[129, 145, 221, 263] (Table 30) that applied a matched-control study design, reported on number of ED-visits in the prehosp traject. Two of them [221, 263] found a significant higher number of ED-visits within 30 days for the RPM group, while the two others did not find a difference. It has to be remarked that the study of Misra et al.[129] in this calculation only included patients that presented first in primary care and excluded patients that presented first to the ED and that the study of Pritchett et al[145] concern patients with cancer and COVID-19. Also regarding the effect found in the study of Beaney[263], it has to be remarked that 2 other publications on the same project but that used another research design (a period without the availability of RPM versus a period with the availability of RPM) (Beaney et al 2021b[267]) and regions with higher uptake of RPM versus regions with lower uptake of RPM (Sherlaw et al 2021[268]), the pre-post analysis [267] also found a slightly higher ED-attendance in the RPM period, but the regional analysis[268] did not show an effect on ED-visits.

Table 30 – ED-visits prehosp in matched-control studies

Var\project		Beaney et al.[263]			Delgado et al.[221]			Misra et al.**[129]			Pritchett et al.***[145]		
		RPM	Control	Adj OR 95 CI	RPM	Control	Adj OR 95 CI	RPM	control	Adj OR 95 CI	RPM	Control	Adj OR 95 CI
N		639	14982		3488	4377		2672	1950		71	116	
ED-visit , N (%)	At 30 days	192 (30,05)	3568* (23.8)	1.37 1.16-1.63	489 (14,02)	252 (5,70)	0.06 0.04-0.07	273 (10.2)	193 (9.9)	1.03 0.76-1.39	7 (9,86)	18 (15,50)	0.59 0.24-1.51
				More			More			NS			NS
	At 90 days							382 (14.3)	275 (14.1)	1.01 0.78-1.31			
										NS			

**recalculated from OR*
***based on the number mentioned for outpatients that did not present first to the ED*
****concern cancer patients with COVID-19*

In conclusion, there is a large variety in number of ED-visits across the prehosp projects and there is no convincing evidence that RPM prehosp leads to less or more ED-visits.

POSTHOSP

In the POSTHOSP group 13 studies reported on ED-visits, varying from 0 to 15.8% with a median of 6 (P25=2.8; P=75=10.3). Two studies reported a 0%: Sha et al. [155] (n=56) and Serra et al.[153] (n=95); the highest % of 15.8 was reported in a small scale study (n=44) by Kilaru et al_2021[261]. Further it has to be mentioned that a project from the Netherlands reported a 18.1% ED-visit rate in a first small-scale study of 33 patients; in a following paper with a larger number of patients (N=320) the ED-visit rate was 12.2%.

Two posthosp studies from the USA made a matched-control comparison on ED-visits: Gordon et al.[93] (n=225 in RPM group versus n=1061 in control group) found 4.9% ED-visits in RPM versus 4.3% in the control group consisting of patients that did not receive RPM and Ye et al.[175] (n=217 in RPM vs n=192 in control) found a non-significant difference of 8.3% ED-visits in RPM versus 14.1% in control group.

In conclusion, there is no convincing evidence that RPM posthosp leads to less or more ED-visits.

4.4.1 Hospital (re)admissions

The number of hospital (re)admissions was presented in 81 projects in pre-hospitalization patients and in 23 with post-hospitalization.

PREHOSP

In the 81 pre-hosp studies reporting on the percentage of telemonitored patients that were admitted to the hospital, it varied from 0 to 30.4%, with a median of 6.4% (P25=3.1; P75=11.4). Five studies[38, 57, 91, 102, 142] reported a 0% of hospital admissions:

- The USA study of Borgen consisted of 78 patients with oxygen saturation ranging from 90% to 93%,
- the Italian study of Panicacci et al.[142] (n=180) a 2-step RPM was applied (low intensity RPM in beginning of symptoms, followed by high intensity RPM + intensive drug therapy when symptoms escalated)
- the Italian study of Gios et al.[91] (n=170) consisted of 107 low-risk symptomatic confirmed COVID-19 patients and 63 cohabitants of these patients
- the Canadian study of Agarwal et al.[38] (n=97) consisted of confirmed/highly suspected COVID-19 patients with a mixed risk profile
- the Australian study of Indraratna et al.[102] (n=26) did not provide patient characteristics

Three studies[118, 123, 154] reported a hospital admission rate above 25%.

- the highest rate of hospital admissions (30.4%) concerns the Australian small scale study of Lwin et al.[118] in 23 high risk patients
- the USA study of Shah[154] with an admission rate of 28.6% concerned 77 patients discharged from ED with resting SpO2 ≥ 92%
- the Italian study of Maurizi [123] with an admission rate of 26.9% concerned 487 patients of which 66% underwent Hydroxychloroquine/ Azithromycin therapy and the RPM consisted only of ECG-monitoring

Five projects[79, 129, 145, 221, 263] that applied a matched-control study design, reported on the 30-day hospital rate in the prehosp traject. Two[221, 263] of found significant higher number of hospital admissions in the RPM group, while two[129, 145] found no significant difference and one study[79] found a lower number of hospital admissions in the RPM group. However, this study that claimed a lower number is a small scale study (N=55 RPM vs N=110 control) and the 30 patients that were 'admitted' in the control group consisted of 25 patients that stayed less than 24 hours and it could be questioned if this has to be regarded as a real hospital admission; when these are taken out of the analysis there is no longer a significant difference.

It has to be remarked that the study of Misra[129] in this calculation only included patients that presented first in primary care and excluded patients that presented first to the ED and that the study of Pritchett_2021 concern patients with cancer and COVID-19. Also regarding the effect found in the study of Beaney[263], it has to be remarked that 2 other publications on the same project but that used another research design (a period without the availability of RPM versus a period with the availability of RPM (Beaney et al 2021b[267]) and regions with higher uptake of RPM versus regions with lower uptake of RPM (Sherlaw et al 2021[268]), the pre-post analysis [267] also found a slightly higher admission rate in the RPM period, but the regional analysis[268] did not show an effect on hospital admissions.

Table 31 – Hospital admission prehosp in matched-control studies

Var\project	Beaney et al.[263]			Delgado et al.[221]			Dirikgil et al.[79]			Misra et al.**[129]			Pritchett et al.***[145]		
	RPM	Control	Adj OR 95 CI	RPM	Control	Adj OR 95 CI	RPM	Control	Adj OR 95 CI	RPM	Control	Adj OR 95 CI	RPM	Control	Adj OR 95 CI
N	639	14982		3488	4377		55	110		2672	1950		71	116	
30 day Admission, N (%)	152 (23,79)	3180* (21.2)	1.59 1.32-1.91	211 (6,05)	141 (3,20)	1.93 1.56-2.41	5 (9,09)	30 (27)	0.27 0.1-0.73	302 (11.3)	242 (12.4)	0.90 0.68-1.20	3 (4,23)	15 (12,90)	0.33 0.09-1.17
			More			More			less			NS			NS

**recalculated from OR*
***based on the number mentioned for outpatients that did not present first to the ED*
****concern cancer patients with COVID-19*

In conclusion, there is no convincing evidence that RPM prehosp leads to less or more hospital admissions.

POSTHOSP

Twenty-three studies on posthosp patients reported on the hospital readmission rate. These varied from 0 to 22.2% with a median of 5.4% (P25=2; P75=10.5).

Three studies[153, 155, 243] reported a 0% of readmissions:

- The USA study of Lisker et al.[243] concerned 81 patients, of which 43 were discharged with supplemental oxygen, 14 were discharged on prophylactic-dose anticoagulation, 12 with rivaroxaban and 2 with apixaban.
- A small scale (n=56) study[155] from the UK found 0% readmissions during RPM and up to 14 days after RPM; no risk characteristics of the patient population are mentioned.
- A Spanish study[153] in 95 patients also reported a 0% of readmissions during a 1 month of RPM follow-up. Patients had to be stable, have passed the critical period of the disease, remained fever-free for at least 48 hours, and had a baseline oxygen saturation > 92%, before they were discharged and included in the RPM.

Three studies[138, 249, 258] reported a hospital readmission rate of ≥ 20%. The highest rate (22.2%) of readmissions posthosp was reported in an Irish small scale (n=18) study[138]. The study of Padilla[249] concerned 10 liver transplant patients with COVID-19 and the Walsh study included only 15 patients.

Two studies [93, 175] applied a matched-cohort research design in their analysis of readmission in the posthosp traject:

- An USA study of Gordon et al.[93] (n=225 in RPM group versus n=1061 in control group) found in multivariate analysis a significant difference of 1.3% hospital readmissions in RPM versus 5.7% in the control group consisting of patients that did not receive RPM (for unclear reasons) (OR=0.22, CI: 0.07-0.71).
- Another USA study of Ye et al.[175] (n=217 in RPM vs n=192 in control) found a non-significant difference of 6.9% hospital readmissions in RPM versus 8.3% in control group.

In conclusion, there is no convincing evidence that RPM posthosp is associated with less or more hospital readmissions.

4.4.2 Mortality

Fifty-five studies reported on mortality in the preshosp traject and 14 in the posthosp traject. However it was not always clear when the mortality was measured.

PREHOSP

Fifty-five studies reported on mortality in preshosp group and the rate varied from 0 to 8.8% with a median of 0.15 (P25=0; P75=1.1). Twenty-four studies reported 0% mortality and 16 studies reported a mortality between 0-1%. Only 2 studies had a mortality rate above 4%: a small scale (n=23) Australian study of Lwin et al.[118]found a mortality rate of 4.35%, but this comes to only 1 single patient; the other study with a high mortality rate (8.8%) concerns the small scale (n=34) study of Cotner et al.[71] . In the three very large studies (>10 000 patients included) with RPM prehosp, the mortality was 0.1% in Yordanov et al.[176], 0.7% in Nascimento et al.[134] and 1.3% in Shaw et al.[158]

Three projects[145, 221, 263] that applied a matched-control study design, reported on the 30 day mortality rate in the prehosp traject. Two [221, 263] found significant less mortality in the RPM group, and the study of Delgado_2021 found the same effect at day 60. The third study of Pritchett et al. concerned a small scale study in cancer patients with COVID in which there was no significant difference.

Table 32 – Mortality prehosp in matched-control studies

Var\project		Beaney et al.[263]			Delgado et al.[221]			Pritchett et al.***[145]		
		RPM	Control	Adj OR 95 CI	RPM	Control	Adj OR 95 CI	RPM	Control	Adj OR 95 CI
N		639	14982		3488	4377		71	116	
Mortality N(%)	At 30 days	9 (1,41)	430* (2.9)	0.48 0.25-0.93	3 (0,09)	12 (0,27)	0.32 0.12-0.72	0	4 (3,40)	0.17 0.01-3.30
				Less			Less			NS
	At 60 days				5 (0.14)	16 (0.37)	0.34 0.16-0.67			
							Less			

**recalculated from OR*
****concern cancer patients with COVID-19*

In conclusion, mortality in RPM prehosp is in general low and there is weak evidence that shows that RPM is associated with lower mortality than non-RPM.

POSTHOSP

Fourteen studies reported on mortality rate in posthosp RPM, varying from 0 to 4.2% with a median of 0% (P25=0; P75=1.4). Nine mentioned a 0% rate. The highest mortality rate was 4.2% in the small scale (n=24) study of Heller et al.[97], but this is only 1 patient. The study of Francis et al.[85, 86] concerning 420 RPM posthosp reported a 3.8% mortality rate with a higher percentage in the patients with comorbidity. In the large scale French study (n=5493 posthosp of which 60% were considered as high risk) of Yordanov et al. the mortality rate was 0.07.

One study[175] that applied a matched-control design found there was no significant difference in the percentage of patients referred to RPM (n=217) versus not referred to RPM (n=192) that died (1.4% vs 2.1%; OR=0.66, CI: 0.15-2.99) within 14 days.

In conclusion, mortality in RPM posthosp is in general low and there is no evidence that RPM is associated with lower or higher mortality than non-RPM.

4.4.3 Previous length of hospital stay (LOS) in posthosp

Eleven studies reported on the previous hospital LOS for RPM patients posthosp. Mean LOS varied from 1.7[261] to 38 days[179] with a median of 6 (P25=4; P75=10).

Two studies [93, 175] that applied a matched-control design compared the LOS between RPM and control; both found no significant differences:

- Gordon et al.[93] (n=225 in RPM group versus n=1061 in control group) found a mean LOS of 5 (3-8) days in RPM versus 5 (3-8) days in the control group consisting of patients that did not receive RPM (for unclear reasons)

- Ye et al.[175] (n=217 in RPM vs n=192 in control) found a mean LOS of 5 (+/-3.9) days in RPM versus 4.2 (+/-3.2) days in the control group (p=0.05).

Based on these studies there is no evidence that RPM posthosp shortens previous hospital length of stay.

4.4.4 Economic outcomes of COVID-19 RPM

Several [3, 4, 40, 41, 47, 48, 55, 57, 60, 67, 73, 79, 87, 88, 93, 95, 97, 107, 108, 125-127, 129, 137, 141, 145, 150, 152, 155, 167-169, 175, 182, 183, 186, 188, 195, 197, 212-214, 224, 251, 261, 266, 271] of the included documents contained information on costs of the intervention or made claims on savings that were made by RPM in terms of avoided ED-visits, avoided hospital admissions and reduction in length of hospital stays (sometimes expressed in monetary values). Appendix 4.3 shows quotes on savings from the studies with a short commentary on it by us.

Common in all these claims, is that they are in favour of RPM. However, it needs to be taken into account that none of these claims and conclusions is based on randomized studies, only a few used some kind of comparison group, and are mainly based on expert opinion and assumptions. In most of the documents that claim savings, a clear methodology is lacking.

However, five studies [3, 137, 168, 195, 212] with an extended method section, were subjected to a comprehensive economic assessment (see Appendix 4.3). We found that all five studies had a low level of methodologically quality and therefore no concrete conclusions could be drawn, except the fact that if telemonitoring really allows to avoid hospitalization and if the cost of such a telemonitoring is inferior to hospital costs, then savings could be made, at least initially. But it would need to be further investigated whether there are more complications in telemonitored patients than in hospitalised patients, which could lead to higher costs in the long run. More studies are therefore needed and telemonitoring in COVID-19 must currently mostly be seen as an alternative if hospitals are overcrowded than as a cost-effective strategy.

In conclusion, many publications make claims in favour of RPM for avoiding ED-visits, hospital admissions, shortening length of hospital stay and reducing costs. But the scientific base for these claims is doubtful.

4.4.5 Patient experience

Seventy-three documents [37, 40-42, 46, 48-50, 59, 60, 65, 66, 69, 74, 75, 77, 80, 82, 84, 87, 95, 98, 99, 102, 103, 107, 110, 111, 118, 120, 125, 127, 130-132, 135, 137, 141, 142, 146, 150, 155, 160, 161, 163, 168, 173, 175, 178, 179, 182-184, 188, 191, 197-199, 209, 217, 218, 223, 224, 230, 232, 234, 236, 245, 246, 253, 257, 258, 264] mentioned some kind of patient experience. In general, patient reports are very positive about RPM; it gives patients mainly a feeling of reassurance. Quotes regarding patient experience can be found in Appendix 4.5. However, it has to be mentioned that this overall positive picture might be skewed, because several projects only included patients that had already some digital proficiency and were familiar with smartphone use.

> "*Only those with initially mild symptoms and a smartphone, tablet or computer, at ease with these recent technologies and accepting the telesurveillance programme were included.*"[177]

Moreover, in most projects patient satisfaction questionnaire were only answered by a part of the patients that received RPM and so there is chance for selection bias.
Also some projects (e.g. [52, 93, 130, 158, 163, 181, 187, 201, 209, 261]) reported that RPM was offered but patients declined to receive it for several reasons (feeling good enough, too much technological embarrassment expected).

In general, patients appreciated RPM and it gave them reassurance.

4.5 RPM in special patient populations

Some studies focused on special populations, such as oncological patients [71, 74, 75, 82, 96, 120, 133, 144-146, 148, 151, 163, 189, 235], children[76, 228, 248], liver transplant patients[249], or pregnant/postpartum women[180, 190, 233, 250, 255] with COVID-19. RPM appeared to be feasible in these type of patients. Further details can be found in Appendix 4.6'

4.6 Barriers and facilitators in implementing RPM for patients with COVID-19

Individual projects sometimes discussed barriers and enablers they encountered in the development and implementation of their RPM initiative. We did not perform an exhaustive data extraction from those individual projects, but some examples are given in Appendix 4.7.

However, in our searches we encountered six overview publications[31, 33, 105, 273-276] that have already listed barriers, challenges and facilitators in implementing telehealth applications during the COVID-19 pandemic, including telemonitoring. Main findings of these are presented below .

- Houlding et al.[31] performed a systematic review 'Barriers to use of remote monitoring technologies (RMT) used to support COVID-19 patients: A rapid review ' in which they identified following barriers to using RMTs for COVID-19 patients:
  - Equity-related barriers
  - A lack of RMT implementation guidelines and research
  - Resources required for technology development and implementation
  - Challenging patient experiences of RMTs
  - Confidentiality-related barriers
  - Workforce training
  - Quality of information
  - Communication-related barriers
  - Ethical concerns with RMTs
  - Policy requirements
  - Quality of care
  - Technology-specific barriers
  - Technology integration related barriers
  - Financial barriers

The most commonly reported barrier themes were a lack of guidance (n=12) and increased resources needed (n=11) for implementation, development and use of RMTs to treat COVID-19. These barriers are likely due to the novel nature of COVID-19 and thus could become less relevant over time. Another main concern cited by several publications was that rigorous privacy and security settings would be necessary to protect patient information (n=9). However, despite emphasizing the importance of privacy and security only 5 publications out of 18 describing implementation of a specific RMT reported privacy and security and privacy features or policies of the software used. Additionally, two publications noted that use of RMT could break down the humanitarian core of care as well as patient-healthcare provider communication. One way to promote effective patient communication is to design user-friendly technology with two-way communication . While patient involvement in technology development can be used to effectively tailor the technology to the specific needs of the patient, no publications reported this in practice. This is unfortunate considering the impact it can have on the success of a RMT. Future technologies should involve rigorous user-evaluation based on feedback from patients. The extent of patient involvement in RMT implementation should be thoroughly described to support use of the technology. Lastly, it will take time and resources to bring RMTs to scale; and information regarding clinical utility and cost will help ascertain which should be prioritised for investment of resources to aid in this development. Equity factors also proved important to consider when implementing RMT. Health interventions should be tailored according to population needs or they risk increasing health inequities. The most common overall barrier theme was concerns regarding equitable use of RMTs (n=15). This is concerning considering marginalised groups are already disproportionately impacted by COVID-19

- The review of Khoshrounejad et al.[105] identified sixty-seven barriers in 28 studies, categorized into the 13 groups as below:
  - Adequacy and accuracy of subjective patient assessment/accuracy of tele-tools

- Change in physician-patient communication
- Technology acceptance/user adoption
- Data privacy and security
- System design
- Resource availability/accessibility
- Technical issues
- Standards and legal considerations
- Insurance policies and reimbursement
- Data availability/accessibility
- System maintenance
- Presence of parallel systems
- Different operational requirements in organizations and lack of widespread use

In the body of research reviewed here, various factors were mentioned as barriers to the deployment of telehealth services. Technology acceptance and user adoption was the most common barriers against using telehealth solutions. Several reasons were raised by physicians and patients for not willing to use new telehealth tools, including lack of time, lack of workflow integration, workload, difficulties with technology, lower levels of internet use, lack of confidence with technology, sensory impairments, health literacy, hearing and vision impairment, and so on.

Adequacy and accuracy of subjective patient assessment and accuracy of tele-tools were identified as the second barrier. This issue was raised by physicians because they believe tele visit limits the ability of providers to perform a complete physical examination and measure vital signs. They also claim that tele visit leads to change in physician-patient communication which is a foundation of clinical care .

Technical issues due to lack of dedicated IT infrastructure was another barrier. This challenge particularly affects synchronous service delivery. A poor internet connection can lead to poor quality audio and video. Forcing people to find alternative approaches might lead to dissatisfaction with telehealth services.

Data availability, resource availability including equipment and human resources and their accessibility for patients and providers, standards and legal considerations, insurance policies and reimbursement and data privacy and security are among the barriers to using telehealth.

- The review of Jaffe et al.[33] focused on telehealth applications in ED services. One of the facilitators mentioned is pre-existing telehealth services that in the pandemic easily could be expanded to serve a broader patient population. It might be that implementing and scaling a new telehealth infrastructure simultaneously with managing a pandemic response was beyond the capacity of sites that did not already have it. They also state that it is likely that multiple policy initiatives, such as the aforementioned CARES Act, have contributed to the increased use of telehealth. This has included the reimbursement of telehealth visits at similar rates to in-person visits as well as permitting MSEs via telehealth. Furthermore they point to the costs associated with telehealth that might have the potential to be prohibitive, particularly for smaller or less-resourced systems
- NSW Agency for Clinical Innovation[276] mentions as RPM facilitators:
  - Pre-existing infrastructure
  - ‘on the ground’ enthusiasm
  - remote monitoring champions had already been identified and were disseminating knowledge and technical skills amongst clinical staff
  - access to funding for the purchase of remote monitoring equipment
  - support to drive innovation in virtual care from executive leaders
  - existing clinical governance frameworks for remote monitoring in Hospital in the Home (HiTH) or chronic disease monitoring settings
  - high levels of change acceptance amongst clinical staff

- When developing governance structures for in-home remote monitoring it is important to ensure these align with existing local governance structures
- Governance structures are supported by executive sponsors and may include: – monitoring committee – evaluation committee – consumer engagement – clinical engagement.
- Patients should be included from the early stages of planning and implementation to evaluation and improvement
- Consistent, frequent and personable communication facilitates meaningful relationships with patients
- Other stakeholders, including GPs and their practices, allied health service providers, primary health networks (PHNs), community services and technology providers should also be engaged, where needed, to enhance care.
- Stakeholder engagement is supported by well documented shared care planning, referral and discharge procedures, protocols clearly defining medical governance, deterioration escalation plans and training and education materials
- Successful models should aim to establish procedures for monitoring and evaluation, including:
  - evaluation of patient and clinician experience
  - collation of evidence of case for change and value propositions
  - mechanisms for continuous quality improvement based on clinical and experience outcomes
  - cost benefit analysis.

- Eickholt et al.[274, 275] performed19 semi-structured interviews with healthcare employees of all Dutch University Medical Centers (UMCs). The interviews assessed why some telemedicine services were successfully implemented while others were not, and what facilitated or prevented the implementation respectively. This study identified that the most prominent facilitators lie particularly in the outer and inner setting. Concerning the outer setting, patients seemed highly satisfied with all telemedicine services, forming a facilitator to implementation. Regarding external policies, financial incentives for healthcare employees turned out an important factor. Regarding the inner setting, communication between departments became more accessible during the pandemic, which improved quick decisions making and remaining oversight of all developments. In line with this, the introduction of multidisciplinary project teams was perceived to facilitate the implementation of telemedicine services. Furthermore, having a 'digital' vision and mission as a hospital, which is clearly communicated to the hospital's employees, was a perceived facilitator to implementation. However, this study also showed that most UMCs experience a lack of resources to realize all these organizational activities. Besides these facilitators to telemedicine implementation during the COVID-19 pandemic, implementation barriers lie mainly in the domains of intervention characteristics and individual characteristics. In terms of intervention characteristics, the perceived complexity of telemonitoring implementation, and lack of adaptability of teleconsulting services formed important barriers. Furthermore, HCPs often mentioned that technologies are unreliable and not user-friendly. However, other staff members noted that both HCPs and patients do not always fully understand the technologies and its possibilities. As such, besides improving user friendliness, increasing explanations, setting up a helpdesk, and providing trainings were perceived helpful as well. Concerning individual characteristics, this study showed that healthcare employee's beliefs about the interventions was amongst the most important constructs and were reported to act as both facilitators and barriers. 'Resistance to change' was often mentioned to play an important role in the lack of adoption by HCPs, and it was often mentioned that they are afraid to lose authority with the increased usage of telemedicine. It was often noted that resistance of HCPs could be overcome through increased engagement during the implementation process, forming a facilitator within the implementation process domain. As such, strong engagement of leaders and healthcare employees was mentioned a great facilitator, however not a guarantee for successful

implementation as healthcare employees' actions are crucial for successful implementation. Changes in reimbursement and financing of telemonitoring services are recommended (if the service is proved effective).

- Vindrola et al.[273, 277] performed a study in which they analyzed eight RPM-COVID-19 initiatives in the UK.

  As facilitators they mention:

  - Implementation was facilitated by the active role played by dedicated clinical leaders in establishing the remote home monitoring models
  - Acute hospitals that had previous pathways in place (i.e. ambulatory care) or digital protocols that could be repurposed by IT teams were able to set-up these models at a quicker pace
  - Good communication between members of the clinical team was identified as a key facilitator
  - During the first wave of the pandemic, staff were available to play a role in the delivery of care in these models due to the cancellation of elective care and other activities; some members of staff were released from clinical responsibilities and could be redeployed to monitor patients remotely.
  - Paper and video patient information (as well as using digital platforms) was very useful to explain the concept of the remote home monitoring models and how to take measurements using pulse oximeters.
  - Additional sources of funding were made available at this time and staff were allowed to use discretionary funds through fast-approval processes established in both primary and secondary care
  - Patient and carer training were identified as the key to the success of these models

  As barriers they mention:

  - Early on, referral criteria and processes were unclear, which led to patients being referred to these models who might have been ineligible in other circumstances.
  - Staff found it difficult to carry out non-verbal assessments using telephone and video consultation alone.
  - Some patient groups were more difficult to monitor remotely (e.g. homeless community) and staff reflected that monitoring using an app only model might not be suitable for all populations, as this approach could exclude patients with low levels of health and technology literacy.
  - The availability of culturally appropriate patient information in different community languages was identified as a key component of patient engagement, but not all study sites were able to develop these materials.
  - Lack of administrative/project management support and resources meant that essential equipment such as pulse oximeters could not be obtained quickly.
  - Staff also found it challenging to deliver a seven day service due to workforce availability.
  - There was a lack of published data to support the design of the remote monitoring models and study sites found it challenging and time consuming to collect the desired data, even when using commercially available apps.
  - The integration of service data with existing patient administration systems was generally poor, and it was not feasible to arrange data sharing between and within sectors in the time available.
  - Additionally, there was no link between NHS Test and Trace systems and the study sites' referral processes.

5 ONGOING STUDIES

Telemonitoring for patients with COVID-19 appeared to be a topic on which every week new evidence became available. It might be expected that this will continue in the next coming months, since COVID-19 continues to put a high burden on health care systems. Furthermore, we came across several publications in which only the intervention was presented without any outcome data; it might be expected that in a later stage follow-up publications will arrive from these projects with outcome data. Therefore this report has to be regarded as limitative.

At the time when we closed searches and data-gathering (mid December 2021), we are aware of ongoing studies[278-304] , of which nine[278, 279, 282, 290, 291, 295, 300-302] are RCTs in which at home patients with COVID-19 will be randomized on yes/no RPM.

Moreover it has to be stressed we only searched in English, Dutch and French for publications in English, Dutch or French; there is a great chance that there are also publications in other languages, since COVID-19 hit the entire world. We came coincidentally across non-English relevant publications that we did not include. Also we encountered English written publications from non-English speaking countries; it may be assumed that these are only the tip of the iceberg of what was ongoing in those countries.

In conclusion, although this review already contains results from over 160 projects and covering about 250 000 patients, it gives only a partial view of the evidence and therefore our conclusions have to regarded as partially and preliminary. We urge that update of this review will take place at least each year to have a more conclusive view.

6 SEARCH UPDATE FOR RANDOMIZED CONTROLLED TRIALS

After closing inclusion period for literature on December 15th 2021, daily Pubmed alerts were followed up to March 6th 2022. And on March 16th 2022 an update of the search (Appendix 4.1) was done in the databases, to check for published randomized controlled trials and newly initiated RCTs. RCTs were followed up through means of Pubmed alerts up until April 16th 2022.

The Pubmed alerts after 15 December 2021 resulted in identification of 3 randomized trials [305-307].

The database search (475 screened hits) identified one previous ongoing trial to be completed.[290] The results are described but no article was yet published.

A short description of these RCT's is given below. They are the first RCTs we could identify.

Van Goor et al. [306] was performed in the Netherlands. It concerned a trial with RPM for patients in the **post-hospital traject**. They included 62 patients of which 32 were randomized to the experimental group with RPM and 32 to the control group, who received usual care. The mean difference in hospital-free days was 1.7 (26.7 control vs. 28.4 intervention, 95% CI of difference −0.5 to 4.2, p = 0.112). In the intervention group, the index hospital length of stay was 1.6 days shorter (95% CI −2.4 to −0.8, p < 0.001), but the total duration of care under hospital responsibility was 4.1 days longer (95% CI 0.5 to 7.7, p = 0.028).

The authors concluded that remote hospital care for recovering COVID-19 patients is feasible, but that they could not demonstrate an increase in hospital-free days in the 30 days following randomisation.

The Spanish study of Marquez-Algaba et al. [305] concerned an RCT with RPM for patients in the **post-hosp traject**. They included 150 patients of which 74 patients were randomized to the experimental group, and 76 to the control group. The primary outcome of the study was reduction in the need for in-person return visits. Secondary outcomes were degree of anxiety,

satisfaction, and perception of global health at the end of follow-up. The intention-to-treat (ITT) analysis included all patients who underwent randomization. Any patients lost to follow-up were considered failures in both strategies. The per-protocol (PP) analysis included patients who completed all end-of-follow-up requirements.

According to the PP analysis, patients in the control group were significantly more likely to return to the ED (ED) for COVID-19–related reasons than those in the experimental group (7.9% vs. 0%; p = 0.029). However, no differences were observed in the intention-to-treat analysis. Satisfaction with outpatient monitoring was rated more highly by the experimental group in both the PP and the ITT analyses. **There were no statistically significant differences in the health status questionnaire or anxiety scale by the end of follow-up**.

In the RCT of Leff (USA)[290] patients without wearable monitoring technology undergoing routine standard of care at the hospital (n=150) were compared to patients who are diagnosed with COVID-19 and are undergoing self-quarantine while being closely monitored using a wearable device, and shared-clinical decisions will be made based on the monitored data and patient data (n=130). The groups had a similar age (65 years), slightly more females in the intervention group, and especially (> 60%) had hispanic/latino ethnicity. Comparing the standard of care versus monitored group, there were 8 versus 9 in-patient admissions within 14 days; 14 versus 12 patients needed to visit ED; if hospitalized the length of stay was 7 days on average in both groups; nearly 65% completed the patient satisfaction survey; none of the subjects required mechanical ventilation or ECMO; serious adverse events (within 14 days) were reported in 2 versus 1 person and considered respiratory, thoracic and mediastinal disorders leading to death. Infections and infestations leading to repeated admission were reported in 8 versus 9 patients.

The results of the fourth RCT of Lee (USA)[307], with more than 1000 patients, were published in a letter to the editor the New England Journal of Medecine. Patients were enrolled in COVID Watch to participate in the standard monitoring program in addition to home pulse oximetry or the standard program alone. Patients in the pulse oximetry group were provided a pulse oximeter and were monitored for subjective symptoms or a low or declining oxygen saturation. The prespecified primary outcome was the number of days the patient was alive and out of the hospital at 30 days, assessed in patients with test-confirmed Covid-19 (n=1217). Among patients with test-confirmed Covid-19, there was no significant between-group difference in the number of days they were alive and out of the hospital at 30 days (mean, 29.4 days in the pulse oximetry group and 29.5 days in the standard program group; P=0.58; difference, −0.1 days; 95% confidence interval [CI], −0.4 to 0.2).

The authors concluded that among patients with COVID-19, the addition of home pulse oximetry to remote monitoring did not result in a greater number of days alive and out of the hospital than subjective assessments of dyspnea alone.

In summary, we identified 2 small scale RCT's with RPM for patients with COVID-19 in a post-hosp traject. Both trials could not demonstrate statistically significant differences in outcomes between the experimental and control group.

We identified 1 small scale RCT with RPM for patients with COVID-19 from USA in the pre-hosp traject. Based on the preliminary results no significant differences in outcomes between the experimental and control group are seen.

We identified 1 large scale RCT with RPM for patients with COVID-19 from USA in the pre-hosp traject. No significant results were found to demonstrate the added value (with completion 30 days survival without hospitalisation) of oxygen saturation measurement on top of twice daily text messages.

7 DISCUSSION

In this section, we first look how our review compares to previous reviews on RPM in patients with COVID-19. Secondly, we have a look at identified overview studies on COVID-19 RPM patients from the UK. Third, some reviews on RPM in patients with other conditions are presented. Finally, some general discussion points are raised.

7.1 Compared to previous reviews on RPM in patients with COVID-19

We came across five previous reviews, in order of publication date:

- The Canadian Agency for Drugs and Technologies in Health (CADTH)[308] performed a review in spring 2020 and on July, 16th 2020, they reported: '***No literature*** *was identified regarding the clinical utility of remote monitoring medical devices for coronavirus disease 2019. In addition, no relevant economic evaluations were identified regarding the cost-effectiveness of remote monitoring medical devices for coronavirus disease 2019*'
- Jaffe et al.[33] (published April 2021) identified 35 studies on telehealth use in patients with COVID-19, among which some related to PM; all identified RPM studies were observational.
- Vindrola et al.[309], performed a systematic review, published on July, 22th 2021, and included 27 studies, covering about 25 000 patients. They concluded "*It was difficult to carry out an analysis of the impact of remote home monitoring across all examples because not all articles reported data on the same outcomes (Table 2). Mortality rates were low, admission or readmission rates ranged from 0 to 29%, and ED attendance or reattendance ranged from 4 to 36%. Six of the models reported data on patient feedback, with high satisfaction rates. Remote home monitoring process outcomes were only included in six of the articles, with time from swab to assessment ranging from 2 to 3.7 days and virtual length of stay from 3.5 days to 13 days. Only one article presented findings on reduction in length of stay, calculated at 5 days fewer per patient. "*
- Joyce_2021[310] (published August, 13th 2021) included 15 studies covering 9 173 patients. They found a large heterogeneity across studies in intervention characteristics.
- A narrative review of Warrier et al.[311] with an unclear number of included studies, published in Sept 2021, concluded '*While these technologies (RPM) are increasing in number and versatility, they are not empirically improving patient outcomes significantly at this time, mainly due to their novelty'.*
- A systematic review of Alboksmaty et al. [312], searching five databases, included 13 articles on the effectiveness and safety of pulse oximetry in RPM of COVID-19 patients at home. The final studies were all observational cohorts and involved a total of 2,908 participants. They concluded "*A meta-analysis was not feasible due to the heterogeneity of the outcomes reported in the included studies. The review confirmed the safety and potential of using pulse oximetry in monitoring COVID-19 patients at home. It can potentially save hospital resources for those who may benefit most from care escalation. However, we could not identify explicit evidence on the impact on health outcomes compared with other monitoring models that have not used pulse oximetry*."

We are aware that another review[313] is still ongoing.

Our review included much more RPM projects (N=164), covering much more patients (250 000) than previous reviews did. Especially very large projects from France (COVIDOM[69, 78, 176, 177, 200, 210]) , Brazil (UNIMED[134]), USA (Kaiser Permanente Virtual Home Care Program[135, 158]) and Spain (Telea[62, 122, 147]) are additional.

Nevertheless, our conclusions on large heterogeneity and lack of evidence regarding clinical outcomes are very similar to the previous reviews.

7.2 Compared to RPM overview studies from the UK

From the United Kingdom several overview studies[87, 263, 267, 268, 273 314] of RPM initiatives in patients with COVID-19 were published.

The National Institute for Health Research, Health Services & Delivery Research programme[87, 273] evaluated eight RPM projects in patients with COVID-19, that were implemented in the UK. Hereto, they analyzed data recorded by the projects and interviewed 22 persons involved in these projects. Projects concerned both the pre- and posthosp traject. They found that **the main aim** of these projects was to **(1) avoid unnecessary hospital admissions and (2) escalate cases of deterioration at an earlier stage**. The study sites collected combinations of demographics, clinical readings, patient experience and outcomes data. Common outcomes collected included hospital and ICU admissions or readmissions, ED attendances, mortality rates and patient satisfaction measures. The need to act quickly at the start of the pandemic meant that there was little time to carefully plan data collection. There was a lack of published data to support the design of the remote monitoring models. Data quality was reported in some sites to be good, while others acknowledged limitations, especially early on. Data collection outside the apps could be cumbersome, and study sites found it challenging to integrate data from apps into their existing patient administration systems. No study site had been able to identify an appropriate group to use as a comparator at the time of the study and consequently these models were not able to establish control groups to compare effectiveness. The total number of escalated patients was 10% for the pre-hospital and 12.2% for the early discharge from the hospital model, from which the majority of patients was seen in ED (76.7% and 91.8%, respectively) and/or admitted to hospital (52.7% and 74.5%). Data on the staff involved in setting-up and running the models did not show clear patterns in terms of specialisation or seniority of the staff involved. The total number of the staff involved in setting up and running the models varied by site. Staff involved were a mix of consultants, ED staff, GP partners, nurses, ANPs, and medical students. On average patients were monitored for 14 days. The mean costs per monitored patient were higher in the pre-hospital (£553 per patient) than in the early discharge from hospital model (£400/patient). Implementation was facilitated by the active role played by dedicated clinical leaders in establishing the remote home monitoring models. Acute hospitals that had previous pathways in place (i.e. ambulatory care) or digital protocols that could be repurposed by IT teams were able to set-up these models at a quicker pace. In both primary and secondary care-led models, participants indicated that monitoring could be delivered by nurses with minimal senior oversight, maintaining clear communication with delivery teams. Good communication between members of the clinical team was identified as a key facilitator. It is important to note that during the first wave of the pandemic, staff were available to play a role in the delivery of care in these models due to the cancellation of elective care and other activities in the NHS. Volunteers were also used. Participants expressed concern that these staff members would not be available during future surges in patient cases. The integration of service data with existing patient administration systems was generally poor, and it was not feasible to arrange data sharing between and within sectors in the time available. In general, patients experienced positive engagement with the remote home monitoring models. However, some of the problems that were raised were increase in patient anxiety and reduction in patient engagement during later follow up calls or at later stages of first wave. The monitoring of patients remotely was perceived by staff as a safe way to ensure patients received the appropriate care at the right place. The impact of remote home monitoring on patient outcomes and their cost-effectiveness should be assessed through the use of more standardised data and appropriate comparators.

Later on, the national program COVID-oximetry@home (CO@h) was evaluated and reported in 3 publications[263, 267, 268]. They applied 3 different approaches to look at the effectivity of the program: a regional comparison, a pre-post comparison and matched-control study. No significant differences were found in the clinical outcomes in the regional approach and the pre-post approach but some small effects (a significant higher number of ED-visits within 30 days and hospital admissions and less mortality for the RPM pre-hosp group) were found in the matched-control study.

So, these overview studies of RPM initiatives in the UK are in line with our findings in the review.

7.3 COVID-19 RPM versus RPM in other diseases

RPM has been used for many other diseases in the past. And although we did not perform a systematic search for that literature, we came accidentally across a number of studies/reviews of RPM in those patient categories.

Analogue to what we found in patients with COVID-19, many publications (e.g. [315-319]) reported a high level of patient acceptance and satisfaction for RPM. Nanda et al. [320], performed a systematic review (published 22/03/21) regarding patient experience with telehealth (including RPM) during the COVID-19 pandemic, but not restricted to patients with COVID-19. They included 25 studies covering upon 48 144 surveyed patients and 146 providers in 12 different countries and concluded that these studies '*revealed high satisfaction with virtual encounters across a spectrum of diseases. Telemedicine was found satisfactory on various outcome measures, such as addressing patients' concerns, communication with health care providers, usefulness, and reliability. Most common advantages were time saved due to lesser traveling and waiting time, better accessibility, convenience, and cost efficiency*.'

Contrary to our review in which convincing evidence is lacking for effectiveness, several studies [32, 316, 321-327]Murphy, 2020 #53}[328-330], on RPM in general and in other diseases already demonstrated similar or improved outcomes (avoiding ED-visits and (re)admission, shortening hospital length of stay and reducing mortality).

However, several review-authors[331-339] point to the high heterogeneity in RPM studies and state that still caution should be taken when interpreting RPM-studies.

> "*However, we were limited by high heterogeneity and scarcity of high-quality studies. The high degree of heterogeneity is likely due to differences in the types of devices used, follow-up periods, and the types of controls in each study. In summary, our results indicate that while some RPM interventions may prove to be promising in changing clinical outcomes in the future, there are still large gaps in the evidence base." [332]*

And Breteler [340] warns that although RPM is a very promising technology, but has to be regarded as a 'complex intervention' and the implementation of it requires a lot of energy and time and several issues still need to be solved and hurdles to be taken.

Regarding barriers in implementing RPM, Thomas et al.[341] performed a systematic review and identified 31 factors (six categories) that impact the effectiveness of RPM innovations on acute care use. They conclude that '*intervention success was related: (1) targeting populations at high risk; (2) accurately detecting a decline in health; (3) providing responsive and timely care; (4) personalising care; (5) enhancing self-management, and (6) ensuring collaborative and coordinated care. While RPM interventions are complex, if they are designed with patients, providers and the implementation setting in mind and incorporate the key variables identified within this review, it is more likely that they will be effective at reducing acute hospital events."*

7.4 How to interpret the clinical outcomes from RPM?

7.4.1 Are ED-visits and hospital admissions good or bad outcomes?

The aim of telemonitoring is on one hand timely detecting deterioration in order to take timely action to stop further deterioration. On the other hand telemonitoring aims to avoid ED-visits and hospital (re)admission. These aims are somewhat contradictory, in case of detecting deterioration it could be appropriate to further assess a patient at the ED or to admit to the hospital. In this way a large % of ED-visits and hospital admission could be interpreted as a 'success' but also as a 'failure'.

In case of sensitive detecting deterioration, RPM could lead to more ED-visits and hospital admission compared to absence of RPM, but this would lead to more pressure on the hospitals, contrary to the aim of RPM.

7.4.2 Is shortening of hospital length of stay really a shortening?

Several articles stated that LOS was shortened due to RPM posthosp. However, these 'savings' do not mean much if these patients need to be re-hospitalized soon after discharge. One problem we encountered during analysis was that the rate of readmissions in posthosp patients differed greatly and that the time frame (7, 15, 30, 60 days after discharge) was not always mentioned. However, there are indications that shorter lengths of stay are related to higher rates of readmission ('*Short-stay hospitalization had significantly increased odds of rehospitalization within 7 days*' [272]; '*However, patients who were readmitted had significantly shorter initial length of stay (median 7 days (range:2-54) vs. 8 days (range:2-107) days, p<0.0001)*'[342]; '*During the COVID-19 pandemic and its outbreaks, the lack of hospital beds, medical facilities, and human resources caused patients to be discharged too early, leading to increased hospital readmissions and possible postdischarge deaths*'[343]).

7.4.3 Does RPM reduces strain on hospital capacity and work force?

Most of the RPM projects aimed to reduce strain on the hospital by trying to avoid ED-visits, hospital (re)admission and shortening length of stay. However, we did not find convincing evidence on this. Moreover, it could also have the reverse effect. Furthermore, we saw that most RPM projects were hospital led, meaning that hospital personnel are needed to staff the RPM-teams. So, RPM may save a hospital bed, but not necessarily hospital personnel. It could be the case if RPM-teams would be staffed by primary care personnel, but this scenario would inevitably lead to increased workload for primary care (which during the COVID-19 pandemic was also confronted with already high workload).

Many RPM projects we identified were (partially) staffed by retired, redeployed personnel together with students and volunteers. This might have led to a reduction of strain on hospital personnel, but is of course only a temporarily solution and no option on the long run.

7.5 Which patients could profit the most of RPM?

We found prehosp RPM-projects that focused on high risk patients only, and others on low risk patients. Focusing on low risk patients has a consequence that many more patients need to be monitored and consequently more devices needed and more workload for the RPM-team to follow all of them; on the other hand it gives more certainty that patients that are deteriorating are detected, what is certainly an advantage in a pandemic with a virus of which the disease course is largely unknown and to better detect those patients with silent hypoxia (contributing more to the goal of early detection before escalation). Focusing on high risk patients limits the number of patients that have to be followed by RPM and assures that patients with the highest risk are optimally monitored and deterioration can timely be detected.

This is not an easy to solve choice. Perhaps RPM can target both groups but with a differentiated RPM approach (number of parameters to be followed, frequency of monitoring, type of devices, stepped RPM-team,…).

Regarding the posthosp RPM-projects, we (and others, e.g. [344, 345]) remarked that most projects did not use clear criteria to decide which patients could be discharged earlier and followed by RPM. Afebrile? Oxygen-independent? No more medication needed? The less criteria applied, the more patients that could leave the hospital and free up a bed, but the higher the complexity of needed post discharge care required and the higher the chance for deterioration. And when is RPM post discharge useful? And how long should it last? And when should telemonitoring be changed to a form of telecounseling (e.g. [346] or telerehabilitation (e.g. [347])?

Also here a difficult balance to find. Nevertheless, we think it could be useful to pay more attention on formulating clear criteria for save discharge and for RPM follow-up post hospital discharge. An asset hereto is given by Gavin et al.[265], who showed application of the simplified HOSPITAL score is an useful instrument to triage hospitalize patients with COVID-19 on their risk for potentially avoidable readmissions. Also other studies (e.g.[272, 342, 348-350] give useful information on the relationship between patient characteristics and risk for readmissions after hospital discharge. However, the review of Ramzi et al.[343] states that '*the number of studies examining risk factors for hospital*

readmissions and post-discharge mortality is small, and sometimes their quality is low due to various reasons'.

7.6 Other remaining questions:

- We observed a diversity in devices applied in RPM for patients with COVID-19, from a very basic cheap thermometer to advanced connected expensive multi-parameter measuring devices. Which parameters are essential to follow? How much precision/accuracy is needed for the measuring devices? Are cheap oxygen saturation meters working as well as expensive ones? How important is it to know if temperature is around 38 or 38.2? More research is needed on this, among other to define an appropriate amount of reimbursement for devices.
- What values of parameters are 'safe'? is 94, 93, 92, 91, 90 saturation the good cut-off to act, or should it be adjusted patient-individually? Must there be a reaction to each individual alerting parameter or should only be reacted on a negative trend in sequential observations? And what is the most appropriate frequency of measuring parameters? Is continuous and automated transfer of parameters needed or are before up on agreed time-points sufficient? This may have consequences for the workforce needed for RPM (and consequently for an appropriate reimbursement of the RPM-team). Many (unnecessary) alerts requires more workforce to react on them, but is a reaction always needed? (Too) few alerts requires less workforce, but may cause adverse patient events.
- We observed a variety in type and amount of personnel in the RPM teams. It remained unclear which health care professionals are the most appropriate and what level of qualifications are required? Nurses? Medical specialists? General practitioners? It also remained unclear if hospital-led RPM is superior to primary care led RPM. Or can the RPM-team be replaced or greatly assisted by a kind of virtual assistant as researched by Garcia Bermudez et al.[351]? It remained also unclear who takes up responsibility?
- What is the role of the government in RPM policy design, upscaling, solving barriers, reimbursement, technology requirements, setting up a research program and evaluation frameworks, specific for patients with COVID-19, but also for RPM in patients with other conditions? There exist already some inspiring publications[352-356] that could be used as starting point.

Our review might be regarded as disappointing, since no firm evidence was found on the value of RPM in patients with COVID-19. This is mainly caused by the large heterogeneity in patient populations, intervention content and process characteristics, aims and outcomes and by the lack of (randomized) controlled trials.

On the other hand this review led to a list of questions that are to be answered before the best combination of elements can be defined. Which patients, which parameters, which devices, which duration, which frequency, which personnel, which outcomes, what time frame, etc.? More research is needed to find the 'winning' combination.

Finally, it has to be kept in mind that many implementations of RPM around the world have been introduced independently and under high pressure to start as soon as possible, without the opportunity to learn one from another. Everyone started with limited knowledge on COVID-19 and developed RPM to their best knowledge and fitting their organization and infrastructure; this might have caused the large heterogeneity we encountered.

8 CONCLUSIONS

Telemonitoring in patients with COVID-19 has been used frequently in the past two years and across the world. It appeared to be a feasible intervention to develop and implement and was in general well accepted by health care professionals and patients. However, there is large heterogeneity in intervention elements, patient characteristics and outcomes. Also there is up till now no convincing evidence that COVID-19 RPM patients is effective in avoiding ED-visits, hospital (re)admissions, shortening length of hospital stay or reducing mortality, but there is also no signal RPM has reverse unexpected outcomes. In general, although there is no convincing evidence that RPM is effective in reducing hospital strains, it is seen as a meaningful intervention by healthcare professionals and appreciated by patients and gives them reassurance.

There is a clear need for carefully designed randomized trials. Also much more insight is needed in which patient groups has most profit of RPM, in what elements of an RPM intervention are essential, which monitoring devices are needed, how the RPM intervention should be carried and by whom, etc..

However, in awaiting furthermore convincing evidence on COVID-19 RPM, there is enough expert based and other disease-related evidence to continue with current RPM practice.

Covid-19 learned that there is no way back for telehealth, telemedicine and RPM.

CHAPTER 5 – INTEGRATION OF RESULTS AND DISCUSSION

This study tried to gain insight in the telemonitoring projects in Belgium for patients with COVID-19. Some of these projects were bottom-up initiated since the beginning of the COVID-19 pandemic, while others were endorsed by the telemonitoring in COVID-19 convention and resources provided by NIHDI. We wanted to know more on the characteristics of the included patients and the needs of the actors involved in RPM in COVID-19. Several scientific methodologies were applied to open up the reflection (survey, interviews, literature, desk research). In the following sections we bring together the main findings from the different chapters of this study. Based on these results we formulate factors that can contribute to the further implementation of remote patient monitoring in COVID-19, and other plausible acute and chronic pathologies.

1 COVID-19 RPM WAS INITIATED DURING AN ACUTE HEALTHCARE CRISIS

Since the beginning of the COVID-19 pandemic, healthcare resources across the world were under a lot of pressure.[1] The responsiveness of the healthcare organizations around the globe generally lacked preparedness for a biological event on a large scale such as in a pandemic. Due to a sudden increase in demand in healthcare services (i.e. the pandemic challenged the capacity of hospitals but at the same time pushed primary care professionals to their limits), strategies were developed to tackle the lack of resources (e.g. hospital beds, strain on healthcare professionals, safety of staff). To increase responsiveness the '**4S strategy**' can be applied by taking into account and rapidly adapting structure, staff, safety and supply.[2]

Throughout the pandemic, healthcare professionals were confronted with a new (unknown) pathology for which the clinical presentation changed with the virus mutations across the waves. Healthcare professionals had to cope with rapidly changing clinical presentations of the disease and circumstances. Many healthcare organisations, especially at the beginning of the pandemic, had to cope with a lack of staff (and staff being ill), a lack of protective material (masks, etc.), a lack of supply (e.g. ventilators), and a lack of infrastructure (e.g. hospital beds). Healthcare professionals had to risk their own lives to treat patients with COVID-19. Moreover, the demand on hospital resources fluctuated with the infectiousness of the virus but also with the governmental measures' countries implemented to fight the pandemic. It is clear that during these past two years, healthcare was under strain across the world.

2 COVID-19 RPM WAS ENDORSED BY EXPERIENCE, MOTIVATION, DEDICATED CLINICAL LEADERS AND RESOURCES

In an attempt to reduce the burden of COVID-19 on the healthcare systems around the globe, a need for community care management was triggered, which catalysed the development of RPM in COVID-19. Most COVID-19 RPM initiatives around the world as well as in Belgium were created **bottom-up**, originated from **experience**, and were endorsed by **highly motivated** health care professionals with strong believes in RPM. Hospitals that had already **a pathway** for RPM in place (i.e. ambulatory care) or digital protocols available were able to set up their project at a quicker pace. **Dedicated clinical leaders** who played an active role in establishing RPM models facilitated implementation in their health care facility or organization. Also (additional) **resources** provided by hospital management (e.g. by freeing up staff, allowing staff to use discretionary funds through fast-approval processes established in both primary and secondary care, the purchase of telemetry devices, etc.) and/or governmental funding (e.g. CMS in USA, NIHDI teleconsultation for GP's, NIHDI telemonitoring COVID-19) endorsed the projects to **learn, adapt and grow** in RPM throughout the waves of the COVID-19 pandemic.

3 COVID-19 RPM IS GENERALLY CHARACTERIZED BY A LARGE HETEROGENEITY AND LACK OF SCIENTIFIC EVIDENCE

COVID-19 RPM was often initiated quickly, and relayed on what was known from experience, what was available (e.g. related to structure, staff, supply) or what could be easily adapted within the organization. As this is different for each healthcare organization within a country, and across countries, the COVID-19 RPM projects were characterized by a **very large heterogeneity**. This heterogeneity relates to all characteristics of RPM such as (the roles of) the actors involved, communication between actors, the characteristics of the patients, the hardware and software used, etc.

None of the studied Belgian projects, and none of the 164 projects (described in nearly 250 retrieved articles) covering 248 431 patients in our literature review (until 15 December 2021) reported on the presence of a randomized control group. Some made an attempt to match groups. A recent literature update detected three small scale RCTs (less than 80 patients in each group) which could not demonstrate statistically significant differences in outcomes between the experimental and control group in the post-hospitalisation phase. On 16 March 2022 an update of the literature search was done, detecting an initial ongoing trial for which results were available (but not yet published). It considered a small scale RCT study, comparing 150 and 130 patients pre-hospitalisation from the USA. The lack of RCTs illustrates the difficulty to **build up evidence** during a health crisis. Setting up RCTs requires time and relies on a standardized scientific method. To learn about (cost)-effectiveness of an intervention and the characteristics of patients, standardized data should be collected. There is a need for systematic registration of data, clear patient related outcome measures, valid inclusion scales for patients, clear determined thresholds for alarm generation, a logbook of performed actions, registration of outcomes, etc.

As stated before, COVID-19 RPM was initiated during an acute healthcare crisis specially to reduce strain on hospital resources by facilitating the discharge of COVID-19 patients and/or avoiding hospitalisation. Most projects aimed to reduce hospital length of stay (in the post-hosp phase) and plausibly reducing emergency visits and readmission rates. On the other hand, they wanted to avoid new hospital admissions (pre-hosp phase). It should be clear that these projects were not designed to evaluate the benefit, effectiveness, or cost-effectiveness of COVID-19 RPM. Thus, the research questions outlined in the NIHDI convention cannot be answered as the design of projects does not stroke with the research objectives.

4 COVID-19 RPM DEMONSTRATED TO BE A FEASIBLE INTERVENTION THROUGHOUT THE PANDEMIC

In absence of randomized controlled trials, solid scientific evidence is lacking. The Belgian projects included in this report, could not be compared because of the high heterogeneity on multiple levels. Therefore, no answers can be given on the research aims outlined in the convention. Taking into account published literature, no conclusions can be drawn on effectiveness, cost-effectiveness, outcomes, or characteristics of patients included. Important to note, the **lack of clear evidence** does not mean that COVID-19 RPM was not (cost-)effective, it means that no research was set up in such a way that this could be shown.

It does neither mean that governments should not invest in these projects *during a crisis,* or that invested resources are wasted*,* because the resources contributed to different aims in the short-term (coping with and adapting to the crisis) and the long-term (lessons learned during the crisis).

4.1 In the short-term, it was believed the investments contributed to the aims for which the projects were initiated.

COVID-19 RPM projects **aimed to** lower pressure on hospital resources/capacity, by avoiding ED-visits and hospital (re)admissions and by shortening hospital length of stay. Some projects aimed also to reduce the workload in primary care. Next to this they aimed at the timely upscaling of healthcare interventions in case of possible deterioration of clinical status, at avoiding deterioration of the patient and mortality, at avoiding contamination and viral spread and at reassuring patients. Based on our study, healthcare professionals and actors in Belgium but also across the world, involved in RPM of COVID-19 patients believed the intervention met (certain) aims. Although hard data is lacking, the healthcare professionals experienced that **RPM reassured COVID-19 patients** as well as **the healthcare professionals**. COVID-19 created a specific context of anxiety

and insecurity in healthcare professionals and patients. RPM reassured physicians of the hospital's management capacity to handle critical moments of the pandemic (preparedness). RPM provided a sense of safety and control for healthcare professionals who experienced uncertainty about COVID-19 as a new and little-known disease of which the clinical presentation also changed.[357] For example, silent hypoxemia occurred (in which the patient subjectively feels good, while desaturating). It was shown in a study of Medina et al.[126] that patients with a pulse oximeter at home present with escalation a few days earlier due to declining oxygen saturation readings, prior to subjective complaint of shortness of breath. The RPM system enabled them to detect (potential) problems earlier and to react when necessary.

The healthcare professionals interviewed believe COVID-19 RPM **reduced the burden on hospital utilization**, by freeing up beds (shortening hospital stays and reducing avoidable hospitalization) by **increasing the hospitals' capacity to cope with new COVID-19 admissions**, and by allowing the **hospitals' usual activities to be maintained** as far as possible. They perceived COVID-19 RPM as useful to provide care to patients who could not be hospitalized but were potentially at risk for acute deterioration. Moreover, the interviewed patients appreciated COVID-19 RPM as they believed it allowed them to be sent home earlier or that in absence of RPM they would have been hospitalized. RPM was perceived reassuring for patients as it addressed their anxiety related to the disease and its potential consequences. It was observed that patients demonstrated a need for interaction regardless of the COVID-19 illness experience, which was interpreted as a need for psychosocial support (due to isolation measures as also seen in literature). From the results in this report is learned that healthcare practitioners and patients involved in COVID-19 RPM perceived the intervention as feasible and helpful.

4.2 In the long-term, investments done during a crisis allow healthcare organizations and professionals to learn from experience.

To cope with these unsecure and continuously changing context, healthcare professionals and organizations **learned continuously from experience.** The context of COVID-19 enabled healthcare organizations and practitioners to use and experiment with relatively new models of care, which could also be useful for the management of other diseases in the future. For example, most projects were hospital-led and had already care paths for remote care of chronic (ambulatory) patients in place (such as in patients with chronic pain, COPD, heart failure), but **care paths for remote care of acute patients** were rare. Thus, (new) interprofessional collaborations were constructed across care lines and care paths were developed.

Professionals experienced an increased in their **know-how and skills in relation to RPM** and might have changed their mindset towards these new pathways of care. Knowledge on the clinical **presentation of COVID-19** and the pathology was also increased by RPM, as experienced by the healthcare professionals involved. As their knowledge progressed, they felt safer sending patients home, for example with oxygen therapy and RPM. Thus, the added value of experience-based learning (and reason why resources should be invested) lays in the opportunity to identify areas to support, improve, and invest in the future organization of health care.

Based on this learning experience, a careful description and analysis of characteristics of COVID-19 RPM projects was performed in this study. From this, the government can learn which factors facilitate the implementation and extrapolation of RPM for sustainable implementation in future. In the next section directions for future improvements will be presented based on the main findings, leading to our final recommendations.

5 LESSONS LEARNED FROM COVID-19 RPM FOR FURTHER DEVELOPMENT AND IMPLEMENTATION

Across the world, COVID-19 RPM was **enrolled at a smaller or larger scale** (range of included patients varied from 10 to 43 103) at a quick pace. Nearly a third of the projects were small-scaled projects with less than 100 patients (comparable to the Belgian projects), but there were also projects[59, 134, 135, 158, 177, 263] with more than 10 000 patients such as in France (COVIDOM[69, 78, 176, 177, 200, 210]), Brazil (UNIMED[134]), USA (Kaiser Permanente Virtual Home Care Program[135, 158]) and Spain (Telea[62, 122, 147]). The NIHDI convention outlined a capacity for the manufacturers platform to monitor at least 200 patients simultaneously, but no included project in Belgium by far reached this (the highest number of simultaneously monitored patients during a day was around 35). Moreover, most manufacturers' platforms have the intrinsic capacity to monitor much more patients simultaneously. Apart from the facilitators described earlier (i.e. dedicated clinical leaders, experience, funding, motivation) the large-scaled projects are especially characterized by **workforce** that can be upscaled fast (e.g. volunteers, students, retired personnel, redeployed hospital staff, etc.). This was especially useful during a crisis, but it is not an option that can be applied to create a long-term sustainable framework for RPM. A **variety in type, qualification level, and number** of personnel was seen across the projects. From our interviews we learned that workforce needs to be **motivated, skilled, and trained**. It remains however unclear which healthcare professionals are the most appropriate, which number is needed and what level of qualification is required. This depends on many factors such as the aims, the roles of the actors involved, from which setting the project is initiated, the resources, etc.

In Belgium, the NIHDI outlined **several roles for different actors across care lines to collaborate** (and communicate) in a framework i.e. the government, the group of healthcare professionals, the telemonitoring team with supervising physician, the helpdesk/manufacturer/platform, the patient, the treating GP and ambulatory care nurse. Although the projects tend to involve everyone, in practice it was seen that the intensity of the role of actors involved differed. As in the rest of the world, also in Belgium projects within the convention were mainly **initiated in-hospital** and rarely dedicated an intense role to primary care professionals. To illustrate, most projects had notified GPs that an RPM project for COVID-19 patients was running; most telemonitoring teams notified GPs once a patient was included in the project by stating this in the discharge letter; most projects set up contacts with ambulatory care nurses but few applied them in practice; few telemonitoring teams contacted GPs directly to discuss patients (as indicated in the convention); rarely GPs included (and/or monitored) patients; the majority of the projects only advised patients to visit their GP. The lack of GPs in some regions also made their involvement difficult. This was illustrated by the limitation that we could only include two GPs, and a limited number of small focus groups with ambulatory care nurses, that were related to one of the projects included in our study. Important to note, the fact that primary care was not intensively involved in these described hospital-led projects does not mean that primary care could not take up a main role or initiate COVID-19 RPM. We interviewed GPs initiating RPM for COVID-19 patients from their private practice, whether or not together with ambulatory care nurses. Also, the program that included most patients in COVID-19 RPM (especially during the second wave) i.e. SafeLink, was initiated from GPs. It illustrates that in Belgium, many COVID-19 RPM were bottom-up initiated, and not necessarily financed by the government.

It remains unclear whether hospital-led RPM is superior to primary care led RPM, who should be involved, and which role should be foreseen, but there are indications that **a collaboration framework across care lines** is preferable:

- Collaboration between hospital-based telemonitoring teams and primary care professionals is imperative for a large group of patients.
- Many patients expect that their GP is involved in their care.
- Several patients required more information and assistance for the installation and usability of RPM. Ambulatory care nurses took up an important role in providing this quality of care.

- Patients expressed also other needs such as wound care, questions on other comorbidities, etc. These actions and answers were often provided by primary care professionals.
- RPM systems allowed Telemonitoring teams in hospitals to implement and deliver the intervention, but in projects in which primary care was actively involved, GPs and ambulatory nurses wanted to be part of the process.
- GPs and ambulatory care nurses, when more actively involved, consider RPM for COVID-19 patients as a feasible intervention.
- Ambulatory nurses believed that their presence and RPM had a reassuring effect on patients. Number of necessary contacts depended on the needs of the patients.
- GPs generally wanted to be involved in RPM as they believe they are the key point of contact for their patients; this was also echoed by several patients. A therapeutic realation facilitated COVID-19 RPM.
- The trust between the general practitioner and the patient was perceived as a factor influencing the use and effectiveness of RPM.
- Ambulatory care nurses supported patients with the installation and use of the RPM system. They had a logistic role but also an informative role.
- Hospital teams have the technological expertise and specialist knowledge about the acute care episode while primary care professionals have a very good knowledge of the home situation and the patient. Knowledge of the patient's personality, medical history and social situation was perceived important in the monitoring of at-risk patients.
- As more support was given to patients (at home) by primary care visits, projects were able to include more dependent patients which augments equity in care.
- Allowing and making it possible for GPs to include patients in RPM augments the accessibility of care.

To enhance future collaboration between actors some important conditions need to be fulfilled.

Although an interprofessional collaboration across care lines seems appropriate, there are factors that might limit the interactions. **Communication between the actors** is key, this involves communication between the (clinical) professionals delivering RPM but also communication between the care givers and the patient was important. Changes in structure such as integration of the RPM platform in the patient record might facilitate this. It appears from our research that **roles and consequently responsibilities between the actors** should be clear. **Data acquisition and information transfers** between levels of care and different information systems should be facilitated. The **data gathered should be relevant and of good quality**. An adequate **financing system** to support the tasks and work of all healthcare professionals involved in the pathway, taking into account 'invisible' tasks, such as coordination of providers and logistic issues should be elaborated on.

5.1 Enhancing the collaboration between the actors across care lines…

5.1.1 Constructing partnerships based on solid communication

The interviewees expressed **cultivating partnerships** between hospitals (telemonitoring teams) and primary care professionals were considered key for their collaboration. Good collaborations between healthcare professionals were based on trust, knowing each other, clear agreements between organizations (management), and **facilitated communication between professionals** (e.g. by means of an integration of the platform in in-house system, burden to contact each other).[358] As each actor took up a role in RPM in COVID-19, they had to rely on each other.

Not only between organizations but also within specific healthcare organizations (e.g. hospital) for example inclusion of COVID-19 patients in RPM across different units is facilitated when there is a good communication e.g. a telemonitoring team operating across the facility, sharing the workload of remote monitoring across certain units. It is seen that in facilities in which

units did not collaborate different platform manufacturers were used, or inclusion of patients focused especially on the trajectory and unit to which the clinical project lead was affiliated to. If there were collaborations and agreements in place, together with an adequate communication, and trust COVID-19 RPM was more rapidly initiated and patients were included at a higher pace, across the facility/facilities, and across trajectories (pre-hosp and post-hosp).

Formal partnerships were considered important for a smooth collaboration and communication between RPM partners.

5.1.2 *Access to the RPM system enhances collaboration across levels of care.*

RPM systems are often developed as standalone **platforms.** Integration of these platforms **in healthcare organisations' systems** required time. Again, projects that invested already in this integration before or at the beginning of the pandemic, were initiated quicker. Integrating RPM data in the electronic patient records facilitated the work considerably and added to the quality of care as there is no need to open two screens, nor insert patient ID's. Data of the platform appears automatically in the patient record, the healthcare professional can easily access additional patient information, etc.

At another level, an **integrated patient record across care lines** (communicating and integrating data between the electronic patient records of the telemonitoring teams and primary care) also facilitated communication and collaboration between healthcare professionals. The interoperability of RPM platforms with existing electronic patient files and regional/federal hubs across levels of care is an important facilitator for a systemwide implementation.

It should be noted that the government might have an important task and to create an electronic integrated patient record that could be more widely implemented and is uniform. Quality indicators for an electronic integrated patient record but also for other electronic devices and platforms should be developed.

5.1.3 *Roles and responsibilities of the actors should be clear*

Together with the legal framework, and patient informed consent, **the responsibility of all actors and their roles** should be clear. The interviews with the telemonitoring teams have shown that there was uncertainty about how (medical) responsibility needs to be organized in RPM projects, and how responsibility is shared between healthcare professionals in both secondary and primary care setting.

Based on the informed consents, an important responsibility for the patient was pointed out in the interviews (e.g. for seeking help when needed, for measurement and registration of parameters as agreed). By the NIHDI an important responsibility was outlined for the GPs (e.g. the telemonitoring team should contact the GP to decide upon ending remote monitoring, etc.), although the GPs were rarely intensively involved in RPM in COVID-19 in practice (due to many reasons such as high workload in primary care, GPs entrusted the in-hospital team, no integration in patient records, GP's being too late informed about patients included in RPM). Teams who had a structural partnership with primary care professionals defined a **shared responsibility** in the follow-up of patients.

In practice responsibility was generally attributed to the supervising medical doctor of the telemonitoring team. Although it can be questioned to which extend the professionals involved in remote monitoring are individually responsible, the idea was that the one in charge of inclusion of the patient is also responsible for the remote monitoring of the patient. If remote monitoring was done by a stand-alone care center the GP or physician that included the patient in the care path took up the responsibility. The stand-alone care center more carefully registered all actions performed in a logbook.

It is clear that many questions concerning (medical/legal) responsibility in RPM in COVID-19 remain. Who is responsible for patient inclusion? Who is responsible for patient monitoring? Who is responsible for ending RPM? It seems clear that a **logbook** of performed actions when alarms are generated could contribute covering responsibility.

5.1.4 A legal framework on RPM and generalized patient informed consent is desirable

Important in the information to patients and their responsibilities is **the patient informed consent**. The information provided in the informed consent was different for each project as no uniform informed consent was provided. The absence of a generalized informed patient consent limited retrieving patient information and data for research. It also meant that in the different projects, patients were better/worse informed, and they received more/less responsibility.

A **clear legal framework** is lacking on RPM, **this also entails a generalized patient informed consent**. We encountered many difficulties and had to ask projects to deliver aggregated patient data. As there was no systematic registration of data (except for the number of patients included in the projects) i.e. patient characteristics, outcomes of RPM, medication provided, duration of hospital stay, severity of disease, etc. it was a difficult task for the projects to collect the requested data. The survey was characterized by a low response rate and incomplete data from which we cannot draw any conclusions.

Registration of data and a homogenous dataset is key for further research. As stated before, it is also important to note actions performed when alerts are generated (i.e. in a logbook). This would allow remote monitoring to be optimised, and quality of care and effectiveness of RPM to be evaluated in the future. An integration of the patient records and the telemonitoring platform optimized data collection, registration and communication of data.

5.1.5 Good quality of data and reliable measurements are needed

Delivery of reliable data from the patient to the telemonitoring team is important in RPM. Differences related to the role of patients in reporting data, the type of measurements (self-reported versus automated), the type of telemetry devices, and the type of data (symptoms or experiences versus 'objective' data). Also the reliability of measurements e.g. respiratory rate or temperature was often questioned.

It was suggested that many alerts were 'false' (e.g. related to technical problems, wrong detection by telemetry devices, threshold settings, wrong measurement) and thus not indicative for deterioration or reaction of the telemonitoring team. Also the telemonitoring teams indicated that the thresholds set, needed to be individualized in most patients to prevent 'alarm tiredness'. As there was no systematic registration of the actions performed when alarms were triggered, it was not possible for us to evaluate the nature of these alarms. Registration evoked alerts together with the performed action of the telemonitoring team (e.g. technical error, individualized alarm threshold set, teleconsult, videoconsult, etc.) together with the outcome, would allow us to learn more about thresholds sets, actions performed, outcomes of those actions and consequently quality of care delivered in RPM.

In this specific 'new' pathology and in a changing context few **validated risk stratification scales** were available and prognostic parameters to measure and monitor were unknown. The healthcare professionals in charge of evaluating these measurements and tackling the alarms indicated that especially temperature, saturation and the subjective 'wellbeing' of the patient (compared to the day before) were considered as important parameters to detect deterioration. Whether these parameters are indeed more indicative for deterioration in COVID-19 RPM should be evaluated in future research. The addition of saturation measurement to subjective questioning was studied in a recent RCT.[307]

Due to the lack of validated scales, a variety of objective and subjective parameters were used. Patients felt that they did not always perceive the requested measurements as **relevant or feasible**. Note that in some daily surveys, more than 20 questions were raised. On the other hand, they expected to be also questioned about their comorbidities and other medical conditions (care not associated with COVID-19). The occurrence of too many (false) alarms and the question whether all requested measurements were relevant, indicate that research is needed to establish relevant evaluation scales and thresholds in COVID-19 RPM.

Due to the absence of validated scales and the novelty of pathology some projects relied on the support of primary care providers at the patient's home,

as they had '**a clinical image**' of the patient which also reduced the uncertainty experienced by the telemonitoring teams. The clinical image of the patient was felt to be relevant in addition to the data obtained by RPM. In some platforms, video consultations were integrated and helped the telemonitoring team to understand and value to data delivered through RPM.

5.2 …to comply with patients needs in COVID-19 RPM

Patients felt more secure knowing that the telemonitoring team monitored them at a distance. However, often a passive communication was done i.e. only when alarms were generated the telemonitoring team phoned to patient, dashboards were not continuously projected and alarms were not always automatically pushed. Thus, it could be questioned how the patients knew and to which extend the telemonitoring teams were effectively looking at and evaluating their parameters i.e. continuously 24/7 or a specific number of times per day. As outlined in the descriptive chapter, alarms were not always immediately pushed to (e.g. the phones of) healthcare professionals and most telemonitoring teams only consulted the dashboard at certain moments during the day. In literature, no agreement was found whether or not data should be monitored continuously. From the descriptive chapter we learned that most projects implemented a rather passive communication strategy from the telemonitoring team towards the patients i.e. when no alarms were generated, the telemonitoring team rarely communicated with the patient, or communication was only performed at certain moments (e.g. once a week) for the evaluation of the need to continue RPM. Patients in these projects often received **passive feedback** after inserting the parameters in the app (i.e. green, yellow or red screen with the action to take). Some patients considered the passive feedback as neutral, while others experienced stress and anxiety. Especially 'too many' alerts triggered emotional distress.

For communication from the patients towards the telemonitoring teams, often a telephone number was provided which felt reassuring. However, communication with any healthcare professional, whether or not taking up an active role in RPM, was perceived to deal with potential anxiety and felt as reassuring. It was observed, from the interviews, that patients might **have additional needs for personal contact and emotional support** (e.g. patients prolonged the conversation when the telemonitoring team called them, patients informed the telemonitoring team on related diseases or their daily life). Social isolation during COVID-19 probably augmented the need for active communication.

In the international literature it was discussed whether an active communication strategy, raising one question on general well-being, might be more relevant than registering objective parameters e.g. in a recent study from The Netherlands, patients received two calls a day informing about their general well-being.[359] Also, in Garcia Bermudez et al.[351] it was discussed whether the telemonitoring team could be replaced or assisted by a kind of virtual assistant.

However, the interviewed patients indicated that **active communication and verifying their general wellbeing is very relevant** for them. Patients valued personal communication with the telemonitoring team and feedback about their clinical status, regardless of the degree of illness. Patients valued the communication with primary caregivers. The felt the treating GP, with whom they have a therapeutic relationship, was important for COVID-19 RPM adherence. Also the ambulatory care nurses, assisting the patients with inserting parameters and providing them with information, were valued.

Based on the patient perceptions, active communication is valued. They experienced an abundancy of measurements and data was asked during COVID-19 RPM. Questioning general well-being for them, was more relevant. There should be sought a balance in active communication between the telemonitoring team and patient, in which the conversations can be rather quick and limited to the essence.

5.3 Partnerships and collaborations can be endorsed by support and resources

COVID-19 RPM was perceived by the healthcare professionals (especially the telemonitoring teams and primary care professionals) as a high-burden intervention because of the **workload associated with the different tasks** in the project. Examples of different tasks are onboarding patients, informing patients, monitoring RPM parameters, medical supervision, communication with patients during follow-up, collaboration with primary care, project management and coordination, ICT support and logistics management. The logistics management of the projects was perceived as challenging and required the cooperation between different hospital support services and primary care partners. Logistics (e.g. installation of telemetry at the home of the patient, delivery of telemetry, returning and decontaminating telemetry devices) were also challenging due to hygienic measures in place because of the contagious character of COVID-19.

The participants felt especially that **adequate funding** allowing optimal staffing was lacking. The tasks in RPM were often added on top of the usual activities of the healthcare professionals, hence increasing their workload. Rarely, supplementary staff was hired, or full-time equivalents were exempted from regular duties. None of the projects worked with volunteers or students (as seen in the large-scale projects in the literature). Thus, workload was increased and limited the capacity needed to scale up the RPM project. The measures reported in literature to scale up staff were temporary measures. It is clear that for a more sustainable roll out of RPM for COVID-19 patients and even other pathologies, staff needs to be upscaled and released from other tasks to allow upscaling of patient inclusion.

Moreover, it is perceived that the current contribution of the NIHDI for primary care professionals involved in COVID-19 RPM is insufficient. Especially for the ambulatory care nurses the nomenclature is based on regular care visits and some nurse interventions but was not adjusted or specified to COVID-19 RPM. Nurses also had to perform time-consuming logistic activities that are not sufficiently compensated under current reimbursement practice. Nurses were dependent on prescriptions of medical doctors, which restricted the range of activities they could perform. Although healthcare professionals implemented the project because they felt responsible for delivering good care, apart from funding, it is recognized that for a sustainable framework adequate funding of all actors and partners is needed.

The tasks in COVID-19 RPM necessitate the involvement of different and skilled staff, however based on international literature it remains unclear what is the ideal number of staffing and their skills.

Besides these different tasks, also other expenses should be taken into account such as cost of telemetry devices (ranging from very cheap to very expensive), manufacturers platform contributions, development of feasible ICT-infrastructure, costs for decontamination and other hygienic measures, costs for logistics, administrative costs, etc.

Note that participants indicated, in case that aims were achieved (e.g. discharging patients earlier, not hospitalizing patients) hospitals potentially lost ‘income’ because patients were discharged home sooner.

Overall, funding was considered an important barrier for future upscaling but the high burden on the hospitals, the motivation of healthcare professionals to deliver quality of care, and the vision of hospitals regarding RPM as future intervention were important factors to overcome this barrier during the pandemic.

5.4 Patient adherence to COVID-19 RPM is facilitated by the user friendliness of the technology and information received

Patients experienced that COVID-19 RPM was facilitated by **user friendly technology**. Most systems were considered to be simple and intuitive. In case of a **technical problem** (which seems to occur quite often) patients could contact someone (e.g. ambulatory care nurse, telemonitoring team) to resolve it. The majority of patients indicated that **the instructions** they received were sufficiently clear. Also **informing about the intervention is** key. Adoption of new care models is often challenged by unfamiliarity with program eligibility, services and logistics, and also patients can be reluctant to try out new approaches of care.

Some options to increase user friendliness and provide information are:

- Installation of the app and telemetry devices in-hospital
- Installation of the telemetry devices at home by primary care professionals
- Carrying out the measurement with telemetry and the transfer of data (inserting data in app) together with a healthcare professional.
- Receiving additional information to consult at home (movie, template, etc.)
- Helpdesk for technical issues
- The moment of onboarding the patient and providing information
- Involving primary care

Based on the data and interviews is seen that it is important to take into account 'when' information on COVID-19 RPM is provided and for 'which patients' (pre-hosp or post-hosp). While patients in the post-hospital traject received RPM information at the moment they were (partially) recovered from severe **symptoms,** patients in the **pre-hospital** traject were informed about RPM in the acute phase of the infection. Receiving and processing information while being very ill and at ED was experienced difficult for patients. Moreover, some patients expected to be hospitalised. Especially in the pre-hosp trajectory, when RPM is started in the acute phase of the infection, the patients indicate they should receive more guidance in the set up of COVID-19 RPM (e.g. active communication from the telemonitoring team towards the patient, setting up and carrying out the measurements at the home situation guided by an experienced healthcare professional, etc.) Moreover, the telemonitoring teams indicated that at an **ED or GP setting** (entrance points of the pre-hosp trajectory), the time healthcare professionals have to give information and education is often limited. Onboarding a patient in RPM was reported to be more time consuming than admitting a patient to the hospital. Onboarding in the post-hosp trajectory was considered easier in terms of informing patients about COVID-19 RPM. Patients being hospitalized can re-read the information and generally have more time to think about it or ask the staff for clarifications.

Which might be of relevance is the fact that, in the post-hosp phase, the patient has built a (limited) **therapeutical relationship** with the physician or healthcare professionals (of the telemonitoring team) in-hospital. A patient at ED does not experience such a therapeutic relationship. Therefore the patient might be more reluctant to contact the telemonitoring team or adhere to the COVID-19 RPM. These factors might indicate that primary care professionals and especially GPs (therapeutic relation) could facilitate patient onboarding and adherence in COVID-19 RPM and plausible other acute pathologies.

5.5 Equity in care should be increased to make COVID-19 RPM sustainable

In international literature as well as in the Belgian projects, only a very small number of patients (selected sub-population) were included in COVID-19 RPM. Next to symptom- and risk stratification many other factors seem to influence the inclusion of patients in RPM such as sufficient digital literacy. In a recent letter-to-the editor was stated that digital literacy is a critical threshold that should be overcome by simplifying the RPM programme and allowing relatives to assist in the RPM tasks.[10] From our data, but also in international literature, the COVID-19 patients included in RPM tend to relatively young. Not many vulnerable elderly patients with high risk profiles were included in COVID-19 RPM. Inclusion of elderly patients in COVID-19 RPM might be essential since this high-risk group might benefit the most. Many projects in international literature as well as in Belgium, also tend to exclude these elderly patients.

From the interviews we learned that many factors might have limited the inclusion of patients, evoked selection bias and raised questions on equity:

- Not having sufficient digital skills
- Non-native speakers facing language problems
- Not having the right equipment such as a connected smartphone or tablet. Note also that sometimes patients needed to buy there own telemetry.
- Not having sufficient internet/WI-FI coverage (this was sometimes solved with a teleconsultation)
- Not having a treating GP (as it was stated in the convention).
- Not having sufficient ability to use the devices and the RPM system.
- Luckily, there were also factors expressed which facilitated inclusion of patients in COVID-19 RPM and increase equity, such as:
- More time or other setting to provide information to patients
- Installation, providing information and try out of RPM at the patients' home (ambulatory care nurse)
- Applications developed in multiple languages (However, language remained a barrier, as health professionals also needed to be proficient in the other language and communication was important for initial instructions and optimal follow-up.)
- RPM processes set up together with patients
- Usability of RPM increased by involving the patient in the development of platforms, and telemerty devices.
- Assessing user friendliness

Increasing equity in care by adjusting processes and devices based on user-experiences and specific patient populations such as vulnerable elderly might increase the usability and sustainability of COVID-19 RPM.

6 MAIN MESSAGE

Now, two years later after the first lockdown on 13 March 2020, professionals who initiated and learned from COVID-19 RPM as well as patients consider it as a feasible intervention.[360] Healthcare professionals are willing to expand RPM to other pathologies. Across the world healthcare organisations are setting up sustainable collaborations.[361] COVID-19 endorsed the fast development of RPM.[362] There is no way back and governments should invest resources to endorse these collaboration frameworks and develop care paths for other chronic and acute pathologies, as well as preventive measures. Moreover, governments should develop an evaluation framework for RPM. As COVID-19 RPM was developed as reaction (to a pandemic) and not as an anticipation, these projects are at all levels characterized by a high degree of heterogeneity. It is essential that solid scientific evidence is gathered to standardize COVID-19 RPM.

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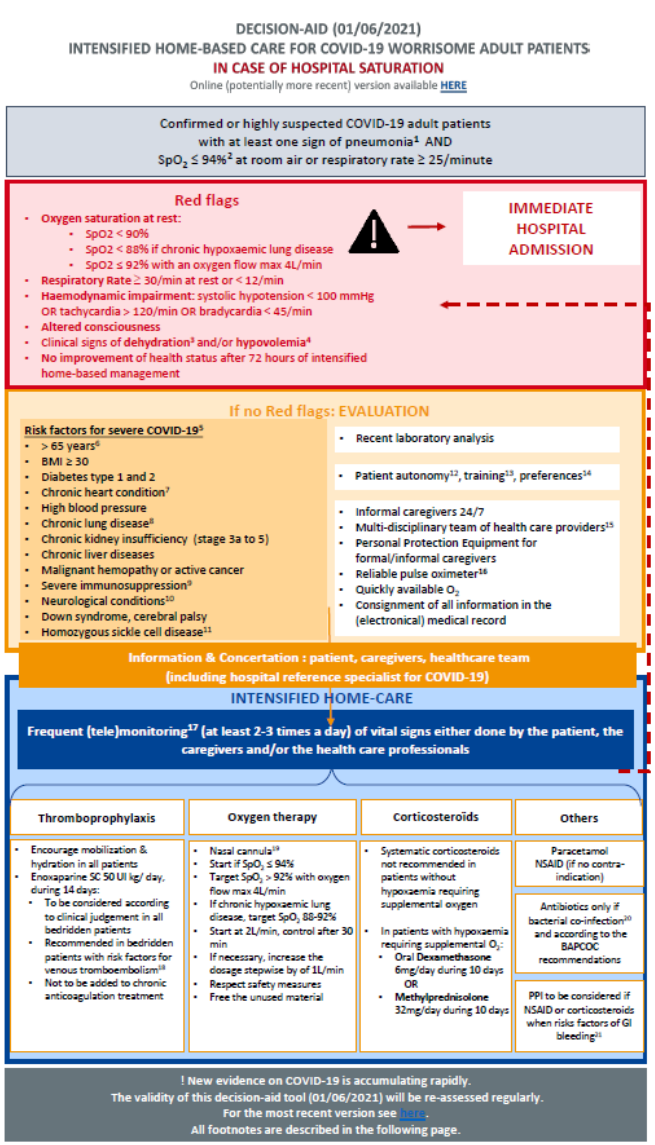
APPENDICES

APPENDIX 1. APPENDICES TO CHAPTER 1

Appendix 1.1. Decision-aid intensified home-based care for COVID-19 worrisome adult patients in case of hospital saturation



[1] **Pneumonia signs**: fever, cough, dyspnoea or fast breathing (RR > 20/min).

[2] **SpO_2** must be measured for at least 1-2 minutes. The level of SpO_2 prompting a hospital admission must be interpreted along with the clinical judgement of the patient's health.

[3] **Clinical signs of dehydration**: weight loss ≥ 5% (severe if > 10%), positive skin fold, thirst, dry mouth, possible confusion and decrease of urine flow.

[4] **Clinical signs of hypovolemia**: arterial hypotension, tachycardia, cold and marbled extremities and decrease of urine flow.

[5] The presence of one of the **risk factors** is a warning sign which should trigger, according to your clinical judgement, a twice more frequent home-based monitoring or, if not possible, an indication for a hospital admission (except when in contradiction with the advanced care planning).

Be aware that each additional age year after 65 years and each accumulation of risk factors induces a higher risk.

[6] For patients over **75 years old** that are residents in an institution, please refer to the therapeutic protocol for COVID-19: in French http://docs.toubibjbp.be/docs/d574edb2e8f0e1a0.pdf.

[7] **Chronic heart conditions**: heart failure, coronary disease, cardiomyopathy and pulmonary hypertension.

[8] **Chronic lung disease**: COPD, interstitial lung disease, cystic fibrosis…

[9] **Severe immunosuppression**: organ transplants, bone marrow transplant, HIV/AIDS, long-term use of prednisone or other treatments which weaken the immune system (chemotherapy or radiotherapy)

[10] **Neurological conditions**: dementia, cerebro-vascular disease…

[11] **For other rare diseases**, although there is no current evidence, be confident to your clinical judgement.

[12] **Patient autonomy** for food, hydration, monitoring, ability to call for help, therapy.

[13] **Patient and/or his/her caregiver training** to use appropriately oxygen therapy and pulse oximeter, or to identify red flags in order to react quickly and call the nearest hospital. A telephone number that can be reached 24/7 can be useful.

[14] **Importance of information and consultation** with the patient, in particular on the level of intensity of care that the patient wants to receive, including admission to hospital in the event of an urgent medical situation (red flags).

[15] This **team** can include a coordinating GP, nurses, physiotherapists and a reference hospital team, sharing information by the same communication channels, information; such a team allows integrated care with the consultation of all parties including the patient and his/her caregivers. Therapeutic options should be duly discussed with the patients.

[16] The use of **pulse oximeter** should follow the following recommendations :
- Use CE **marked oximeters** and, if possible, obtain the ARMS (Accuracy root mean square) as information to assess their reliability.
- Use **devices with a curve display or at least a pulse signal display and only accept values associated with a strong pulse signal.**
- When interpreting the results, be cautious of **possible hypoperfusion** (hypotension, vasoconstrictor drugs and vascular patient) and warm the cold extremities before measurement.
- Perform **measurements at rest**, during silent breathing.
- Use **index or middle finger**, clean the finger and remove nail polish if necessary (avoid measuring at toes or earlobes).
- **Stabilize the device** to avoid motion and
- **Observe the readings for 30 to 60 seconds** to identify the most current value.
- In case of patient self-use, provide **clear instructions on how to use** the device.

[17] **Monitoring** can be carried out by the patient, relatives or a health professional (general practitioner, nurse, physiotherapist etc.) BUT the medical decision remains the responsibility of the general practitioner. Telemonitoring appears feasible in COVID-19 patients even though there is currently no evidence on the (cost)effectiveness of telemonitoring for COVID-19 patients cared for at home.

[18] **Risk of venous thromboembolism**: known thrombophilia; personal or familial history of VTE ; obesity (BMI>30); heart failure; respiratory failure; age >70; active cancer; major surgery in the last 3 months.

[19] Preferably give **oxygen** through nasal cannula. A classical oxygen mask can be used in case of a congested nose.

[20] If **bacterial pneumonia** is suspected or confirmed in patients with COVID-19, the appropriateness of **antibiotics** depends on the local resistance profiles and patients allergy: in Belgium, the Belgian Antibiotic Policy Coordination Commission (BAPCOC) recommends high-dose amoxicillin or amoxicillin clavulanate.

[21] Risk factors for **GI bleeding** : combined use of NSAIDs and corticosteroids / NSAIDs or corticosteroids used jointly with anticoagulants or antiplatelet therapy / History of GI ulcer, bleeding, or perforation />65 years and/or serious comorbidities.

More information on COVID-19: https://covid-19.sciensano.be/sites/default/files/Covid19/COVID-19_fact_sheet_ENG.pdf

With the support of:

APPENDIX 2. APPENDICES TO CHAPTER 2

Appendix 2.1. An example of a risk stratification scale as provided in the convention (pre-hospitalisation)

Voorbeeld inclusiecriteria telemonitoring prehospitalisatie covid-19

A. **Geslacht: V (0) M (1) , indien vrouw zwanger (1)**
B. **Leeftijd :**
    a. **boven 50: (1)**
    b. **boven 60: (2)**
    c. **boven 70: (3)**
    d. **boven 80: (6)**
C. **BMI :**
    a. **BMI boven 30: (1)**
D. **Minstens 2 hoofdsymptomen, die acuut ontstaan zijn, zonder andere duidelijke oorzaak : hoest; dyspnoe; thoracale pijn; acute anosmie of dysgeusie: (2)**
E. **Co-morbiditeiten**
    a. **Chronische aandoening die stabiel is: (1)**
    b. **chronische aandoening die niet stabiel is: (2)**
    c. **een actieve ernstige aandoening: (3)**

Voorbeelden co-morbiditeiten:

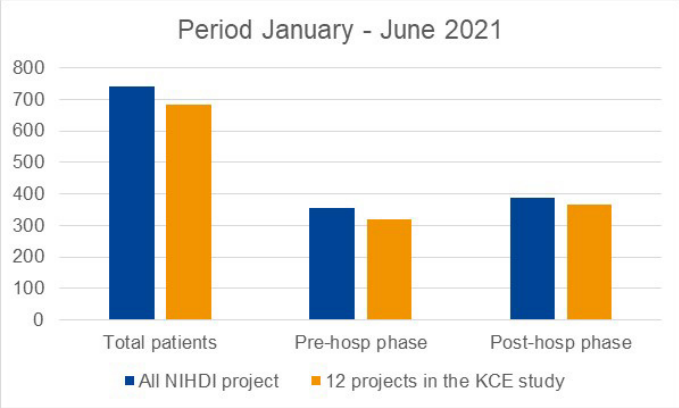
- *Actieve kwaadaardige aandoening (gehad in de afgelopen 3 jaar) (3)*
- *Een niet-kwaadaardige ziekte die uw weerstand verzwakt (2)*
- *Geneesmiddelen die uw weerstand verzwakken (zoals corticoïden, methotrexaat, ciclosporine, tacrolimus, sirolimus, everolimus, cyclofosfamide, azathioprine - Mycophenolate – etanercept (niet-limitatieve lijst) (1)*
- *Heeft u langdurig verbleven in een hersteloord of in een woonzorgcentrum (1)*
- *Een hart- of vaataandoening (zoals hartfalen) (2)*
- *Chronische longziekte (waarvoor u in opvolging bent bij een longarts) (2)*
- *Astma (1)*
- *Diabetes (suikerziekte) (1)*
- *Nierziekte die dialyse vereist (1)*
- *Chronische leverziekte (1)*
- *Verhoogde bloeddruk (hypertensie) (1)*

Een score van 0, 1 of 2 classificeert de patiënten als laag-risico

Een drempel van hoger dan 2 selecteert patiënten als hoog-risico, deze patiënten kunnen geïncludeerd worden in het prehospitalisatie telemonitoring zorgpad.

Appendix 2.2. Overview of the patients included in NIHDI projects (n=17) versus patients included in the projects subjected to evaluation in this report (n=12).

Figure 17 – Number of patients included in the projects during the study period



Appendix 2.3. Topic guide zoom meetings with projects

Short introduction KCE project

Opening: How is the project going now? What was the process you went through?

- Duration.

- Experience gained in 1st / 2nd wave.

- Differences in characteristics COVID-19 patient.

- Adjustments made to the process.

Guide:

- Is your focus mainly on the pre-hospital phase or the post-hospital phase or both, why and how?

- Can you tell us something about the inclusion of patients (in both phases)? How are patients included and by whom?

- Can you tell us something about the follow-up of the patients? How are patients followed up, which thresholds, by whom?

- Do you have an own telemonitoring team and how it is composed in practice? Communication strategy with the patient (call, videocall, text message, no communication, etc.), with the ambulatory nursing care (direct data transfer, role, platform access, etc.), with the GP (direct data transfer, role of the GP, platform access, etc.)?

- How long does it seem necessary to follow up the standard patient (3 weeks - 6 weeks is that feasible)?

- Are there many alarms? Is this often technical, or have there already been decompensations?

- Is the medical file linked to the platform (vital parameters, comorbidities, etc.), which actors have access to it?

- …

Closing: next steps

Appendix 2.4. Survey aggregated patient data

Appendix 2.4.1. Version in Dutch

Vraag 1. Namens welk ziekenhuis/project beantwoordt u deze vragenlijst ?

Kies één van de volgende mogelijkheden:

○ Aalst, O.L.V Ziekenhuis / Mederi

○ Aalst, Algemeen Stedelijk Ziekenhuis / Mederi

○ Antwerpen, UZA

○ Gent, AZ Jan Palfijn

○ Gent, AZ Maria Middelares

○ Gent, AZ Sint Lucas Gent

○ Gent, UZ Gent

○ Genk, ZOL

○ Mol, Heilig Hart ziekenhuis

○ Waregem, O.L.V. Van Lourdes Ziekenhuis

○ Ath, Baudour, Hornu, Center Hospitalier Epicura

○ Herstal, Clinique André Renard

○ Tournai, CHwapi

○ Anders :

Vraag 2. Wat is uw naam en functie in dit project ?

Vraag 3. Hoeveel patiënten met COVID-19 werden **op de spoedafdeling** van uw ziekenhuis gezien in de periode van 01/01/21 tot en met 30/06/21 ?

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N=

Vraag 4. Hoeveel patiënten met COVID-19 werden **in uw ziekenhuis opgenomen** in de periode van 01/01/21 tot en met 30/06/21?

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N=

Vraag 4.1. Hoeveel van deze patiënten werden **doorverwezen** door andere ziekenhuizen ?

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N=

Vraag 5.1. Aan hoeveel patiënten met COVID-19 werd telemonitoring **aangeboden** in de periode 01/01/21 tot en met 30/06/21, in de **PRE-HOSPITALISATIE** fase?

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N= [ ]

Vraag 5.2. Aan hoeveel patiënten met COVID-19 werd telemonitoring **aangeboden** in de periode 01/01/21 tot en met 30/06/21, in de **POST-HOSPITALISATIE** fase ?

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N= [ ]

Vraag 5.3. Wat waren de redenen om geen telemonitoring aan te bieden ?

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Reden om geen telemonitoring aan te bieden		

Vraag 6.1. Hoeveel patiënten met COVID-19 hebben **ingestemd** met de aangeboden telemonitoring in de periode 01/01/21 tot en met 30/06/21, in de **PRE-HOSPITALISATIE** fase ?

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N= [ ]

Vraag 6.2. Hoeveel patiënten met COVID-19 hebben **ingestemd** met de aangeboden telemonitoring in de periode 01/01/21 tot en met 30/06/21, in de **POST-HOSPITALISATIE** fase ?

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N= [ ]

Vraag 6.3. Wat waren de redenen van weigering door patiënten ?

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Reden van weigering		

Vraag 7.1. Bij hoeveel patiënten met COVID-19 is de telemonitoring effectief opgestart in de periode 01/01/21 t/m 30/06/21, in de PRE-HOSPITALISATIE fase?

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N=

Vraag 7.2. Bij hoeveel patiënten met COVID-19 is de telemonitoring effectief **opgestart** in de periode 01/01/21 t/m 30/06/21, in de **POST-HOSPITALISATIE** fase ?

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N=

Vraag 8. Zijn er patiënten die telemonitoring kregen, zowel als pre-hospitalisatie en als post-hospitalisatie ?

○ Ja

○ Nee

Vraag 8.1. Zo ja, hoeveel ?

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N=

Vraag 9.1. Bij hoeveel van de geïncludeerde patiënten in de PRE-HOSPITALISATIE fase werd de COVID-19 besmetting bevestigd ? (zie https://covid-19.sciensano.be/nl/covid-19-gevalsdefinitie-en-testing).

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N=

Vraag 9.2. Bij hoeveel van de geïncludeerde patiënten in de POST-HOSPITALISATIE fase werd de COVID-19 besmetting bevestigd ? (zie https://covid-19.sciensano.be/nl/covid-19-gevalsdefinitie-en-testing).

Indien u "N=" kiest, specifieer het aantal in het tekstvak.

○ Onbekend

○ N= 0

○ N=

Vraag 10. Vul het aantal van de geïncludeerde patiënten **per geslacht en leeftijdscategorie** in.

	Pre-hospitalisatie fase		Post-hospitalisatie fase	
	Man	Vrouw	Man	Vrouw
0-20				
21-40				
41-60				
61-70				
71-80				
80+				
Gemiddelde leeftijd				

Vraag 11. Vul het aantal geïncludeerde patiënten in per **provincie.**

	Pre-hospitalisatie fase	Post-hospitalisatie fase
West-Vlaanderen		
Oost-Vlaanderen		
Antwerpen		
Limburg		
Vlaams-Brabant		
Brussels hoofdstedelijk gewest		
Waals-Brabant		
Henegouwen		
Namen		
Luxemburg		
Luik		
Buitenland		
Onbekend		

Vraag 12. Vul het aantal geïncludeerde patiënten in volgens **moedertaal**.

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Nederlands		
Frans		
Duits		
Engels		
Turks		
Arabisch		
Andere taal		
Onbekend		

Vraag 13. Vul het aantal geïncludeerde patiënten in per **leefsituatie**.

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Zelfstandig wonend met minstens 1 andere volwassen persoon		
Alleenwonend		
Woonzorgcentrum		

Andere leefsituatie		
Onbekend		

Vraag 14. Vul het aantal geïncludeerde patiënten in per **opleidingsniveau**.

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Geen diploma		
Diploma lager onderwijs		
Diploma secundair onderwijs		
Diploma hoger onderwijs/universiteit		
Onbekend		

Vraag 15. Vul het aantal geïncludeerde patiënten in met een **verhoogde tegemoetkoming**.

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Aantal patiënten met een verhoogde tegemoetkoming		
Aantal patiënten zonder een verhoogde tegemoetkoming		
Onbekend		

*Vraag 16. Hoeveel van de geïncludeerde patiënten vertoonden één of meerdere **ziektekenmerken** op het moment van inclusie in het telemonitoring project ?*

Verschillende mogelijkheden per patiënt, geef een aantal voor elk ziektekenmerk

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Koorts (>37.5°C)		
Ademhalingsfrequentie in rust >20/min		
Zuurstofsaturatie in rust SpO2 < 90%		
Hartfrequentie >100/min		
Hartfrequentie <45/min		
Bloeddruk systolisch <100mm HG		
Gewijzigd bewustzijn		
Klinische symptomen van dehydratatie en/of hypovolemie		
Hoesten		
Reuk en/of smaakverlies		
Hoofdpijn		
Buikpijn		
Diarrhee		
Andere ziektekenmerken (schrijf het aantal patiënten en zie vraag 16.1)		
Onbekend		

Vraag 16.1. Als andere **ziektekenmerken**, namelijk :

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Andere ziektekenmerken		

Vraag 17. Hoeveel van de geïncludeerde patiënten hadden één of meerdere van deze onderliggende **comorbiditeiten** op het moment van inclusie in het telemonitoring project ? (lijst gebaseerd op KCE-beslisboom https://kce.fgov.be/sites/default/files/atoms/files/Decision-aid-Worrisome%20patient-NL_01062021.pdf).

Verschillende mogelijkheden per patiënt

	Pre-hospitalisatie fase	Post-hospitalisatie fase
BMI ≥ 30		
Diabetes Mellitus type 1 of diabetes mellitus type 2		
Chronische hartaandoening (hartfalen, coronaire hartziekte, cardiomyopathie of pulmonale hypertensie)		
Arteriële hypertensie		
Chronische longaandoening (COPD, Interstitiële longziekten, mucoviscidose…)		
Chronische nierinsufficiëntie (stadium 3a tot 5)		
Chronische leverziekte		
Kwaadaardige bloedziekte of actieve kanker		
Ernstige immunosuppressie		
Neurologische aandoening (dementie, cerebrovasculaire aandoening, …)		
Down syndroom, hersenverlamming		
Homozygote sikkelcelziekte		
Andere comorbiditeiten (schrijf het aantal patiënten en zie vraag 17.1)		
Geen comorbiditeiten		

Vraag 17.1. Als andere comorbiditeiten, namelijk:

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Andere comorbiditeiten		

Vraag 18. Maakte u bij de inclusie gebruik van een instrument om het risico op klinische achteruitgang in te schatten ? (bv New Early Warning Score, ISARIC 4C, Charlson Comorbidity Index...)

○ Ja

○ Nee

Vraag 18.1. Zo ja, welk instrument ?

Vraag 18.2. Hoeveel van de geïncludeerde patiënten hadden volgens het door u gebruikte risicotaxatieinstrument een **verhoogd risico** op klinische achteruitgang *op het moment van inclusie?*

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Geen risico		
Laag risico		
Gemiddeld risico		
Hoog risico		

Vraag 19. Hoeveel geïncludeerde patiënten kregen *op het moment van de inclusie* één of meerdere van de onderstaande **medicijnen?**

	Pre-hospitalisatie fase	Post-hospitalisatie fase
antibiotica		
corticosteroiden		
tromboprofylaxe		
koortsremmers/pijnstillers (paracetamol, NSAID)		
andere medicaties		
onbekend		

Vraag 20. Hoeveel van de patiënten die u monitorde in *post-hospitalisatie fase*, werden tijdens hun ziekenhuisverblijf ook **op de afdeling intensieve zorgen** opgenomen?

Indien u "N=" kiest, specifieer het aantal in het tekstvak

○ Onbekend

○ N= 0

○ N=

Vraag 21. Voor zover u patiënten *monitorde in de post-hospitalisatie fase*, vul het aantal geïncludeerde patiënten in **per afdeling** vanwaar patiënten werden ontslagen met telemonitoring.

	Pre-hospitalisatie fase	Post-hospitalisatie fase
COVID-afdeling		
Pneumologie		
Oncologie		
Cardiologie		
Algemeen interne		
Andere afdeling (schrijf het aantal patiënten en zie vraag 21.1)		
Onbekend		

Vraag 21.1. Als andere afdeling, namelijk

Vraag 22. Voor zover u patiënten *monitorde in post-hospitalisatiefase*, vul het aantal geïncludeerde patiënten in per **ligduurcategorie** (eventuele ligduur op intensieve zorgen inbegrepen)

	Totale ligduur ziekenhuis	Ligduur op de intensive care
1-3 dagen		
4-10 dagen		
11-20 dagen		
>20 dagen		
gemiddelde ligduur		
onbekend		

Vraag 23. Vul het aantal geïncludeerde patiënten in die **telemetrie apparatuur** hebben gekregen (bijv. saturatiemeter, tensiemeter, hartslagmeter, bloeddrukmeter…)

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Patiënten met telemetrie apparatuur		
Patiënten zonder telemetrie apparatuur		
Onbekend		

Vraag 24. Vul het aantal geïncludeerde patiënten in per **categorie van duur** van de telemonitoring

	Pre-hospitalisatie fase	Post-hospitalisatie fase
minder dan 1 dag		
1-3 dagen		
4-7 dagen		
8-11 dagen		
12-15 dagen		
16-19 dagen		
20-23 dagen		
24-27 dagen		
28-31 dagen		
32-35 dagen		
36-39 dagen		
40-43 dagen		
meer dan 43 dagen		
nog gemonitord op het moment van het invullen van de vragenlijst		
gemiddelde duur van de telemonitoring		

Vraag 25. Hoeveel geïncludeerde patiënten kregen *tijdens de telemonitoring periode* één of meerdere van de onderstaande **medicijnen?**

	Pre-hospitalisatie fase	Post-hospitalisatie fase
zuurstoftherapie (schrijf het aantal patiënten en zie vraag 25.1)		
antibiotica		
corticosteroïden		
tromboprofylaxe		
koortsremmers/pijnstillers (paracetamol, NSAID)		
andere medicaties		
onbekend		

Vraag 25.1. *Indien patiënten tijdens de telemonitoring een vorm van zuurstoftherapie kregen*, vul het aantal patiënten in per **categorie van de duur van de zuurstoftherapie**

	Pre-hospitalisatie fase	Post-hospitalisatie fase
minder dan 1 dag		
1-3 dagen		
4-7 dagen		
8-11 dagen		
12-15 dagen		
16-19 dagen		
20-23 dagen		
24-27 dagen		
28-31 dagen		
32-35 dagen		
36-39 dagen		
40-43 dagen		
meer dan 43 dagen		
nog gemonitord op het moment van het invullen van de vragenlijst		
gemiddelde		

Vraag 26. *Voor de parameters die tijdens de telemonitoring werden opgevolgd*, geef de **standaard frequentie** per dag.

Als de parameter niet werd opgevolgd, geef 0 aan.

Als de parameter continu werd opgevolgd, vul 24 in

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Temperatuur		
Hartslag		
Perifere zuurstofsaturatie		
Ademhalingsfrequentie		
Bloeddruk		
Subjectieve gezondheidstoestand volgens patiënt (vraaglijst)		
Andere parameters (schrijf 1 en zie vraag 26.1)		

Vraag 26.1. Als andere parameters, welke en frequentie per dag:

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Parameter en frequentie per dag		

Vraag 27. Vul het aantal geïncludeerde patiënten in voor wie de **meetfrequentie** of het **alarmniveau** van (bepaalde) parameters werd geïndividualiseerd.

Indien u "N=" kiest, specifieer het aantal in het tekstvak

○ Onbekend

○ N= 0

○ N=

Vraag 27.1. Zo ja, welk(e) parameter(s) en reden ?

Vraag 28. Vul het aantal geïncludeerde patiënten in volgens het **klinische verloop** tijdens de telemonitoring periode.

Verschillende mogelijkheden per patiënt (niet wederzijds exclusief)

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Geen duidelijke verbetering of achteruitgang, status-quo		
Geleidelijke verbetering gedurende telemonitoring periode		
Verslechtering zodanig dat consultatie op de spoed of van de huisarts noodzakelijk was, maar geen verdere ziekenhuisopname		
Verslechtering met noodzaak tot ziekenhuisopname		
Overlijden (thuis of in het ziekenhuis)		

Vraag 29. Vul het aantal geïncludeerde patiënten in volgens de **reden om te stoppen** met telemonitoren.

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Klinische toestand zodanig verbeterd dat telemonitoren niet langer nodig was		
Ziekenhuisopname		
Overlijden		
Op verzoek van de patiënt		
Geen input van parameters meer door de patient		
Andere reden (schrijf het aantal patiënten en zie vraag 29.1)		

Vraag 29.1. Als andere reden, namelijk:

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Andere reden		

Vraag 30. Stuurde u na afloop van de telemonitoring nog een **tevredenheidsvragenlijst** naar de patiënten ?

○ Ja

○ Nee

Vraag 30.1. *Voor zover u een tevredenheidsvragenlijst stuurde*, vul het aantal geïncludeerde patiënten in die **(on)tevreden** waren over de telemonitoring.

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Zeer tevreden		
Tevreden		
Niet tevreden/ niet ontevreden		
Ontevreden		
Zeer ontevreden		
Onbekend		

Vraag 31. Eventuele additionele opmerkingen kunt u hieronder invullen:

Appendix 2.4.2. Version in French

Question 1. Quel projet/hôpital représentez-vous ?

Veuillez sélectionner une seule des propositions suivantes :

○ Ath, Baudour, Hornu, Center Hospitalier Epicura

○ Herstal, Clinique André Renard

○ Tournai, CHwapi

○ Aalst, O.L.V Ziekenhuis / Mederi

○ Aalst, Algemeen Stedelijk Ziekenhuis / Mederi

○ Antwerpen, UZA

○ Gent, AZ Jan Palfijn

○ Gent, AZ Maria Middelares

○ Gent, AZ Sint Lucas Gent

○ Gent, UZ Gent

○ Genk, ZOL

○ Mol, Heilig Hart ziekenhuis

○ Waregem, O.L.V. Van Lourdes Ziekenhuis

○ Autre : [ ]

Question 2. Quel est votre nom et votre fonction dans le projet ?

Question 3. Combien de patients atteints de COVID-19 ont été admis **aux urgences** de votre hôpital durant la période du 01/01/21 au 30/06/21 inclus ?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 4. Combien de patients atteints de COVID-19 ont été **hospitalisés** dans votre hôpital durant la période du 01/01/21 au 30/06/21 inclus ?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 4.1. Combien de ces patients provenaient d'un **transfert** d'un autre hôpital ?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 5.1. A combien de patients COVID-19 le télémonitoring a-t-il été **proposé** durant la période du 01/01/21 au 30/06/21 inclus, en phase de **PRE-HOSPITALISATION** ?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 5.2. A combien de patients COVID-19 le télémonitoring a-t-il été **proposé** durant la période du 01/01/21 au 30/06/21 inclus, en phase de **POST-HOSPITALISATION** ?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 5.3. Quelles étaient les raisons pour ne pas proposer le télémonitoring?

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Raisons de ne pas proposer le monitoring		

Question 6.2. Combien de patients COVID-19 ont **accepté de participer** au projet de télémonitoring durant la période du 01/01/21 au 30/06/21 inclus, en phase de **POST-HOSPITALISATION** ?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 6.3. Pourquoi les patients ont-ils refusé de participer au projet de télémonitoring ?

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Raisons de refus de participation au Projet		

Question 7.1. Pour combien de patients COVID-19 le télémonitoring a-t-il **effectivement démarré** durant la période du 01/01/21 au 30/06/21 inclus pour la phase de **PRE-HOSPITALISATION**?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 7.2. Pour combien de patients COVID-19 le télémonitoring a-t-il **effectivement démarré** durant la période du 01/01/21 au 30/06/21 inclus pour la phase de **POST-HOSPITALISATION** ?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 8. Y a-t-il eu des patients qui ont bénéficié à la fois d'une surveillance par télémonitoring en phase de pré- et de post-hospitalisation ?

○ Oui

○ Non

Question 8.1. Si oui, combien?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 9.1. Pour combien de patients inclus dans le projet en phase de **PRE-HOSPITALISATION** le COVID-19 a-t-il **été confirmé** ? (par test PCR, test antigénique, radiologie (voir https://covid-19.sciensano.be/fr/covid-19-definition-decas-et-testing)?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 9.2. Pour combien de patients inclus dans le projet en phase de **POST-HOSPITALISATION** le COVID-19 a-t-il **été confirmé** ? (par test PCR, test antigénique, radiologie (voir https://covid-19.sciensano.be/fr/covid-19-definition-decas-et-testing)?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 10. Pouvez-vous donner le nombre de patients inclus par sexe et **catégorie d'âge**.

	Phase de pré-hospitalisation		Phase de post-hospitalisation	
	Homme	Femme	Homme	Femme
0-20				
21-40				
41-60				
61-70				
71-80				
80+				
Age moyen				

Question 11. Pouvez-vous donner le nombre de patients inclus par **province** (province du domicile du patient)**.**

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Hainaut		
Namur		
Luxembourg		
Liège		
Brabant Wallon		
Région de Bruxelles-Capitale		
Flandre Occidentale		
Flandre Orientale		
Anvers		
Limbourg		
Brabant Flamand		
Pays différent que la Belgique		
Inconnu		

Vraag 12. Vul het aantal geïncludeerde patiënten in volgens **moedertaal**.

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Français		
Néerlandais		
Allemand		
Anglais		
Turc		
Arabe		
Autre langue		
Inconnu		

Question 13. Pouvez-vous donner le nombre de patients inclus selon leur **situation de vie ?**

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Autonome avec au moins un autre adulte		
Vivant seul		
Vivant en maison de repos et résidence services		
Autre situation de vie		
Inconnu		

Question 14. Pouvez-vous donner le nombre de patients inclus selon le **niveau d'étude** (diplôme le plus élevé obtenu) ?

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Pas de diplôme		
Enseignement primaire		
Enseignement secondaire		
Haute école / Université		
Inconnu		

Question 15. Pouvez-vous donner le nombre de patients inclus qui sont bénéficiaires du **tarif préférentiel de l'assurance obligatoire** (BIM) ?

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Nombre de patients qui bénéficient du tarif préférentiel de l'assurance obligatoire		
Nombre de patients qui ne bénéficient pas du tarif préférentiel de l'assurance obligatoire		
Inconnu		

Question 16. Pouvez-vous donner le nombre de patients inclus qui présentaient un ou plusieurs des **symptômes suivants** de la maladie *au moment de leur inclusion* dans le projet de télémonitoring*?*

Plusieurs options sont possibles pour un patient

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Fièvre (>37.5°C)		
Fréquence respiratoire >20/min		
Saturation en oxygène au repos (SpO2 < 90%)		
Fréquence cardiaque >100/min		
Fréquence cardiaque <45/min		
Tension artérielle systolique <100mmHg		
Altération de l'état de conscience		
Signes cliniques de déshydratation et/ou d'hypovolémie		
Toux		
Perte de goût et/ou de l'odorat		
Maux de tête		
Douleurs abdominales		
Diarrhée		
Autre plainte (notez le nombre de patients et voir question 16.1)		
Inconnu		

Question 16.1 Si autre plainte, précisez

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Autres plainte		

Question 17. Pouvez-vous donner le nombre de patients inclus qui présentaient une ou plusieurs **comorbidités** *au moment de leur inclusion* dans le projet de télémonitoring ? (liste basée sur l'arbre décisionnel KCE https://kce.fgov.be/sites/default/files/atoms/files/Decision-aid-Worrisome%20patient-FR_01062021.pdf).

Plusieurs options sont possibles pour un patient

	Phase de pré-hospitalisation	Phase de post-hospitalisation

BMI ≥ 30		
Diabète de type 1 ou de type 2		
Problèmes cardiaques (insuffisance cardiaque, maladie coronaire, cardiomyopathie et hypertension artérielle pulmonaire)		
Hypertension artérielle		
Maladie pulmonaire chronique (BPCO,maladie pulmonaire interstitielle, mucoviscidose…)		
Insuffisance rénale chronique (stade 3a à 5)		
Maladie hépatique chronique		
Maladies hématologiques ou cancer actif		
Immunosuppression sévère		
Trouble neurologique (démence,maladie cérébrovasculaires...)		
Syndrome de Down, paralysie cérébrale		
Drépanocytose homozygote		

Autre comorbidité (notez le nombre de patients et voir question 17.1)		
Inconnu		

Question 17.1. Si autres comorbidités, précisez

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Autres comorbitités		

Question 18. *Au moment de l'inclusion du patient*, avez-vous utilisé **une échelle de risque d'une détérioration clinique** ? (par exemple: New Early Warning Score, ISARIC 4C, Charlson Comorbidity Index...)

○ Oui

○ Non

Question 18.1. Si oui, laquelle ?

Question 18.2. Selon l'échelle de risque que vous avez utilisée, pouvez-vous donner le nombre de patients inclus présentent un **risque faible/modéré/élevé** de détérioration clinique *au moment de l'inclusion*

	Phase de pré-hospitalisation	Phase de post-hospitalisation

Pas de risque		
Risque faible		
Risque modéré		
Risque élevé		

Question 19. Pouvez-vous donner le nombre de patients inclus qui reçoivent *au moment de l'inclusion* un des **médicaments** suivants ?

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Antibiotiques		
Corticoïdes		
Thromboprophylaxie		
Antidouleurs (paracetamol, AINS)		
Autre traitement		
Inconnu		

Question 20. Pouvez-vous donner le nombre de patients inclus qui sont passés par **les soins intensifs** durant leur hospitalisation ?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 21. Pour les patients *suivis en phase de post-hospitalisation*, pouvez-vous donner le nombre de patients inclus selon **la dernière unité d'hospitalisation**, via laquelle le suivi par télémonitoring a démarré ?

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Unité COVID		
Pneumologie		
Oncologie		
Cardiologie		
Médecine interne		
Autre unité (notez le nombre de patients et voir question 21.1)		
Inconnu		

Question 21.1. Si autre unité, précisez :

Question 22. Pour les patients *suivi en phase de post-hospitalisation*, pouvez-vous donner le nombre de patients suivis selon la **durée de séjour** (par catégorie), à l'hôpital et éventuellement aux soins intensifs ?

	Durée de séjour à l'hôpital	Durée de séjour aux soins intensifs
1-3 jours		
4-10 jours		
11-20 jours		
>20 jours		
Durée de séjour moyenne		
Inconnu		

Question 23. Parmi les patients inclus, combien ont reçu un **équipement de télémétrie** (p.ex. saturomètre, tensiomètre...) ?

	Phase de pré-hospitalisation	Phase de post-hospitalisation

Nombre de patients ayant reçu un équipement de télémonitoring		
Nombre de patients n'ayant pas reçu d'équipement de télémonitoring		
Inconnu		

Question 24. Pouvez-vous donner le nombre de patients inclus selon la **durée du télémonitoring** (par catégorie) ?

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Moins d'un jour		
1-3 jours		
4-7 jours		
8-11 jours		
12-15 jours		
16-19 jours		
20-23 jours		
24-27 jours		
28-31 jours		
32-35 jours		
36-39 jours		
40-43 jours		
Plus de 43 jours		
Nombre de patients encore suivis en ce moment		
Durée moyenne du télémonitoring		

Question 25. Pouvez-vous donner le nombre de patients inclus qui reçoivent *pendant la durée du télémonitoring* un des **médicaments** suivants ?

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Oxygénothérapie (notez le nombre de patients et voir question 25.1)		
Antibiotiques		
Corticoïdes		
Thromboprophylaxie		
Antidouleurs (paracetamol, AINS)		
Autre traitement		
Inconnu		

Question 25.1 *Pour les patients sous oxygénothérapie*, pouvez-vous donner le nombre de patients selon la durée (par catégorie) de l'oxygénothérapie ?

	Pre-hospitalisatie fase	Post-hospitalisatie fase
Moins d'un jour		
1-3 jours		
4-7 jours		
8-11 jours		
12-15 jours		
16-19 jours		
20-23 jours		
24-27 jours		
28-31 jours		
32-35 jours		
36-39 jours		
40-43 jours		
Plus de 43 jours		
Nombre de patients encore suivis en ce moment		
Durée moyenne		

Question 26. *Pour les paramètres qui ont été mesurés* durant le télémonitoring, pouvez-vous donner **la fréquence standard de mesure par jour ?**

Si le paramètre n'a pas été mesuré durant le télémonitoring, veuillez noter 0 comme fréquence.

Si le paramètre a été mesuré en continu, veuillez noter 24 comme fréquence

	Phase de pré-hospitalisation	Phase de post-hospitalisation
La température		
La fréquence cardiaque		
La saturation en oxygène périphérique		
La fréquence respiratoire		
La tension artérielle		
L'état de santé subjectif selon le patient (via questionnaire)		
Autres paramètres (notez 1 et voir question 26.1)		

Question 26.1 Si autres paramètres, le(es)quelle(s), et à quelle fréquence

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Mesure et fréquence par jour		

Question 27. Pour combien de patients inclus, la **fréquence de mesure** ou le **niveau d'alarme** des paramètres a été individualisée ?

Si vous cochez N=, veuillez spécifier le nombre dans la zone de texte.

○ Inconnu

○ N= 0

○ N= [ ]

Question 27.1. Si oui, quel(s) paramètre(s) et pour quelle raison ?

Question 28. Pouvez-vous donner le nombre de patients inclus en fonction de **l'évolution clinique** sur la durée du télémonitoring ?

Plusieurs options sont possibles pour un patient (pas d'exclusivité mutuelle)

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Aucune amélioration (ou détérioration) marquée, statu quo		
Amélioration progressive		
Détérioration telle qu'une consultation aux urgences ou chez le généraliste a été nécessaire, mais pas d'hospitalisation		
Détérioration nécessitant une hospitalisation		
Décès (à domicile ou à l'hôpital)		

Question 29. Pouvez-vous donner le nombre de patients inclus en fonction des **raisons d'arrêt** du suivi par télémonitoring ?

	Phase de pré-hospitalisation	Phase de post-hospitalisation
L'état clinique du patient s'est amélioré au point que la télésurveillance n'est plus nécessaire.		

Admission à l'hôpital		
Décès		
A la demande du patient		
Plus d'enregistrements mesurés		
Autre raison (notez le nombre de patients et voir question 29.1)		

Question 29.1. Si autre raison, précisez :

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Autre raison		

Question 30. Avez-vous envoyé un questionnaire de satisfaction aux patients après la fin du suivi par télémonitoring ?

○ Oui

○ Non

Question 30.1. *Dans le cas où un questionnaire de satisfaction a bien été envoyé*, pouvez-vous donner le nombre de patients inclus qui ont été **(in)satisfaits** du télémonitoring ?.

	Phase de pré-hospitalisation	Phase de post-hospitalisation
Très satisfait		
Satisfait		
Ni satisfait, ni insatisfait		
Pas satisfait		
Pas du tout satisfait		
Inconnu		

Question 31. Vous pouvez ajouter des remarques/commentaires éventuels ci-dessous :

Appendix 2.5. Survey overview received and missing data

Figure 18 – Visualisation of the filling the questionnaire (left: for the pre-hospitalisation phase, right: for the post-hospitalisation phase)

Colour code: Blank: Available answers; Orange: "NA" answers ; Red: Missing answers

Appendix 2.6. Press releases on the projects

AZMM

https://www.youtube.com/watch?v=TGg9Tx3Ghuo

Byteflies

http://impact.dimesociety.org/wp-content/uploads/2021/06/V1C-vignette-Byteflies-_-CC@H-DiMe-Server.pdf

https://kanaalz.knack.be/nieuws/byteflies-technologie-voor-covid-patienten-erkent-door-riziv/video-normal-1681171.html

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Appendix 2.7. Details on selected and included patient population

Table 33 – Number of Covid-19 patients admitted to ED and/or hospitalized

	UZA	AZMM	HH Mol	AZ Jan Palfijn	Mederi	OLV Waregem	ZOL	EpiCURA	CHwapi
Nb of Covid Patients admitted in ED	341	504	354	178	588	Missing	265	157	3679
Nb of Covid Patients hospitalized	229	402	206	227	516	Missing	581	70	392
Nb of Covid Patients hospitalized who were transferred from another hospital (% of the hospitalized patients)	9 (3.9%)	26 (6.5%)	9 (4.4%)	31 (13.7%)	30 (5.8%)	Missing	30 (5.2%)	3 (4.3%)	15 (3.8%)

Table 34 – Amount of included patients in the projects for the pre- and the post-hospitalization phases

	UZA	AZMM	HH Mol	AZ Jan Palfijn	Mederi	OLV Waregem	ZOL	EpiCURA	CHwapi
Prehosp phase: - Study proposed	252	13	14	Missing	16	Missing	1	0	0
- Study accepted	230	9	14	1	16	Missing	1	0	0
Posthosp phase: - Study proposed	45	253	11	Missing	Missing	Missing	Missing	4	28
- Study accepted	45	40	11	12	55	Missing	97	2	28

Appendix 2.8. Details on the general characteristics of the included patients

Appendix 2.8.1. Details on gender, age, geographical reach and language of the included patients in the pre- and post-hospitalisation phase

Table 35 – Gender, age, geographical reach and language in the pre-hospitalisation phase

Number of patients	UZA (230 patients)	AZMM (9 patients)	HH Mol (14 patients)	AZ Jan Palfijn (1 patients)	Mederi (15 patients)	Waregem (7 patients)	ZOL (1 patients)	EpiCURA (0 patients)	CHwapi (0 patients)	TOTAL
GENDER										
Men	100	6	9	1	7	4	1	NA	NA	128
Women	130	3	5	0	8	3	0	NA	NA	149

AGE CATEGORIES										
0-20	4	0			0			NA	NA	4
21-40	43	4	1	1	1	2		NA	NA	52
41-60	82	4	7		5	3	1	NA	NA	102
61-70	80	0	3		3			NA	NA	86
71-80	15	1	3		4	2		NA	NA	25
80+	6	0			2			NA	NA	8
PROVINCE										
Hainaut	1	Missing						NA	NA	1
Brabant Wallon	0	Missing						NA	NA	0
Brussel	17	Missing						NA	NA	17
West-Vlaanderen	3	Missing				7		NA	NA	10
Oost-Vlaanderen	6	Missing		1	8			NA	NA	15
Antwerpen	154	Missing	14					NA	NA	168
Limburg	28	Missing					1	NA	NA	29
Vlaams-Brabant	13	Missing			7			NA	NA	20
Foreign	4	Missing						NA	NA	4
LANGUAGE										
French	6			Missing	1			NA	NA	7
Dutch	189	9	14	Missing	14	7	1	NA	NA	234
German	1			Missing				NA	NA	1
Engels	15			Missing				NA	NA	15
Turkish	5			Missing				NA	NA	5
Arabic	3			Missing				NA	NA	3
Other	11			Missing				NA	NA	11

Table 36 – Gender, age, geographical reach and language in the post-hospitalisation phase

Number of patients	UZA (45 patients)	AZMM (40 patients)	HH Mol (11 patients)	AZ Jan Palfijn (12 patients)	Mederi (55 patients)	Waregem (58 patients)	ZOL (97 patients)	EpiCURA (2 patients)	CHwapi (28 patients)	TOTAL
GENDER										
Men	15	25	7	7	35	33	63	2	18	205
Women	30	15	4	4	20	25	34	0	10	142
AGE CATEGORIES										
0-20	3	0		1	0	1				5
21-40	7	4		2	1	8	3		3	28
41-60	4	22	2	6	30	30	49	2	13	158
61-70	29	9	7	2	13	11	33		6	110
71-80	1	5	2		10	8	10		5	41
80+	1	0			1		2		1	5
PROVINCE										
Hainaut	0	Missing						1	27	28
Brabant Wallon	0	Missing						1		1
Brussel	0	Missing			1					1
West-Vlaanderen	1	Missing		1		58			1	60
Oost-Vlaanderen	1	Missing		11	25					38
Antwerpen	32	Missing	11							43
Limburg	8	Missing					94			102
Vlaams-Brabant	0	Missing			29					29
Foreign	3	Missing					3			6
LANGUAGE										
French	8				1			2	27	38
Dutch	20	37	11	4	47	52	83			254
German							1			1

Engels	7							7
Turkish	3			2		4		9
Arabic				2			1	3
Other	7		1	3	6	8		25

Appendix 2.8.2. Details on living situation, educational level and status of reimbursement of the included patients in the pre- and post-hospitalisation phase

Table 37 – Living situation, degree and reimbursement status in the pre-hospitalisation phase

Number of patients	UZA (230 patients)	AZMM (10 patients)	HH Mol (14 patients)	Jan Palfijn (1 patients)	Mederi (15 patients)	Waregem (7 patients)	ZOL (1 patients)	Epicura (0 patients)	Chwapi (0 patients)
LIVING SITUATION									
Together with another adult	Missing	10	Missing	Missing	Missing	Missing	Missing	NA	NA
Living alone	Missing	1	Missing	Missing	Missing	Missing	Missing	NA	NA
Living in a nursing home or residence service	14		Missing	Missing	Missing	Missing	Missing	NA	NA
Other living situation	Missing		Missing	Missing	Missing	Missing	Missing	NA	NA
EDUCATION									
No diploma	Missing		Missing	Missing	Missing	Missing	Missing	NA	NA
Primary school	Missing		Missing	Missing	Missing	Missing	Missing	NA	NA
Secondary school	Missing	7	Missing	Missing	Missing	Missing	Missing	NA	NA
High school / university	Missing	4	Missing	Missing	Missing	Missing	Missing	NA	NA
REIMBURSEMENT STATUS									
Patients with increased reimbursement status	Missing	Missing	Missing		Missing	Missing	Missing	NA	NA
Patients without increased reimbursement status	Missing	Missing	Missing	1	Missing	Missing	Missing	NA	NA

It is possible that the numbers do not correspond to the number of patients per projects due to missing data or coding errors.

Table 38 – Living situation, degree and reimbursement status in the post-hospitalisation phase

Number of patients	UZA (45 patients)	AZMM (40 patients)	HH Mol (11 patients)	AZ Jan Palfijn (12 patients)	Mederi (55 patients)	OLV Waregem (58 patients)	ZOL (97 patients)	EpiCURA (2 patients)	CHwapi (28 patients)
LIVING SITUATION									
Together with another adult	Missing	36	Missing	Missing	47	Missing	81	2	24
Living alone	Missing	3	Missing	Missing	8	Missing	8		4
Living in a nursing home or residence service	6		Missing	Missing		Missing			
Other living situation	Missing	1	Missing	Missing		Missing			
EDUCATION									
No diploma	Missing		Missing	Missing	Missing	Missing			Missing
Primary school	Missing	1	Missing	Missing	Missing	Missing	7		Missing
Secondary school	Missing	18	Missing	Missing	Missing	Missing	23		Missing
High school / university	Missing	17	Missing	Missing	Missing	Missing	9	1	Missing
REIMBURSEMENT STATUS									
Patients with increased reimbursement status	Missing	Missing	Missing	4	9	Missing	Missing	Missing	6
Patients without increased reimbursement status	Missing	Missing	Missing	8	46	Missing	Missing	Missing	22

It is possible that the numbers do not correspond to the number of patients per projects due to missing data or coding error.

Appendix 2.9. Details on the clinical characteristics

Appendix 2.9.1. Description of the symptoms presented by the included patients in the pre- and post-hospitalisation phase

Table 39 – Symptoms in the pre-hospitalisation phase

Number of patients	UZA (230 patients)	AZMM (9 patients)	HH Mol (14 patients)	AZ Jan Palfijn (1 patients)	Mederi (15 patients)	OLV Waregem (7 patients)	ZOL (1 patients)	EpiCURA (0 patients)	CHwapi (0 patients)
Coughing	185 (80.4%)	Missing	Missing	Missing	Missing	0	1	NA	NA
Headache	66 (28.7%)	Missing	Missing	Missing	Missing	0	1	NA	NA
Loss of taste and/or smell	106 (46.1%)	Missing	Missing	Missing	Missing	1	Missing	NA	NA
Fever (>37.5°C)	114 (49.6%)	Missing	Missing	Missing	Missing	0	1	NA	NA
Heart rate >100/min	19 (8.3%)	Missing	Missing	Missing	Missing	0	Missing	NA	NA
Respiratory rate >20/min	78 (33.9%)	Missing	Missing	Missing	Missing	0	Missing	NA	NA
Diarrhoea	3 (1.3%)	Missing	Missing	Missing	Missing	0	Missing	NA	NA
Abdominal pain	41 (17.8%)	Missing	Missing	Missing	Missing	0	Missing	NA	NA
Altered consciousness	11 (4.8%)	Missing	Missing	Missing	Missing	0	Missing	NA	NA
SpO2 < 90%	2 (0.9%)	Missing	Missing	Missing	Missing	1	Missing	NA	NA
Systolic BP <100mmHg	1 (0.4%)	Missing	Missing	Missing	Missing	0	Missing	NA	NA
Dehydration and/or hypovolemia	7 (3.0%)	Missing	Missing	Missing	Missing	0	1	NA	NA
Other	0 (0%)	Missing	Missing	Missing	Missing	1	1	NA	NA
Detail other	NA	Missing	Missing	Missing	Missing	fatigue	Loss of appetite	NA	NA

Table 40 – Symptoms in the post-hospitalisation phase

Number of patients	UZA (45 patients)	AZMM (40 patients)	HH Mol (11 patients)	AZ Jan Palfijn (12 patients)	Mederi (55 patients)	OLV Waregem (58 patients)	ZOL (97 patients)	EpiCURA (2 patients)	CHwapi (28 patients)
Coughing	26 (57.8%)	Missing	Missing	Missing	55 (100%)	38 (65.5%)	34 (35.1%)	2 (100%)	4 (14.3%)
Headache	8 (17.8%)	Missing	Missing	Missing	55 (100%)	19 (32.8%)	2 (2.1%)	Missing	Missing
Loss of taste and/or smell	15 (33.3%)	Missing	Missing	Missing	55 (100%)	4 (6.9%)	1 (1.0%)	Missing	Missing

Fever (>37.5°C)	0	Missing	Missing	Missing	0	36 (62.1%)	1 (1.0%)	Missing	1 (3.6%)
Heart rate >100/min	16 (35.6%)	Missing	Missing	Missing	0	11 (19.0%)	6 (6.2%)	Missing	2 (7.1%)
Respiratory rate >20/min	10 (22.2%)	Missing	Missing	Missing	0	0	2 (2.1%)	Missing	9 (32.1%)
Diarrhoea	0	Missing	Missing	Missing	Missing	9 (15.5%)	2 (2.1%)	Missing	2 (7.1%)
Abdominal pain	4 (8.9%)	Missing	Missing	Missing	0	3 (5.2%)	Missing	Missing	Missing
Altered consciousness	6 (13.3%)	Missing	Missing	Missing	0	0	Missing	Missing	Missing
SpO2 < 90%	0	Missing	Missing	Missing	0	4 (6.9%)	1 (1.0%)	Missing	Missing
Systolic BP <100mmHg	0	Missing	Missing	Missing	0	0	3 (3.1%)	Missing	2 (7.1%)
Dehydration and/or hypovolemia	0	Missing	Missing	Missing	0	0	Missing	Missing	Missing
Other	0	Missing	Missing	Missing	Missing	16 (27.6%)	1 (1.0%)	2 (100%)	Missing
Detail other	NA	Missing	Missing	Missing	Missing	Fatigue	Joint pain	fatigue, exertional dyspnoea	Missing

Appendix 2.9.2. Description of the comorbidities presented by the included patients in the pre- and post-hospitalisation phase

Table 41 – Comorbidity in the pre-hospitalisation phase

Number of patients	UZA (230 patients)	AZMM (9 patients)	HH Mol (14 patients)	AZ Jan Palfijn (1 patients)	Mederi (15 patients)	OLV Waregem (7 patients)	ZOL (1 patients)	EpiCURA (0 patients)	CHwapi (0 patients)
BMI ≥ 30	142 (61.7%)	1 (11.1%)	Missing	Missing	Missing	Missing	Missing	NA	NA
Hypertension	32 (13.9%)	1 (11.1%)	Missing	Missing	Missing	Missing	1 (100%)	NA	NA
Diabetes Type 1 or 2	32 (13.9%)	0	Missing	Missing	Missing	Missing	1 (100%)	NA	NA
Chronic pulmonary disease	19 (8.3%)	1 (11.1%)	Missing	Missing	Missing	Missing	Missing	NA	NA
Cardiac disorders	30 (13.0%)	2 (22.2%)	Missing	Missing	Missing	Missing	Missing	NA	NA
Severe immunosuppression	24 (10.4%)	0	Missing	Missing	Missing	Missing	Missing	NA	NA
Kidney disease	6 (2.6%)	0	Missing	Missing	Missing	Missing	Missing	NA	NA
Haematologic disease or active cancer	3 (1.3%)	0	Missing	Missing	Missing	Missing	Missing	NA	NA
Neurological disease	38 (16.5%)	Missing	Missing	Missing	Missing	Missing	Missing	NA	NA

Chronic liver disease	11 (4.8%)	1 (11.1%)	Missing	Missing	Missing	Missing	Missing	NA	NA
Neurological conditions or major psychiatric disorders	0	Missing	Missing	Missing	Missing	Missing	Missing	NA	NA
Homozygous sickle cell disease	0	Missing	Missing	Missing	Missing	Missing	Missing	NA	NA
No comorbidity	Missing	6 (66.7%)	Missing	Missing	Missing	Missing	Missing	NA	NA
Other	Missing	Missing	Missing	Missing	Missing	Missing	Missing	NA	NA
Detail other	Missing	Missing	Missing	Missing	Missing	Missing	Missing	NA	NA

Table 42 – Comorbidity in the post-hospitalisation phase

Number of patients	UZA (45 patients)	AZMM (40 patients)	HH Mol (11 patients)	AZ Jan Palfijn (12 patients)	Mederi (55 patients)	OLV Waregem (58 patients)	ZOL (97 patients)	EpiCURA (2 patients)	CHwapi (28 patients)
BMI ≥ 30	21 (46.7%)	13 (32.5%)	Missing	Missing	17 (30.9%)	5 (8.6%)	41 (42.3%)	2 (100%)	10 (35.7%)
Hypertension	10 (22.2%)	9 (22.5%)	Missing	Missing	20 (36.4%)	1 (1.7%)	26 (28.6%)	1 (50.0%)	9 (32.1%)
Diabetes Type 1 or 2	11 (24.4%)	5 (12.5%)	Missing	Missing	28 (50.9%)	0	19 (19.6%)	Missing	8 (28.6%)
Chronic pulmonary disease	6 (13.3%)	5 (12.5%)	Missing	Missing	12 (21.8%)	1 (1.7%)	16 (16.5%)	Missing	6 (21.4%)
Cardiac disorders	9 (20.0%)	5 (12.5%)	Missing	Missing	8 (14.5%)	2 (3.4%)	12 (12.4%)	Missing	5 (17.9%)
Severe immunosuppression	8 (17.8%)	3 (7.5%)	Missing	Missing	1 (1.8%)	3 (5.2%)	4 (4.1%)	Missing	1 (3.6%)
Kidney disease	3 (6.7%)	1 (2.5%)	Missing	Missing	3 (5.5%)	1 (1.7%)	6 (6.2%)	Missing	1 (3.6%)
Haematologic disease or active cancer	1 (2.2%)	2 (5.0%)	Missing	Missing	Missing	1 (1.7%)	8 (8.2%)	Missing	Missing
Neurological disease	2 (4.4%)	0	Missing	Missing	1 (1.8%)	0	5 (5.2%)	Missing	Missing
Chronic liver disease	0	0	Missing	Missing	Missing	0	1 (1.0%)	Missing	2 (7.1%)
Neurological conditions or major psychiatric disorders	0	Missing	Missing	Missing	Missing	0	Missing	Missing	Missing
Homozygous sickle cell disease	0	Missing	Missing	Missing	Missing	0	Missing	Missing	Missing
No comorbidity	Missing	11 (27.5%)	Missing	Missing	Missing	Missing	19 (19.6%)	Missing	Missing
Other	Missing	Missing	Missing	Missing	Missing	Missing	34 (35.1%)	Missing	Missing
Detail other	Missing	Missing	Missing	Missing	Missing	Missing	**	Missing	Missing

***Hypercholesterolemie (12), slaapapnoe -nCPAP(10), reumatoïde artritis (6), hypothyroïdie (3), depressie (2), ...*

Appendix 2.9.3. Risk score classification in the pre- and post-hospitalisation phase

Table 43 – Classification of patients in four categories of risk following the risk score measurement tool used.

Number of patients	UZA		Mederi		OLV Waregem		CHwapi	
Hospitalisation phase	Pre- (230 patients)	Post- (45 patients)	Pre- (15 patients)	Post- (55 patients)	Pre- (7 patients)	Post- (58 patients)	Pre- (0 patients)	Post- (28 patients)
No-Risk	2 (0.9%)	0	Missing	Missing	Missing	Missing	NA	13 (46.4%)
Low-risk	7 (3.0%)	1 (2.2%)	Missing	Missing	Missing	Missing	NA	6 (21.4%)
Medium-risk	41 (17.8%)	5 (11.1%)	Missing	Missing	Missing	Missing	NA	8 (28.6%)
High-risk	180 (78.3%)	39 (86.7%)	Missing	Missing	Missing	Missing	NA	1 (3.6%)

Appendix 2.9.4. Hospitalisation characteristics for patients included in the post-hospitalisation phase

Table 44 – Hospitalisation characteristics of patients included in the post-hospitalisation phase

Number of patients	UZA (45 patients)	AZMM (40 patients)	HH Mol (11 patients)	AZ Jan Palfijn (12 patients)	Mederi (55 patients)	OLV Waregem (58 patients)	ZOL (97 patients)	EpiCURA (2 patients)	CHwapi (28 patients)
LAST UNIT BEFORE STARTING TELEMONITORING									
Covid Unit	45	Missing	11	13	54	59	97	2	28
Other Unit		Missing			1	7			
If other, which unit	NA	Missing	NA	NA	Geriatrics	Missing	NA	NA	NA
HOSPITAL DURATION									
1-3 days	9	Missing	1	0	2	Missing	23		1
4-10 days	16	Missing	8	7	46	Missing	55	1	13
11-20 days	5	Missing	2	1	6	Missing	14	1	9
>20 days	15	Missing		0	1	Missing	5		5
Average	Missing	Missing	Missing	7	7,45	Missing	7	Missing	12
Calculated average	11.6	Missing	8.1	8.1	8.0	Missing	7.8	11.3	12.1

Nb Patient in ICU	11 (24.4%)	Missing	Missing	0	7 (12.7%)	Missing	22 (22.7%)	1 (50.0%)	8 (28.6%)
ICU DURATION									
1-3 days	2	Missing	Missing	NA	2	Missing	6		2
4-10 days	3	Missing	Missing	NA	5	Missing	13	1	5
11-20 days	1	Missing	Missing	NA		Missing	2		1
>20 days	5	Missing	Missing	NA		Missing	1		0
Average	Missing	Missing	Missing	NA	6,14	Missing	6	NA	6,6
Calculated average	13.2	Missing	Missing	NA	5.6	Missing	7.0	NA	6.8

It is possible that the count does not correspond to the number of patients per projects due to missing data or coding error.

Appendix 2.10. Details on other therapy provided during the telemonitoring intervention (medication and oxygen therapy)

Appendix 2.10.1. Number of patients receiving specific treatments in the pre- and post-hospitalisation phase

Table 45 – Number of patients receiving specific treatments in the pre-hospitalisation phase

Number of patients	UZA (230 patients)	AZMM (9 patients)	HH Mol (14 patients)	AZ Jan Palfijn (1 patients)	Mederi (15 patients)	OLV Waregem (7 patients)	ZOL Genk (1 patients)	EpiCURA (0 patients)	CHwapi (0 patients)
Oxygen therapy	29 (12.6%)	Missing	Missing	Missing	0	Missing	Missing	NA	NA
Antibiotics	6 (2.6%)	Missing	Missing	Missing	Missing	Missing	Missing	NA	NA
Corticoids	11 (4.8%)	Missing	Missing	Missing	Missing	Missing	Missing	NA	NA
Thromboprophylaxis	49 (21.3%)	Missing	Missing	Missing	Missing	Missing	Missing	NA	NA
Pain medication (paracetamol, NSAIDs)	200 (87.0%)	Missing	Missing	Missing	Missing	Missing	Missing	NA	NA
Other treatment	Missing	Missing	Missing	Missing	Missing	Missing	1	NA	NA

Table 46 – Number of patients receiving specific treatments in the post-hospitalisation phase

Number of patients	UZA (45 patients)	AZMM (40 patients)	HH Mol (11 patients)	AZ Jan Palfijn (12 patients)	Mederi (55 patients)	OLV Waregem (58 patients)	ZOL (97 patients)	EpiCURA (2 patients)	CHwapi (28 patients)
Oxygen therapy	9 (20.0%)	Missing	Missing	Missing	48 (87.3%)	Missing	37 (38.1%)	Missing	4 (14.3%)
Antibiotics	1 (2.2%)	Missing	Missing	Missing	0	Missing	35 (36.1%)	Missing	2 (7.1%)

Corticoids	3 (6.7%)	Missing	Missing	Missing	27 (49.1%)	Missing	29 (29.9%)	Missing	12 (42.9%)
Thromboprophylaxis	45 (100%)	Missing	Missing	Missing	55 (100%)	Missing	19 (19.6%)	2 (100%)	26 (92.9%)
Pain medication (paracetamol, NSAIDs)	12 (26.7%)	Missing	Missing	Missing	Missing	Missing	65 (67.0%)	1 (50.0%)	3 (10.7%)
Other treatment	Missing	Missing	Missing	Missing	Missing	Missing	80 (82.5%)	1 (50.0%)	22 (78.6%)

Appendix 2.10.2. Duration of oxygen therapy application in the pre- and post-hospitalisation phase

Table 47 – Length of oxygen therapy in the pre-hospitalisation phase

Number of patients	UZA	AZMM	HH Mol	AZ Jan Palfijn	Mederi	OLV Waregem	ZOL	EpiCURA	CHwapi
<1 days	0	NA	NA	NA	NA	NA	NA	NA	NA
1-3 days	0	NA	NA	NA	NA	NA	NA	NA	NA
4-7 days	6	NA	NA	NA	NA	NA	NA	NA	NA
8-11 days	14	NA	NA	NA	NA	NA	NA	NA	NA
12-15 days	7	NA	NA	NA	NA	NA	NA	NA	NA
16-19 days	2	NA	NA	NA	NA	NA	NA	NA	NA
20-23 days		NA	NA	NA	NA	NA	NA	NA	NA
24-27 days		NA	NA	NA	NA	NA	NA	NA	NA
28-31 days		NA	NA	NA	NA	NA	NA	NA	NA
32-35 days		NA	NA	NA	NA	NA	NA	NA	NA
36-39 days		NA	NA	NA	NA	NA	NA	NA	NA
40-43 days		NA	NA	NA	NA	NA	NA	NA	NA
>43 days		NA	NA	NA	NA	NA	NA	NA	NA
Average	Missing	NA	NA	NA	NA	NA	NA	NA	NA
Calculated average	10.2	NA	NA	NA	NA	NA	NA	NA	NA

Table 48 – Length of oxygen therapy in the post-hospitalisation phase

Number of patients	UZA	AZMM	HH Mol	AZ Jan Palfijn	Mederi	OLV Waregem	ZOL	EpiCURA	CHwapi
<1 days	0	NA	NA	NA	3	NA		NA	Missing
1-3 days	0	NA	NA	NA	3	NA	7	NA	Missing
4-7 days	3	NA	NA	NA	6	NA	3	NA	Missing
8-11 days	5	NA	NA	NA	7	NA	2	NA	Missing
12-15 days	1	NA	NA	NA	3	NA	1	NA	Missing
16-19 days	0	NA	NA	NA	5	NA		NA	Missing
20-23 days		NA	NA	NA	0	NA		NA	Missing
24-27 days		NA	NA	NA	2	NA		NA	Missing
28-31 days		NA	NA	NA	1	NA		NA	Missing
32-35 days		NA	NA	NA	1	NA		NA	Missing
36-39 days		NA	NA	NA		NA	1	NA	Missing
40-43 days		NA	NA	NA		NA		NA	Missing
>43 days		NA	NA	NA		NA		NA	Missing
Average	Missing	NA	NA	NA	Missing	NA	Missing	NA	Missing
Calculated average	8.6	NA	NA	NA	11.3	NA	7.2	NA	Missing

Appendix 2.11. Patient satisfaction survey

Table 49 – Classification of patients in 5 category of satisfaction following the questionnaire of satisfaction sent.

Number of patients	Mederi		CHwapi	
Hospitalisatie phase	Pre- (15 patients)	Post- (55 patients)	Pre- (0 patients)	Post- (28 patients)
Very satisfy	6	23	NA	20
Satisfy	4	19	NA	7
Neither satisfied nor dissatisfied			NA	1
Not satisfy		1		
Not satisfy at all			NA	

APPENDIX 3. APPENDICES TO CHAPTER 3

Appendix 3.1. Interview guide for interviews with patients

Appendix 3.1.1. Dutch version

Inleidende vragen

Kan u zich kort even voorstellen?

* Leeftijd
* Beroep
* Thuissituatie (alleenstaand, gezin,…)
* Gezondheid toestand voor COVID

Kan u iets meer vertellen over het verloop van COVID-19, vanaf het moment dat u de eerste symptomen voelde tot nu?

* Covid
    - Wanneer
    - Ernst
    - Symptomen
    - Herstel
* Eventuele opname in het ziekenhuis
    - Duur
    - Afdeling
    - Heropname
* Wanneer gestart met telemonitoring
    - Prehospital of posthospital
    - Welke zorgverleners waren betrokken
    - Wat was uw toestand; Symptomen; Zuurstof; Behandeling;
    - Duur
    - Toestemmingsformulier
* Heropname

Hoofdvraag

Hoe is de telemonitoring verlopen voor u?

Alternatieven op hoofdvraag:

Hoe heeft u telemonitoring ervaren?

Hoe heeft u het ervaren om thuis met telemonitoring te worden opgevolgd?

Hoe verliep een typische dag voor u tijdens de opvolging?

Sleutelvragen rond initiële belangrijke thema's

- Informatie & kennis

Welke informatie heeft u bij de opstart gekregen?

* Hoe en van wie?

Hoe duidelijk was het voor u wat u moest doen?

* Nood aan bijkomende informatie?

Waarom werd telemonitoring aan u voorgesteld?

- Competenties & gebruik

Hoe is de opstart van de telemonitoring verlopen?

* Wat moest u doen?
    - Welke apparatuur gekregen?
* Kon u het systeem gebruiken?
    - Wat vond u er makkelijk aan?
    - Wat vond u er moeilijk aan?

* Had u hulp nodig? (hulp bij meten van paramaters, ingeven van gegevens

- Wie heeft u geholpen?

- Op welke wijze heeft u hulp gekregen?

- Technologie (technisch gebruik: gebruiksgemak, technische defecten)

Wat is gemakkelijk en moeilijk geweest in het gebruik van het system?

Wat is moeilijk geweest in het gebruik van het system

Heeft u technische problemen gekend.

* Zo ja, welke?

* Hulp gekregen? Van wie?

* Wat was de oplossing? Hoe hebben ze het opgelost?

- Gebruik van technologie (perceptie: vertrouwen in technologie)

* Toen ze u het voorstel deden om met technologie thuis gevolgd te worden, wat waren uw eerste gedachten?

- Had u vertrouwen in dit voorstel; waarom?

- Heeft u getwijfeld? Zo ja, waarover?

- Wat was uw voornaamste drijfveer / redenen om toe te stemmen?

- Technologie & patient needs (is there a fit?)

Toen u naar huis ging, welke noden ervaarde u?

* Hoe heeft telemonitoring u daarbij geholpen?

Welke verwachting had u toen u naar huis ging?

* Hoe zijn deze verwachtingen geëvolueerd?

Heeft u de opvolging als voldoende ervaren?

* Waarom?

* Duur, frequentie?

Welk gevoel had u toen de opvolging stopte?

* Hoe is de beslissing om te stoppen genomen?

Hoe zouden we de opvolging met telemonitoring nog kunnen verbeteren voor u?

* Hoe kunnen we u met telemonitoring nog beter kunnen ondersteunen?

- Ziektebeleving & identiteit (impact op dagelijks leven, autonomie, sense of control)

Hoe verliep een typische dag voor u tijdens de opvolging?

Hoe vond u dat om uzelf iedere dag op te volgen?

- Events (identificatie nood aan opvolging/zkhopname)

Zijn er tijdens de opvolgingen problemen geweest waarvoor u hulp nodig had?

* Wat is er dan gebeurd?

* Hoe vond u de hulp die u gekregen heeft?

Heeft u zelf hulp moeten zoeken voor een probleem?

* Wat is er dan gebeurd?

- Communicatie met hulpverleners

Heeft u in de dagen dat u via telemonitoring gevolgd werd contact gehad met zorgverstrekkers?

* Met wie? Kende u deze personen reeds?

* Om welke reden? Wat deden deze zorgverstrekkers?

* Op welke manier is dat contact verlopen?

- Telefonisch, video, etc.?

* Wie kon u contacteren bij een medisch probleem? Bij een technisch probleem?

* Hoe heeft u dat ervaren? Wat vond u van deze communicatie?

Heeft u contact gehad met de huisarts? En met een thuisverpleegkundige?

Om welke reden?

* Op welke manier is dat contact verlopen?

- Telefonisch, video, etc.?

* Hoe heeft u dat ervaren?

- Voordelen & nadelen

Wat waren voor u de voordelen van telemonitoring?

* Wat was voor u de meerwaarde?

Wat waren voor u de nadelen van telemonitoring?

- Satisfaction & gevoel van veiligheid

Zou u het opnieuw doen mocht het u nog eens worden aangeboden (bv in verband met een andere aandoening?) Waarom? Waarom niet?

* Voelde u zich veilig? Waarom?

Appendix 3.1.2. French version

Questions d'introduction

Pouvez-vous vous présenter brièvement ?

- Age
- Profession
- Situation familiale (habite seul, habite en famille, en co-location...)
- Etat de santé avant le COVID-19

Pouvez-vous nous en dire un peu plus sur l'évolution de COVID-19, depuis le moment où vous avez ressenti les premiers symptômes jusqu'à maintenant ?

* Covid
  - Quand l'avez-vous eu ?
  - Gravité ?
  - Symptômes ?
  - Récupération ?

* Dans le cas d'hospitalisation
  - Durée ?
  - Département ?
  - Réadmission ?

* Quand la télésurveillance, a-t-elle commencée ?
  - En préhospitalier ou en posthospitalier ?
  - Quels sont les prestataires de soins de santé qui ont été impliqués dans votre prise en charge ?
  - Quelle était votre état de santé ? Quels étaient les symptômes ? Aviez-vous besoin d'oxygène ? Un traitement médicamenteux ?
  - Quelle a été la durée de la télésurveillance ?
  - (Aviez-vous signé ?) un formulaire de consentement

* Réadmission ?

Question principale

*Comment la télésurveillance a-t-il fonctionnée pour vous ?

Alternatives à la question principale :

- Comment avez-vous vécu la télésurveillance ?
- Comment avez-vous vécu le fait d'être suivi à domicile grâce à la télésurveillance ?
- Comment s'est déroulée une journée type pour vous pendant le suivi ?

Questions clés sur les premiers thèmes importants

- Informations et connaissances

*Quelles informations avez-vous reçues au départ ?

- Comment et de qui ?

*C'était clair pour vous ce qu'il fallait faire ?

- Besoin d'informations supplémentaires ?

*Savez-vous pourquoi la télésurveillance, vous a-t-elle été proposée ?

-Compétences et utilisation

Comment s'est déroulée la mise en route de la télésurveillance ?

*Que deviez-vous faire ?

- Quels appareils vous a-t-on fournis ?

* Avez-vous été en mesure de les utiliser -les appareils- ?

- Qu'avez-vous trouvé facile
- Qu'avez-vous trouvé difficile ?

*Avez-vous eu besoin d'aide (aide pour mesurer les paramètres, pour saisir les données…) ?

- *Qui vous a aidé ?*
- *Comment avez-vous obtenu de l'aide ?*

- Technologie (utilisation technique : facilité d'utilisation, défauts techniques)

*Qu'est-ce qui a été facile et difficile dans l'utilisation du système ?

*Avez-vous rencontré des problèmes techniques ?

- Si oui, lesquels ?
- Avez-vous obtenu de l'aide ? De qui ?
- Quelle était la solution ? Comment l'ont-ils résolu ?

-Utilisation de la technologie (perception, confiance dans la technologie)

*Lorsqu'on vous a proposé de vous suivre à domicile à l'aide de la télésurveillance, quelles ont été vos premières pensées ?

- Avez-vous eu confiance dans cette proposition ; pourquoi ?
- Avez-vous eu des doutes ? Si oui, à quel sujet ?
- Quelle a été votre principale motivation / les raisons de votre accord ?

-Technologie et besoins des patients (y a-t-il une adéquation ?)

*Lorsque vous êtes rentré chez vous, quels besoins avez-vous éprouvés ?

- Comment la télésurveillance vous a-t-il aidée ?

*Quelles étaient vos attentes lorsque vous êtes rentré chez vous ?

- Comment ces attentes ont-elles évolué ?

*Le suivi vous a-t-il semblé suffisant ?

- Pourquoi ?
- Durée, fréquence ?

*Quel sentiment avez-vous eu lorsque le suivi s'est arrêté ?

- Comment la décision d'arrêter a-t-elle été prise ?

*Comment pourrions-nous améliorer la télésurveillance à votre avis ?

- Comment pouvons-nous mieux vous aider avec la télésurveillance ?

Perception et identité de la maladie (impact sur la vie quotidienne, autonomie, sentiment de contrôle)

*Comment s'est déroulée une journée type pour vous pendant le suivi ?

*Comment avez-vous ressenti le fait d'être suivi chaque jour ?

Événements (identification de la nécessité d'un suivi ou d'une hospitalisation)

* Y a-t-il eu des problèmes (de santé) pendant le suivi pour lesquels vous avez eu besoin d'aide ?

- Que s'est-il passé ?
- Comment avez-vous trouvé l'aide que vous avez reçue ?

* Avez-vous dû demander de l'aide pour un problème ?

- Que s'est-il passé ?

- Communication avec les prestataires de soins

* Pendant les jours où vous étiez suivi par télésurveillance, avez-vous eu des contacts avec des prestataires de soins ?

- Avec qui ? Connaissiez-vous déjà ces personnes ?
- Pour quelle raison ? Qu'ont fait ces soignants ?
- Comment s'est déroulé le contact ?
- Par téléphone, vidéo, etc.
- Qui pouvez-vous contacter en cas de problème médical ? En cas de problème technique ?
- Comment avez-vous vécu cette expérience ? Que pensez-vous de cette communication ?

*Avez-vous eu des contacts avec le médecin généraliste ? Et avec une infirmière à domicile ?

- Pour quelle raison ?
- De quelle manière le contact a-t-il été établi ? Par téléphone, vidéo, etc.
- Comment avez-vous vécu cela ?

- Avantages et inconvénients

*Quels ont été les avantages de la télésurveillance pour vous ?

- Qu'est-ce que vous considérez comme une valeur ajoutée ?

* Quels ont été les inconvénients de la télésurveillance pour vous ?

Satisfaction et sentiment de sécurité

* Le feriez-vous à nouveau si on vous le proposait à nouveau (par exemple, pour une autre maladie) ? Pourquoi pas?

- Vous êtes-vous senti en sécurité ? Pourquoi ?

Appendix 3.2. Interview guide for interviews with telemonitoring teams

Appendix 3.2.1. Dutch version

Introductie: Voor ons, maar ook voor de analyse van dit interview is het wel handig als jullie één voor één nog kort aan kunnen geven wie jullie zijn en wat jullie rol binnen het telemonitoringteam is.

En ik zou dit meteen willen combineren met de eerste vraag

Hoofdvraag 1: Hoe heeft ieder van jullie als teamlid het ervaren om patiënten met COVID thuis op te volgen door middel van telemonitoring?

- Hoe verdelen jullie de verantwoordelijkheid?

Hoofdvraag 2: Welke noden hebben jullie ervaren bij patiënten die jullie met telemonitoring hebben opgevolgd?

- Hoe komt telemonitoring, zoals uitgevoerd in jullie project, tegemoet aan deze noden?

- Wat is voor jullie het doel van telemonitoring?

- Welke patiënten proberen jullie te includeren?

- Hoe zou telemonitoring nog verbeterd kunnen worden?

Hoofdvraag 3: Wat was de impact van telemonitoring, zoals ervaren door jullie in het project?

- Op patiënten

- Op gezondheidszorguitkomsten

- Op de samenwerking 1e en 2de lijn

- Op jullie eigen werking

- Hoe zouden jullie de impact nog kunnen verbeteren?

Hoofdvraag 4: In hoeverre hebben jullie telemonitoring in de praktijk kunnen brengen (ofwel kunnen implementeren) zoals jullie dit voor ogen hadden?

Vraag goed introduceren, welke moeilijkheden, welke

- Welke factoren maakten de implementatie moeilijk?

- Welke factoren hebben de implementatie juist bevorderd?

- Alleen indien niet spontaan genoemd, vraag als interviewer dan naar

* kenmerken van telemonitoring

* factoren bij patiënten (digivaardigheid, ziekteernst)

* factoren bij zorgverleners (werkdruk, innovatiebereidheid, eerdere ervaring)

* factoren in de samenwerking van professionals (gedeeld patiëntendossier)

* noodzakelijke randvoorwaarden, materialen, middelen… (financiëring)

* factoren in het leiderschap/de samenwerking van de betrokken organisaties

* maatschappelijke factoren, inclusief het gezondheidszorgbeleid

<u>Afsluitende vraag</u>

Op basis van jullie ervaring, welke aanbevelingen kunnen jullie maken over het gebruik van telemonitoring, of de implementatie van telemonitoring, binnen de Belgische zorgcontext.

- Bij patiënten met Covid-19?

- Bij andere patiëntengroepen?

Alternatieve/aanvullende vragen (indien onvoldoende beantwoord aan de hand van vragen 1 t/m 4)
Wat zijn volgens jullie de succesfactoren van jullie project?

- Vraag naar een voorbeeld/casus die het succes kan aantonen, vb. waar er een heropname nodig was en deze al dan niet gedetecteerd werd

Welke problemen of moeilijkheden hebben jullie ervaren met de opvolging van patiënten?

- Wat was de oorzaak van het probleem?

- Hoe is het probleem opgelost?

- Hoe hebben jullie het project aangepast?

Hoe hebben jullie het gebruik van de technologie voor de opvolging ervaren?

- Hoe zijn jullie met defecten omgegaan?

- Wat waren de uitdagingen?

Appendix 3.2.2. French version

Introduction : Pour nous faciliter le travail, mais aussi pour l'analyse de cet entretien, il serait utile que vous présentiez brièvement, un par un : qui vous êtes et quel est votre rôle dans l'équipe de télésurveillance.

Et nous voulons combiner cette question avec la première question

Question principale 1 : Comment chacun d'entre vous, en tant que membre de l'équipe, a-t-il vécu le suivi des patients atteints de COVID à domicile par le biais de la télésurveillance ?

Question principale 2 : Quels besoins avez-vous rencontrés chez les patients que vous avez suivis par télésurveillance ?

- Comment la télésurveillance, telle que mise en œuvre dans votre projet, répond-elle à ces besoins ?

- Comment la télésurveillance pourrait-il être encore amélioré ?

Question principale 3 : Quel a été l'influence de la télésurveillance, tel que vous l'avez vécu dans le cadre du projet ?

- Sur les patients
- Sur les résultats des soins de santé
- Sur la collaboration de 1ère et 2ème ligne
- Sur votre travail
- Comment pourriez-vous améliorer encore cette expérience ?

Question principale 4 : Dans quelle mesure avez-vous pu mettre en pratique (ou appliquer) la télésurveillance comme vous l'aviez prévu ?

- Bien introduire la question, quelles difficultés -)
- Quels facteurs ont rendu la mise en œuvre difficile ?
- Quels sont les facteurs qui ont facilité la mise en œuvre ?

(Seulement si elle n'est pas mentionnée spontanément, lorsque l'enquêteur pose des questions à ce sujet.)

- Caractéristiques de la télésurveillance
- Facteurs relatifs aux patients (culture numérique, gravité de la maladie)
- Facteurs chez les prestataires de soins de santé (charge de travail, volonté d'innover, expérience antérieure)
- Facteurs de la coopération des professionnels (dossier patient partagé)
- Conditions préalables nécessaires, matériaux, ressources... (financement)
- Facteurs de leadership/de collaboration des organisations concernées

- Facteurs sociaux, y compris la politique en matière de soins de santé

Question finale

Sur la base de votre expérience, quelles recommandations pouvez-vous faire concernant l'utilisation de la télésurveillance, ou la mise en œuvre de la télésurveillance, dans le contexte des soins de santé en Belgique ?

- Chez les patients avec Covid-19 ?
- Dans d'autres groupes de patients ?

Questions alternatives/supplémentaires (en cas de réponse insuffisante sur la base des questions 1 à 4)

Quels sont, selon vous, les facteurs de réussite de votre projet ?

- Demander un exemple/un cas qui peut montrer le succès, par exemple lorsqu'une réadmission était nécessaire et a été détectée ou non.

Quels problèmes ou difficultés avez-vous rencontrés dans le suivi des patients ?

- Quelle était la cause du problème ?
- Comment le problème a-t-il été résolu ?
- Comment avez-vous adapté le projet ?
- Comment avez-vous vécu l'utilisation de la technologie de surveillance ?
- Comment avez-vous traité les défauts ?
- Quels ont été les défis ?

Appendix 3.3. Interview guide for interviews with general practitioners from NIHDI projects

Voorstelling: Voor we beginnen, stel ik voor dat u zich zich kort even voorstelt. Wie bent u, in welke regio werk je, met welk ziekenhuizen heeft u samengewerkt voor de opvolging van patiënten met Covid-19 door middel van telemonitoring, en hoeveel patiënten heeft u opgevolgd?

Inleidende vraag: Hoe was u betrokken bij de opvolging van patiënten met Covid-19 in de telemonitoring projecten?

- Wat was uw rol in de opvolging?

- Hoe was de samenwerking met andere hulpverleners (ziekenhuis, verpleegkundigen, anderen)?

- Is de betrokkenheid geëvolueerd over de tijd? Wat was de reden van de verandering?

Hoofdvraag 1: Hoe heeft u het ervaren om patiënten met Covid-19 thuis op te volgen in de telemonitoring projecten

- Wat waren de voordelen voor u als huisarts?

- Wat waren de nadelen voor u als huisarts?

Hoofdvraag 2: Welke noden heeft u ervaren bij deze patiënten?

- Hoe komt telemonitoring zoals uitgevoerd in de projecten, tegemoet aan deze noden?

- Wat is de rol van de huisarts?

- Hoe zou telemonitoring nog verbeterd kunnen worden?

Hoofdvraag 3: Wat was de impact van telemonitoring, zoals ervaren door u in deze projecten?

- Op patiënten

- Op gezondheidszorguitkomsten

- Op de samenwerking 1e en 2de lijn

- Op jullie eigen werking

- Hoe zouden de projecten de impact kunnen verbeteren?

Hoofdvraag 4: Wat zijn volgens u de succesfactoren van de telemonitoring projecten waarmee u in aanraking bent gekomen?

- Vraag naar een voorbeeld/casus die het succes kan aantonen, vb. waar er een heropname nodig was en deze al dan niet gedetecteerd werd

Hoofdvraag 5: Welke problemen of moeilijkheden heeft u ervaren met de opvolging van patiënten in de projecten?

- Wat was de oorzaak van het probleem?

- Hoe is het probleem opgelost?

- Heeft u veranderingen ervaren in de opvolging naar aanleiding van de problemen?

Hoofdvraag 6: Hoe heeft u de implementatie van de projecten ervaren?

- Hoe bent u betrokken geweest in de implementatie?

- Welke factoren maakten de implementatie moeilijk?

- Welke factoren hebben de implementatie juist bevorderd?

- Alleen indien niet spontaan genoemd, vraag als interviewer dan naar

* kenmerken van telemonitoring

* factoren bij patiënten (digivaardigheid, ziekteernst, eerdere ervaring))

* factoren bij zorgverleners (werkdruk, innovatiebereidheid)

* factoren in de samenwerking van professionals (gedeeld patiëntendossier)

* noodzakelijke randvoorwaarden, materialen, middelen… (financiëring)

* factoren in het leiderschap/de samenwerking van de betrokken organisaties

* maatschappelijke factoren, inclusief het gezondheidszorgbeleid

Afsluitende vraag: Op basis van uw ervaring, welke aanbevelingen kan u maken over het gebruik van telemonitoring, of de implementatie van telemonitoring, binnen de Belgische zorgcontext.

- Bij patiënten met Covid-19?

- Bij andere patiëntengroepen?

Appendix 3.4. Interview guide for interviews with general practitioners who implemented their own RPM project

Appendix 3.4.1. Dutch version

Voorstelling: Voor we beginnen, stel ik voor dat u zich kort even voorstelt. Wie ben je, in welke regio werk je, met welk ziekenhuizen heeft u samengewerkt voor de opvolging van patiënten met Covid-19 door middel van telemonitoring, en hoeveel patiënten heeft u opgevolgd?

Inleidende vraag: Hoe is de telemonitoring voor de patiënten verlopen?

Wat was uw rol als huisarts? Of, op welke manier bent u betrokken geweest in de opvolging?

Hoofdvraag 1: Hoe heeft u die opvolging ervaren?

Wat is de meerwaarde voor de patiënt?

Wat is de meerwaarde voor u als huisarts?

Welke problemen heeft u ervaren met de opvolging?

Wat heeft u belemmerd om patiënten met Covid-19 op te volgen?

Hoofdvraag 2: In welke mate bent u betrokken geweest in de uitwerking van het project?

Wat heeft u belemmerd om mee te werken aan de uitwerking van het project?

Hoe bent u op de hoogte gebracht van het project?

Afsluitende vraag: Hoe ziet u de rol van de HA bij telemonitoring in de toekomst?

Wat zijn de belangrijke voorwaarden zodat u als HA kan participeren met telemonitoring?

Appendix 3.4.2. French version

Introduction : Avant de commencer, je vous suggère de vous présenter brièvement. Qui êtes-vous, dans quelle région travaillez-vous, avec quels hôpitaux avez-vous travaillé pour le suivi des patients atteints de Covid-19 par le biais du télémonitoring, et combien de patients avez-vous suivis ?

Question introductive : Comment s'est déroulée la télésurveillance pour les patients ?

Quel était votre rôle en tant que médecin généraliste ? Ou, de quelle manière avez-vous été impliqué dans le suivi ?

Question principale 1 : Comment avez-vous vécu le suivi ?

Quelle est la valeur ajoutée pour le patient ?

Quelle est la valeur ajoutée pour vous en tant que médecin généraliste ?

Quels problèmes avez-vous rencontrés lors du suivi ?

Qu'est-ce qui vous a empêché de suivre les patients avec Covid-19 ?

- Quelles barrières ont-ils rencontrés ? Quels leviers ?
- Comment relèvent-ils des défis spécifiques (par exemple, la qualité des données, la gestion de la peur/de l'anxiété des patients) ?

Question principale 2 : Comment les groupes de télésurveillance, les médecins généralistes et les infirmières vivent-ils la télésurveillance par rapport à leur perception de la qualité des soins, des besoins des patients et des résultats attendus pour les patients et le système de santé ?

Cette question de recherche nous permettra de comprendre comment la télésurveillance a été mise en œuvre et fournie aux patients, et comment les praticiens de santé ont vécu ce processus. Nous explorerons plusieurs sous-questions qui éclairent la pratique clinique :

2.1 Quels sont les facteurs de réussite perçus (points forts) ?

2.2 Quels sont les difficultés et les problèmes rencontrés au cours de l'intervention, et quelles adaptations ont été apportées à l'intervention (faiblesses et opportunités mises en œuvre) ?

2.3 Quels sont les facilitateurs et les obstacles perçus associés à la mise en œuvre de la télésurveillance ? (Opportunités et menaces)

Appendix 3.5. Interview guide for interviews with general practitioners who participated in the Safelink project

Comment les médecins généralistes perçoivent-ils SafeLink ?

Résultats attendus de SafeLink

- La valeur ajoutée de TM (Safelink) pour le médecin ?
- Valeur ajoutée de TM (Safelink) pour le patient ?
- Valeur ajoutée de TM (Safelink) pour les autres prestataires de soins de santé ?
    - Au sein de la première ligne (les patients ont eu accès aux données et ont pu échanger des données peu après le début du projet) ?

- Entre la première ligne et l'hôpital ?

Barrières, leviers

- Quelles barrières ont-ils rencontrés ? Quels leviers ?
- Comment relèvent-ils des défis spécifiques (par exemple, la qualité des données, la gestion de la peur/de l'anxiété des patients) ?

Finale

- Points forts de TM (Safelink) ?

Recommandations éventuelles ?

- Pour qui ?

Appendix 3.6. Interview guide for interviews with ambulatory nurses

Appendix 3.6.1. Dutch version

Voorstelling: Voor we beginnen, stel ik voor dat iedereen zich kort even voorstelt. Wie ben je, in welke regio werk je, met welk ziekenhuizen heeft u samengewerkt voor de opvolging van patiënten met Covid-19 door middel van telemonitoring, en hoeveel patiënten heeft u opgevolgd?

Inleidende vraag: Hoe waren jullie betrokken bij de opvolging van patiënten met Covid-19 door middel van telemonitoring?

- Wat was jullie rol in de opvolging?

- Hoe was jullie samenwerking met andere hulpverleners (ziekenhuis, verpleegkundigen, anderen)?

- Is jullie betrokkenheid geëvolueerd over de tijd? Wat was de reden van de verandering?

Hoofdvraag 1: Welke noden hebben jullie ervaren bij deze patiënten?

- Hoe komt telemonitoring, zoals uitgevoerd in de projecten, tegemoet aan deze noden?

- Hoe zou telemonitoring nog verbeterd kunnen worden?

Hoofdvraag 2: Wat is voor jullie een goede opvolging op basis van telemonitoring bij deze patiënten?

- Wat is de rol van de thuisverpleegkundigen in deze opvolging?

Hoofdvraag 3: Hoe hebben jullie het gebruik van de telemonitoring technologie door patiënten ervaren?

- Hoe was de gebruiksvriendelijkheid voor patiënten?

- Welke hulp hebben jullie moeten bieden?

Hoofdvraag 4: Wat was de impact van telemonitoring, zoals ervaren door jullie in deze projecten?

- Op patiënten

- Op gezondheidszorguitkomsten

- Op de samenwerking 1e en 2de lijn

- Op jullie eigen werking

- Hoe zouden de projecten de impact kunnen verbeteren?

Hoofdvraag 5: Wat zijn volgens jullie de succesfactoren van de telemonitoring projecten waarmee jullie in aanraking zijn gekomen?

- Vraag naar een voorbeeld/casus die het succes kan aantonen, vb. waar er een heropname nodig was en deze al dan niet gedetecteerd werd

Hoofdvraag 6: Welke problemen of moeilijkheden hebben jullie ervaren met de opvolging van patiënten in de projecten?

- Wat was de oorzaak van het probleem?

- Hoe is het probleem opgelost?

- Hebben jullie veranderingen ervaren in de opvolging naar aanleiding van de problemen?

Hoofdvraag 7: Hoe hebben jullie de implementatie van de projecten ervaren?

- Hoe zijn jullie betrokken geweest in de implementatie?

- Welke factoren maakten de implementatie moeilijk?

- Welke factoren hebben de implementatie juist bevorderd?

- Alleen indien niet spontaan genoemd, vraag als interviewer dan naar

  * kenmerken van telemonitoring

  * factoren bij patiënten (digivaardigheid, ziekteernst)

  * factoren bij zorgverleners (werkdruk, innovatiebereidheid, eerdere ervaringen)

  * factoren in de samenwerking van professionals (gedeeld patiëntendossier)

  * noodzakelijke randvoorwaarden, materialen, middelen… (financiëring)

  * factoren in het leiderschap/de samenwerking van de betrokken organisaties

  * maatschappelijke factoren, inclusief het gezondheidszorgbeleid

Afsluitende vraag: Op basis van jullie ervaring, welke aanbevelingen kunnen jullie maken over het gebruik van telemonitoring, of de implementatie van telemonitoring, binnen de Belgische zorgcontext.

- Bij patiënten met Covid-19?

- Bij andere patiëntengroepen?

Appendix 3.6.2. French version

Introduction : Avant de commencer, je suggère que chacun se présente brièvement. Qui êtes-vous, dans quelle région travaillez-vous, avec quels hôpitaux avez-vous travaillé pour le suivi des patients atteints de Covid-19 par le biais de la télésurveillance, et combien de patients avez-vous suivis ?

Question introductive : Comment avez-vous été impliqué dans le suivi des patients atteints de Covid-19 par télésurveillance ?

- Quel a été votre rôle dans le suivi ?

- Comment s'est déroulée votre collaboration avec les autres soignants (hôpital, infirmières, autres) ?

- Votre engagement a-t-il évolué au fil du temps ? Quelle était la raison de ce changement ?

Question principale 1 : Quels besoins avez-vous rencontrés avec ces patients ?

- Comment la télésurveillance, telle que mise en œuvre dans le projet, répond-elle à ces besoins ?

- Comment améliorer la télésurveillance pour ce faire ?

Question principale 2 : Que considérez-vous comme un bon suivi de télésurveillance pour ces patients ?

- Quel est le rôle des infirmières à domicile dans ce suivi ?

Question principale 3 : Comment avez-vous vécu l'utilisation de la technologie de télésurveillance par les patients ?

- Quelle a été la convivialité pour les patients ?

- Quelle aide avez-vous pu apporter ?

Question principale 4 : Quel a été l'impact de la télésurveillance, tel que vous l'avez vécu dans ce projet ?

- Sur les patients

- Sur les résultats des soins de santé

- Sur la collaboration de 1ère et 2ème ligne

- Sur vos propres opérations

- Comment les projets pourraient-ils améliorer leur impact ?

Question principale 5 : Quels sont, selon vous, les facteurs de réussite du projet de télésurveillance?

- Demandez un exemple/un cas qui peut démontrer le succès, par exemple lorsqu'une réadmission était nécessaire et la télésurveillance a aidé à détecter le besoin ou non.

Question principale 6 : Quels problèmes ou difficultés avez-vous rencontrés dans le suivi des patients dans le cadre du projet ?

- Quelle était la cause du problème ?

- Comment le problème a-t-il été résolu ?

- Avez-vous constaté des changements dans le suivi à la suite des problèmes ?

Question principale 7 : Comment avez-vous vécu la mise en œuvre des projets ?

- Comment avez-vous été impliqué dans la mise en œuvre ?

- Quels sont les facteurs qui ont rendu la mise en œuvre difficile ?

- Quels sont les facteurs qui ont facilité la mise en œuvre ?

Seulement si elle n'est pas mentionnée spontanément, lorsque l'enquêteur pose des questions à ce sujet.

* Caractéristiques de la télésurveillance

* Facteurs relatifs aux patients (culture numérique, gravité de la maladie)

* facteurs chez les prestataires de soins de santé (charge de travail, volonté d'innover, expérience antérieure)

* Facteurs de la coopération des professionnels (dossier patient partagé)

* Conditions préalables nécessaires, matériaux, ressources... (financement)

* les facteurs de leadership/de collaboration des organisations concernées

* les facteurs sociaux, y compris la politique en matière de soins de santé

Question finale : Sur la base de votre expérience, quelles recommandations pouvez-vous formuler concernant l'utilisation de la télésurveillance, ou la mise en œuvre de la télésurveillance, dans le contexte des soins de santé en Belgique ?

- Chez les patients avec Covid-19 ?

- Dans d'autres groupes de patients ?

APPENDIX 4. APPENDICES TO CHAPTER 4

Appendix 4.1. SEARCH STRATEGIES

Appendix 4.1.1. Traditional databases

PUBMED SEARCH

("telemedicine"[MeSH Terms] OR telemedicine[Text Word] OR Telemonitor OR telemonitoring OR "remote monitor" OR “remote patient monitoring” OR “remote home monitoring” OR "hospital at home" OR "virtual visit" OR "virtual hospital" OR telehealth OR telemedicine OR smartphone OR wearable OR "mobile health" OR mhealth) AND ((Covid-19 OR Covid* OR corona OR Sars-Cov2) AND (home OR discharge OR post-hospital)) AND ("2020/03/01"[Date - Publication] : "3000"[Date - Publication]) AND ((English[Language]) OR (Dutch[Language]) OR (French[Language]) OR (German[Language]))

Hits on 160921: 1106

CINAHL

(MH telemedicine OR MH telehealth OR TI (telemedicine OR telehealth OR "hospital at home" OR Telemonitor OR telemonitoring OR "remote monitor" OR “remote patient monitoring” OR "virtual visit" OR "virtual hospital" OR smartphone OR wearable OR "mobile health" OR mhealth) OR AB (telemedicine OR telehealth OR "hospital at home" OR Telemonitor OR telemonitoring OR "remote monitor" OR “remote patient monitoring” OR "virtual visit" OR "virtual hospital" OR smartphone OR wearable OR "mobile health" OR mhealth)) AND (MW Covid-19 OR TI (Covid-19 OR Covid* OR corona OR Sars-Cov2) OR AB (Covid-19 OR Covid* OR corona OR Sars-Cov2)) AND (TI (home OR discharge OR post-hospital) OR AB (home OR discharge OR post-hospital))

And limited to 2020-2021

Hits on 160921: 439

EMBASE

(('telemedicine'/exp/mj OR telemonitor OR telemonitoring OR 'remote monitor' OR 'remote patient monitoring' OR 'hospital at home' OR 'virtual visit' OR 'virtual hospital' OR telehealth OR telemedicine OR smartphone OR wearable OR 'mobile health' OR mhealth) AND ('covid 19' OR covid* OR corona OR 'sars cov2') AND (home OR discharge OR 'post hospital')) AND (2020:py OR 2021:py) AND [embase]/lim NOT ([embase]/lim AND [medline]/lim) AND ([dutch]/lim OR [english]/lim OR [french]/lim OR [german]/lim)

Hits on 160921: 782

LISSA

https://www.lissa.fr/dc/#env=lissa

((Télémétrie.tl) OU (Télémétrie.mc) OU (telemonitor.tl) OU (telemonitor.mc) OU (télésuivi.tl) OU (télésuivi.mc) OU (distance.tl) OU (distance.mc)) ET ((COVID-19.tl) OU (COVID-19.mc) OU (corona.tl) OU (corona.mc) OU (SARS-CoV-2.tl) OU (SARS-CoV-2.mc))

(limited to 2020-2021)

Hits on 160921 : 105

COCHRANE LIBRARY

((telemedicine OR Telemonitor OR telemonitoring OR "remote monitor" OR “remote patient monitoring” OR "hospital at home" OR "virtual visit" OR "virtual hospital" OR telehealth OR smartphone OR wearable OR "mobile health" OR mhealth) AND (Covid-19 OR Covid* OR corona OR Sars-Cov2)):ti,ab,kw (Word variations have been searched)" with Cochrane Library publication date Between Mar 2020 and Dec 2021, in Cochrane Reviews, Cochrane Protocols, Clinical Answers, Editorials (Word variations have been searched)

https://www-cochranelibrary-com.gateway2.cdlh.be/advanced-search/search-manager?search=4616178

Hits on 160921: 88

Appendix 4.1.2. Special developed COVID-19 literature databases

https://www.ncbi.nlm.nih.gov/research/coronavirus/

(telemedicine[ti] OR Telemonitor[ti] OR telemonitoring[ti] OR "remote monitor" [ti] OR “remote patient monitoring” [ti] OR "hospital at home"[ti] OR "virtual visit"[ti] OR "virtual hospital"[ti] OR telehealth[ti] OR smartphone[ti] OR wearable[ti] OR "mobile health"[ti] OR mhealth[ti]) AND (2020[dp] OR 2021[dp])

Hits on 160921: 1910

Appendix 4.1.3. trial-registers

- https://clinicaltrials.gov/,

(telemonitor OR "remote patient monitoring" OR "hospital at home" OR "virtual ward") AND (covid-19 OR corona OR Sars-cov2)

hits on 101121: 7

https://clinicaltrials.gov/ct2/results?cond=covid-19+OR+corona+OR+Sars-cov2&term=telemonitor+OR+%22remote+patient+monitoring%22+OR+%22hospital+at+home%22+OR+%22virtual+ward%22&type=&rslt=&age_v=&gndr=&intr=&titles=&outc=&spons=&lead=&id=&cntry=&state=&city=&dist=&locn=&rsub=&strd_s=&strd_e=&prcd_s=&prcd_e=&sfpd_s=&sfpd_e=&rfpd_s=&rfpd_e=&lupd_s=&lupd_e=&sort=

- https://www.clinicaltrialsregister.eu/,

(covid-19 OR corona OR Sars-cov2) AND (remote OR telemonitor OR virtual OR "hospital at home")

Hits on 091121: 5

https://www.clinicaltrialsregister.eu/ctr-search/search?query=%28covid-19+OR+corona+OR+Sars-cov2%29+AND+%28remote+OR+telemonitor+OR+virtual+OR+%22hospital+at+home%22%29

- https://www.who.int/clinical-trials-registry-platform,

telemonitor OR "remote patient monitoring" OR "virtual ward" OR "hospital at home" (restricted to COVID-19)

hits on 091121: 6

- https://clinicaltrialsdatabase.be/en)

monitor AND covid

hits on 101121: 0

Appendix 4.1.4. worldwide web with Google

- daily searches with (telemonitoring AND COVID) and with (COVID AND “remote patient monitoring”) in past 24 hours in the period 01/02/21-16/09/21
- monthly searches with ((”virtual ward” OR “hospital at home”) AND Covid) in the past month in the period Feb 2021- Sep 2021
- monthly searches with (thuismonitoring AND Covid) in the past month in the period Feb 2021- Sep 2021

Appendix 4.2. Human resources

Below are descriptions of the kind and number of the staff used in the projects, as far they were described. We used literally quotes from the publications.

- Agarwal et al. and Laur et al.[38, 115, 205]: (not quantified) The team included a family physician, a family medicine resident, a registered nurse, a mental health or social worker, a nurse practitioner and a pharmacist. Specialists, including specialists in general internal medicine, respirology and psychiatry, were available for virtual consultations. Patients also had access to a 24-hour on-call service. All clinicians were recruited from Women's College Hospital and typically worked 1 day a week in the program. For initial staffing, a primary care, team-based approach was used, relying on redeployed physicians and staff from Women's College Hospital, primary care residents, and a multidisciplinary team (MDT) of providers. The MDT included nurses, a pharmacist, social workers, mental health workers, and other available specialists, who worked together to remotely address clinical needs as well as the social determinants of health of the patients.
- Akama-Garren et al.[222]: medical, nurse practitioner, and physician assistant students volunteers
- Al-Tawfic et al.[40]: (not quantified) The program was a physician-led service with a team including other physicians, case manager, registered nurses, and admin personnel.
- Annis et al.[41]: Residents and students on this rotation, with supervision from faculty, comprised the main workforce of the first responder team from 8 AM to 5 PM during the peak volume of patient responses. The 8 AM to 5 PM hours were typically covered by 3-4 medical students, 2-4 residents, and 1-2 dedicated supervising physicians who would either respond to patients with text comments or a phone call if an alert or comment was particularly concerning or complicated. Within the first few days, it was apparent that despite a notification to the patient to call the MHealth triage line for alerts or comments outside of 8 AM to 5 PM, patients were still routinely sending messages in the RPM application after-hours. In response to this, we expanded the workforce to include providers already doing 24/7 virtual care to respond to these urgent after-hours alerts from 5 PM to 8 AM. Additionally, as volumes rose in the first several weeks, the 8 AM to 5 PM workforce was expanded to include a nurse practitioner supervising 2 nurse practitioner students. Some of the main challenges we experienced were titrating the program to ensure adequate staffing to match the widely variable number of newly enrolled patients and number of messages at any given time.
- Anonymous [194] (not quantified): the specialist team of respiratory nurses
- Artandi et al.[216]: CROWN was staffed with providers drawn from Stanford Express Care, a same-day urgent care clinic. Each day, CROWN staffing included: 1 medical provider (physicians or advanced practice provider), 3 medical assistants, 1–2 nurses, and ancillary staff support (radiology, information technology [IT], and other services). All staff were volunteers (and in discussion they state this was an advantage in the way they really wanted to go for it and made it work)
- Atrium health [4]: Within AH-HaH, we created 2 virtual "floors" defined by the level of acuity. These floors are staffed with separate care teams that include physicians, advanced practice providers (APPs), registered nurses (RNs), pharmacists, social workers, and community paramedics. The "first floor," or virtual observation unit (VOU), is designed for low-acuity patients who can be managed remotely with daily telemedicine-supported symptom monitoring by RNs. The "second floor," or virtual acute care unit (VACU), is designed for patients who would otherwise have been admitted to a traditional brick-and-mortar hospital providing inpatient care, such as oxygen, medical treatments, daily virtual physician rounds, vital sign monitoring, twice-daily nursing assessments, and daily paramedic visits. Initially, AH-HaH utilized existing staff who were redeployed from their usual duties owing to the pandemic, but over time it has transitioned to reliance on newly created, dedicated roles. Staffing levels for the AH-HaH service depended on the daily patient census. In the VACU, there was a daily census of 20 to 30 patients, and we targeted staffing around 12 to 13 patients per virtual rounding physician, 1 quarterback physician dedicated to

evaluating patient eligibility and admissions, 1 covering nocturnist physician, 1 nocturnist RN, 2 or 3 daytime RNs, and 10 to 12 community paramedics. In addition, on Monday through Friday, 1 pharmacist, 1 social worker, 1 palliative care APP, and 1 behavioral health APP were available for virtual consultation. The VOU was staffed only by virtual RNs (day) and certified medical assistants (night); availability of a virtual primary care physician was scheduled each day and night to be available for questions from the care team.

- Bajracharva et al.[223]: medical students
- Bouabida et al.[217]: The staff is dedicated to the platform and consists of nurses, residents, and physicians accessible by phone and working 24/7
- Buck et al. [59]: (not quantified) RPM – HT programs to have plans in place by May 1 to add weekend hours. To help accommodate this change, VHA decided to train and make use of non-RPM – HT staff, such as those working in outpatient clinics that were closed at the time because of the pandemic. To accomplish this, the Telehealth services training center developed a new training for non-RPM – HT staff, which allowed for an abbreviated orientation and timely onboarding
- Casale et al.[61] (not quantified): In the midst of the crisis, a diverse team, including nurses and nurse practitioners, physician assistants, care managers, and volunteer medical and nursing students, was organized to monitor patient oxygen readings remotely and assess any worsening symptoms. Physician assistants and medical students conducted daily follow-up calls to enrolled patients for a 14-day period, monitoring COVID-19 symptoms, pulse, temperature, and oxygen saturation.
- Clarke et al.[1]: (not quantified) The development of the service was first discussed on 15th July 2020 and the service went live on 21st July 2020. Nursing staff furloughed due to medical risk issues and allied health staff from community programs were engaged to work in the service.
- Connolly et al.[185] : A team of 2-14 healthcare providers monitored results.
- Copeland et al. [70] (not quantified) : all data was reviewed by an APP (Advanced Practice Provider)
- COVIDOM[69, 78, 176, 200, 210]: The Covidom regional control center is open from 8 AM to 8 PM, 7 days a week, and consists of autonomous “remote monitoring cells”. Each cell is made up of 4 to 6 trained remote monitoring responders (RMRs) and a supervising physician, all physically colocated at the Covidom regional control center. The control center cell physicians and RMRs are volunteers from different backgrounds. Physicians are rarely infectious disease specialists, GPs, or emergency physicians since those individuals are on the frontline caring for patients in need of acute care. Covidom personnel are mostly other specialists with decreased activity because of the lockdown who wanted to contribute to crisis management. They do not receive any financial incentives, but nonfinancial incentives are offered, such as meals or transportation solutions if public transport is not available.
- Au pic de l’épidémie, jusqu’à 10.000 alertes/jour ont été prises en charge par 40 « cellules » de télésurveillance, soit 200 postes de travail 7j/7 de 8 h à 20 h. La capacité de suivi était d’environ 1.200 patients par cellule. Sur le plateau 1.100 intervenants de télésurveillance (ITS) ont été formés : externes médecine/dentaires, professionnels de santé (kiné, pharmaciens, IDE, dentistes, cadres de santé), plus de 990 médecins référents (salariés AP-HP, libéraux, retraités) et enfin plus de 500 bénévoles, ces derniers étaient chargé s de rappeler les patients « non répondants ».
- The Covidom system was sustainable during the lockdown due to the personnel availability that resulted from nonurgent elective procedures or appointments being rescheduled; most of the workforce comprised salaried employees (as opposed to a pay-per-service system). We observed significant fluctuations in the availability of human resources. At first, and due to the lockdown, many volunteers offered their help. Since lockdown measures were lifted (May 11, 2020) and as control center cell physicians and RMRs progressively resumed their usual activities, finding enough personnel has become more of a challenge.

- Daly et al.[75] (not quantified): A team of physicians, advanced practice providers, and oncology registered nurses, called the COVID-19 Cohort Management Team (CCMT), provided monitoring and symptom management for enrolled patients. The CCMT actively monitored patient responses to the ePROs and the pulse oximeter readings from 7 AM to 7 PM 7 days per week. After-hours, an overnight support line was staffed by acute care clinicians to respond to patient concerns
- Driver et al.[80]: By week four after launch, the Primary Care Service had identified staff who could be temporarily re-assigned to replicate the C-TraC model. The RNs had both acute care and telehealth experience. Based on estimates that patient volume might triple, the Primary Care COVID-19 Outpatient Intensive Management Team (OIMT) consisted of two full-time RNs and two supervising physicians.
- Emory Clinic[139, 140]: The VOMC comprised an intake team of 14 physicians and 3 APPs from two primary care clinics; and follow-up call teams included 19 redeployed RNs and 20 APPs.
- Ferrua et al.[82]: The CSE consists of nine NNs and one assistant nurse in contact with patients and primary care providers via a telephone platform. All NNs had French nursing grade, relevant skills in oncology, and knowledge of homecare services and healthcare system, with a dedicated post-graduation diploma. Patients were allowed to contact the NNs every day from 8:30 AM to 6:00 PM. The CAPRI-COVID intervention involved an average of two full-time NNs, 7 days a week,
- Gios et al.[91]: Therefore, within the COVID-19 Special Unit, a selected group of health care professionals were put in charge of monitoring patients at the provincial level, namely, 2 medical doctors and 2 nurse coordinators were in charge of managing and coordinating the monitoring activities and 13 nurses, 2 medical doctors (specialists), and 1 medical doctor from the Special Continuity Care Unit (so-called Unità Speciali di Continuità Assistenziale [USCA]) were in charge of performing the actual monitoring of COVID-19–positive cases. A total of nearly 80 health care professionals were also involved in the monitoring phase at the community level.
- Gootenberg et al.[92] (not quantified): The follow-up calls were scripted and were not intended to provide any medical evaluation or advice (online supplemental text B). This allowed for flexibility with regard to the personnel used as volunteer callers. These callers were mostly medical students who were being pulled out of clinical rotations during the height of the pandemic. A telemedicine service staffed by ED physicians was also available at no charge during this time as part of our health system safety net
- Gordon et al. [93](not quantified) The pooled EHR inbox was staffed by a team of triage nurses 8 A.M. to 8 P.M. in a centralized call-center established specifically for calls related to COVID-19. The nurses would then contact the patient, perform a clinical assessment, and then determine an appropriate plan, for example, refer to the ED, contact the primary care physician, offer empiric treatment, or simply continue monitoring. Given the potential severity of COVID-19 and that our program was started during the early stages of the pandemic, we did not opt for automatic monitoring. The program was staffed with 24/7 physician backup, and patients were instructed how to reach the on-call physician in the evening hours of 8 P.M. to 8 A.M. when there was no nursing coverage available
- Graca et al. [94]: From May to July 2020, 73 professionals coursing the first or second year of medical or nursing residency from Hospital Sírio-Libanês were invited voluntarily and agreed to participate in the programme. Consultations by telephone were made from a unique physical setting, located in the administrative building of Hospital Sírio-Libanês, from Monday to Friday, from 07:30 to 20:00 and on Saturdays, from 08:00 to 18:00.
- Heller et al.[97] (not quantified): Patients received twice daily in-person visits from nurses and daily telehealth visits from nurse practitioners or physicians.
- Horton et al.[234]: The COVID-19 clinic staff is comprised of a dedicated nurse, administrative assistant, and four infectious diseases (ID) physicians who aim to see patients within 24 hours of referral via virtual clinics 5 days a week.

- Hutchings et al. [101]: The stand-alone monitoring center commenced operations with 4 full-time–equivalent registered nurses and gradually increased to 9.5 full-time–equivalent at the end of the period, which equated to a ratio of approximately 25 patients per registered nurse per shift. A ratio of approximately 1 nurse per 25 patients per shift was required to support a model of care with high extensive of videoconferencing and continuous monitoring of patient observations with 24/7 operations; however, this could be reduced during low-activity periods such as during nighttime when patient contact was not scheduled.
- Jankovic et al.[235](Cancer patients) Deux Médecins référents soutiennent le suivi téléphonique effectué par les infirmiers et infirmières lors de cas complexes.
- Kaiser permanente [135](not quantified): A centralized clinical pool of nurses and Permanente physicians at the Virtual Medical Center were engaged to provide coverage for all participating sites after hours, 7 days a week Local areas mobilized an interdisciplinary team for the Home Monitoring program with the following clearly defined roles:
- Program manager: coordination between local and regional teams; stakeholder engagement
- Enrollers: patient registration and education
- Patient advocates: patient adherence, including reminding
- patients to enter their vital signs into the system and helping with patient education
- Clinical support team (nurses and physicians): receive and follow up on patient alerts; coverage 7 days a week
- Deactivators: patient deactivation from program
- Kesavadev et al.[188]: WhatsApp group comprised of the HCP team (5 doctors, 5 nurses, a dietitian, a diabetes educator and a psychologist). For each patient, there was a primary physician and a nurse in charge from the day of admission to discharge. The duty was rotated among different physicians, nurses and other healthcare professionals
- Kodama et al. [110]: A nurse was assigned to monitor each patient with a ratio of 1 nurse to 50 patients. Our program used registered nurses (RNs) and later expanded to the use of nurse practitioner (NP) students with a supervising NP.
- Krenitsky et al.[180] : The providers assigned to the virtual clinic were either faculty or trainees with direct oversight. Patient volume dictated the allocation of providers to the virtual clinic, with a maximum of three providers per day required during the peak of the pandemic
- Kricke et al.[111]: We developed a monitoring program that delivers a daily electronic symptom and coping questionnaire, uses text message reminders, and relies on telephone-based care. Within 10 days, we organized 193 nurses, 70 advanced practice professionals, 152 medical students, and 115 physician attendings to care for about 1000 patients per day using an electronic health record registry. As of May 21, 6,853 individuals had been through the monitoring program. Initially, educational faculty put us in touch with about 60 fourth-year medical students whose clerkships were on hold and who were eager to contribute. Other fourth-year students finishing clerkships and third year students subsequently joined the program. To supervise the medical students, we recruited primary care physicians, specialists, and other physicians who were quarantining after Covid-19 exposure, could not do face-to-face work based on personal risk, or were recently retired. The program operates from 8 a.m. to 8 p.m. seven days a week. An average of 90 different nurses, APPs, and medical students work four-, eight-, or 12-hour shifts for an average of roughly 500 staffed person-hours per day. Three attending physicians, working four-hour shifts, provide clinical supervision, for a total of nine attendings per day. Each team member receives training before their first shift, which includes orienting to the program and its goals, setting up EHR tools, and modeling the telephone call workflow. Nurses and APPs, whose usual clinic sites are closed or have reduced staffing because of the pandemic, are paid their usual hourly rate. We quickly expanded the

program from 5 medical students per shift to about 50 nurses, APPs, and medical students per shift. Nurses, who are used to operating under protocols, become very efficient once they understand the program guidelines. However, they often seek reassurance that they are applying rules properly. Medical students tend to seek support and reassurance for clinical decision-making.

- Lam et al.[114] : One infectious diseases physician is assigned to the COVIDEO program each week; the program is maintained through a rotating weekly schedule among 5 infectious diseases physicians. In the intervening period, patients are also contacted by telephone by their Toronto Public Health case worker, who notifies the infectious diseases physician if there are any concerns
- Lam et al.[240] : medical students
- Lee et al.[241]: The first operating HMS team was formed in August of 2020, and it was comprised of 12 medical staff members, including 3 public health doctors and 9 nurses. The second operating HMS team was developed in December of 2020, and it consisted of 15 staff members, including 3 Korean medicine doctors (KMD), 11 nurses, and 1 general manager
- Lejeune et al.[242] : incluant infectiologues, médecins généralistes, hygiénistes, psychologues, psychiatres et gynécologues-obstétriciens volontaires.
- Louie et al. [117]: A COVID-19 community telemonitoring team (CTAC) was formed consisting of one full-time equivalent (FTE) respiratory specialists and two FTE registered nurses.
- Lwin et al.[118] (not quantified): The HITH COVID team, led by our respiratory physician, functions with a HITH registrar and HITH Clinical Nurse Consultant within office hours and an on-take medical officer rostered for after hours
- Mayo clinic[104]: (not quantified): Our CVC team consisted of two arms—the patient screening arm primarily covered by resident physicians and the COVID- 19–positive patients arm primarily staffed by attending physicians and an advanced practice provider (APP). Both arms received support from nurses, schedulers, and an administrative assistant.
- Mayo Clinics[184]: two models; 1:50 (nurse to patient ratio) in low intensity monitor model and 1:30 (nurse to patient ratio) in high intensity model;
- Medina et al.[126] (not quantified):A pool of nurses and clinicians monitor the EMR registry and flag symptoms that are worsening.
- Micaleff et al. (not quantified): Additionally, as seen at our own hospital, staff forced into isolation due to exposure to people with COVID-19 are able to continue to provide valuable telehealthcare from home quarantine.
- Misra[129] (not quantified) The home monitoring telephone calls were provided by a variety of CCHS patient-facing clinical staff (for example, nurses, medical assistants, clinical technicians) who were trained by registered nurse team leads and personnel from the CCHS Nursing Education department
- Morgan et al.[130]: The team comprised members from the Center for Health Care Innovation and the three programs listed above, and eventually included its own medical director, a nursing director, the clinical nurses (approximately seven FTE at peak), and several medical students. The follow-up call component was staffed by physicians and nurses whose normal clinical activities were displaced by the pandemic. As clinical staff return to their usual roles, we have faced the question of how to support continued operations.
- Motta et al. [132] (not quantified): Physiotherapists supervised by pulmonologists managed the dashboard.
- Nogues et al.[136]: Our center has overseen a Hospital-at-Home program since 2000. It can currently attend 30 patients and has a staff composed of 7 nurses, 3 doctors, 1 clerical worker, and 1 social worker. It has maintained a positive relationship with primary care services. Therefore, to take advantage of their experience and logistical resources, we quickly built a new section called the COVID-HaH. Recently retired senior physicians and all other physicians who were either

immunosuppressed or undergoing immunosuppressive therapy and presented with an increased risk of infection were asked to volunteer. Participating physicians then worked remotely from home with access to the hospital's electronic health records. A total of 24 physicians comprised the COVID-HaH staff. Specialties of these physicians were as follows: internal medicine, anesthesia, gastroenterology, emergency care, pediatrics, rheumatology, epidemiology and pharmacy. Last, when reflecting on our COVID-HaH experience, the participation of retired senior physicians and other experienced physicians was important. At that time, little was known about COVID-19; however, physicians' skillsets were adequate enough to learn quickly from the abundant literature published during those days and identify alarm signals in patients via telemedicine tools.

- Nunan et al.[137]: Physician Associate students rang each patient in the virtual ward on a daily basis and went through a scripted set of questions. The PA students were supported by three ED Associate Specialist doctors who had been furloughed. Pay: 57 k UK pounds; cost include clerical support, PA and medical student salaries; notably much of the resourcing for this project has been accomplished within the existing resource envelope by redeploying substantive ED associate specialists; the costs of employing the senior clinicians would be approx 60 K UK pounds over 6 months. Project lead and project manager costs are excluded and again within the existing resource envelope. NON PAY: 35K uk pouns for 500 finger-tip pulse oximeters. TOTAL COSTS for a 6month period: 92876 UK pounds
- Owens[141]: (not quantified): Since we do not have an established monitoring center, we leverage demployed staff across our system to check the patient portal around the clock.This involves physician assistants, nurse practitioners, nurses, medical assistants, and case managers supported by physicians and specialists.
- Pritchett et al.[145] : (not quantified)The Mayo Clinic COVID-19 RPM program was designed and implemented by an interdisciplinary team composed of RPM clinical nurse specialists, physicians, patient education specialists, and COVID-19 physician experts from the Divisions of General Internal Medicine, Infectious Disease, and Pulmonary or Critical Care Medicine. Details related to this RPM program, including clinical workflow design and escalation parameters, have been described elsewhere (Coffey et al, under review)].
- Schultz et al. [150](not quantified): The virtual ward staffing profile varied by demand and included Administrative Officers, Allied Health staff (Pharmacy and Social Work), Nursing staff and Medical Officers.
- Shah et al. [155]: During this period, 7 clinicians monitored the 56 cohort patients. In terms of health economics, we observed a reduction of 3.30 FTE (ie, the number of clinicians reviewing these 56 patients). Each clinician spent an average of 10.9 minutes a day reviewing data of patients in cohort 2, resulting in a total time of 38.68 hours spent on the clinician dashboard. The FTE adjusted for time spent reviewing data was 1.1 per 100 patients; that is, for every 100 patients monitored in cohort 2, 1 less clinical personnel was needed compared to cohort 1.
- Shapiro et al.[157]: (not quantified) This comprehensive, nationwide coordinated outpatient care program called 'Maccabi COVID-19 Care' is staffed by a multidisciplinary team that includes physicians, most of them primary care physicians, nurses, social workers and other health care professionals
- Shaw et al.[158]: Starting March 1, the VHCP census rose from an average daily census of 40 active patients and peaked at 1,470 patients in early May, dropping off to *300 patients during the summer months before rising again in early October. This necessitated a proportional increase in provider staffing, from 4 physicians (known as the ''core'' physicians), 1 nurse, and 1 program manager to >292 physicians, 70 nurses, 17 nurse practitioners, and 4 physicians assistants. This resulted in a daily average of 29 patients per physician
- Swift et al.[195]: These contacts were conducted by band 7 specialist respiratory nurses or physiotherapists.
- Tabacof et al.[164, 165](not quantified) : The PRP was staffed by a group of clinicians (physicians, physical therapists) and clinical coordinators (physician's assistants, clinical coordinators, and clinical research

coordinators) and involved the daily reporting of symptoms and vital signs by patients on their own smart device using the MyCap application

- TELEA [62, 122, 147]: (not quantified) teams of professionals were created for the TELEA COVID-19 monitoring program that included medical personnel from the internal medicine and nursing departments.
- University of Pennsylvania Health System[130, 221, 271]: The clinical team eventually included its own medical director, a nursing director, nurses (the equivalent of approximately 7 full-time staff members), and several medical students (3). Using this model, 2 to 4 staff members oversaw more than 1000 patients.
- Van Herwerden et al.[168] : Omdat er destijds beperkte ervaring was met het ziektebeeld covid-19 en met telebegeleiding van deze patiënten, bleef het hoofdbehandelaarschap na ontslag onder verantwoordelijkheid van de longarts. Er was 7 dagen per week een longverpleegkundige (binnen kantooruren) of longarts (in weekend en avonduren) beschikbaar die de inclusie, monitoring en begeleiding verzorgde. Tijdens de nachturen was er een telefoonnummer beschikbaar voor begeleiding bij calamiteiten, maar werden geen patiënten geïncludeerd.
- Vinton et al.[193] (not quantified): At home patients were remotely managed by trained Advanced Practitioner Providers who addressed vital sign changes and escalated care needs when appropriate.
- Walsh et al.[258]: Data was reviewed by a respiratory physiotherapist
- Wariri et al. [170]: we constituted a multidisciplinary team made up of a cross-section of clinical staff (14 physicians and 10 nurses who are duly registered as practitioners in The Gambia), four project management and administrative staff, and a dedicated ambulance driver. At the beginning of the pandemic, physicians who found themselves away from The Gambia and unable to return due to travel restrictions at the time were drafted into the team if they wished to support the VW system. We have also been able to leverage the services of other physicians among our staff who are unable to provide face-to-face clinical services or continue with research activities because they have been assessed to be at risk for severe COVID-19 as a result of their background medical condition that warrants their shielding.
- Wurzer et al.[173] : The data is monitored 24/7 by a trained team. Each staff member can monitor up to 20 patients at a time. A team of physicians supports the Telecovid team and consults with them once a day and checks the data.
- Xu et al. [174]: The multidisciplinary team consisted of multidisciplinary medical workers, including 2 physicians, 3 nurses, 1 rehabilitation physician, and 1 psychologist. From the resource management perspective, the telemedicine system enabled management of 188 individuals initially and 74 patients later by a team consisting of only 7 medical workers

Appendix 4.3. Claims on savings

Below studies are listed in which authors make a claim on savings by RPM, and commented by us in the right column.

Study	Type of patients	*Claim*	Remarks
Al-Tawfic et al.[40]	prehosp	*At the institutional level this RPM-service helped decreasing the load on the hospital and Zone-2 facility, and avoided the necessity for the opening of a second Zone-2 facility and the opening of a dedicated medical floor in the current Zone-2 quarantine facility.*	Before RPM started, it was mandated by law that **all** (even asymptomatic low risk) patients with COVID-19 infection should be admitted to the hospital or a designated hotel (zone2). In this sense RPM helped decreasing the hospital load.
Annis et al.[41]	prehosp	*Anecdotally, patients reported avoiding an ED or urgent care visit because of the availability of a provider, but additional analysis will be necessary to establish if this RPM system significantly reduces unnecessary utilization of care.*	Patients' opinion; N of patients reporting this is missing.
Boniface et al.[55]	prehosp	*The 80th percentile length of stay for the intervention group was 9 days, 10 days shorter than the 21 days for the control group. The mean length of stay was 6.9 days (95% CI 5.6 - 8.1 days) in the intervention group, and 13.2 days (95% CI 12.2 – 14.1 days) in the control group.* *CO@h has demonstrated considerably improved patient outcomes reducing the odds of longer length hospital stays and mortality.*	A comparison is made between a group of patients that were not sick enough to be admitted immediately (but escalated later) and a group of patients that were that sick they required immediate hospitalization. So baseline characteristics of both groups are that different that a comparison has no solid ground.
Borgen et al.[57]	Pre- & posthosp	*Assuming that the total patient bed days saved related to implementation of this intervention was the difference in total length of stay between the comparison group and the ITCM ED and observation unit groups, the calculated savings is 481.6 patient days for the 78 participants who were enrolled in the intervention and discharged directly from the ED or from observation units. Subsequent readmissions for the intervention group, while very uncommon with 3.5% (n = 4) admitted during the intervention at an average of 8.25 days (range 4 to 11 days post inclusion in the intervention), were not significantly different than the 4.4% (n = 26) readmissions for the comparison group.*	Pre- and posthosp are taken together in the intervention group, while the control-group consist of only posthosp patients. Moreover, they combine ED-visits with admission to observation unit. When doing the comparison for only posthosp patients and taken the reported numbers separately, there was 14.9% ED-visits in the RPM group vs 4.7% in the control group, and 3.5% hospital readmission in the RPM group vs 4.4% in the control group. It is not clear how those 481.6 saved patient days were calculated

		Overall, the data suggest that this intervention resulted in increasing bed capacity by reducing the number of patients with COVID-19 remaining in the ED, observation, and inpatient units.	
Brennan[224]	posthosp	*Patients assigned to these top three DRGs who were enrolled in tRPM had a 24.6% reduction in 30-day readmissions and a 12.9% reduction in hospital length of stay when compared to patients assigned to these DRGs with similar LACE scores.*	No method, no underlying data presented
Byteflies[60]	posthosp	*Preliminary data indicates patients were discharged from the hospital on average one day earlier with CC@H. [...]From the data collected in the first phase, we estimate that patients are discharged from the hospital at least one day earlier with CC@H. A hospital day for a COVID-19 patient in Belgium costs around €800 (nonintensive care and excluding any procedures). A telemonitoring week with CC@H is roughly four times less.*	No method presented how the length of stay and costs were calculated
Dinh[214]	posthosp	*Oxygen therapy of 4L/min or less was required for a median [IQR] of 20 [16–31] days. Altogether, the 1,337 days of oxygen therapy at home allowed to save about 70 hospital beds for 20 days.*	Same logic as applied in LUSCII And to quote the authors themselves: '*Nevertheless, we present only a small cohort with preliminary results with no control group*'
Dirikgil et al.[79]	prehosp	*Home-monitoring reduced short stay admissions in suspected COVID-19 patients: COVID-box project.* *We calculated that the bed occupancy was 20 days per 100 patients discharged with home-monitoring compared to 47 days per 100 patients discharged without home-monitoring, equal to a 58% reduction*	Allocation to RPM or control was based on physicians' clinical judgement for patients with moderate symptoms or underlying comorbidities posing patients at risk for worse prognosis, but with a propensity-score matching analysis. Unclear how the hospital length of stay was calculated in RPM and control group; no underlying data given. Further small scale study (55 patients in RPM and 110 in control)
Gaeta et al.[88]	prehosp	*The telehealth program cumulative costs of were $621,800, including charges attributed to their actual admissions, were substantially less than the projected cumulative mitigated hospitalization charges of $6,718,296 (IQR: $4,767,344; $9,902,496).*	Unclear how the costs calculation has been done

Gordon [93]	posthosp	*Our work suggests that RPM reduces readmissions for patients with COVID-19 and provides scalable remote monitoring capabilities upon hospital discharge. RPM for postdischarge patients with COVID-19 was associated with a decreased risk of readmission to the ED or hospital, and provided a scalable mechanism to monitor patients in their home environment.*	
Heller et al.[97]	prehosp	*The mean length of stay (excluding the hospital) was 3.1 days, representing 75 potentially averted hospital days overall*	They calculated the number of RPM patients (n=24) multiplied by the mean length of RPM (3.1 day) and assumed that these are potentially averted hospital days. This is only true in case when all COVID-19 patients would need hospital admission.
John et al.[186]	prehosp	*In a review of the first 20 patients of ours who met the criteria for in-patient admission at other area hospitals, nine avoided hospitalization completely and one was managed at home for three days before admission. Based on the average length of stay for Covid-19 patients at Cambridge Health Alliance who do not require admission to the intensive care unit, we conservatively estimate that 39 hospital days were saved for these20 patients.*	No method presented
Kesavadev[188]	prehosp	*A hospitalization for 10-14 days is 20 times as expensive as VCIP management for the same period*	No method presented
Khalid[213]	prehosp	*The Family Medicine-led TMS saved 77% inpatient admissions and on average 4.4 hospital days and $3400 per patient (P < . 0001).*	
Kilaru_2021[272]	posthosp	*We estimate that patients in the CACP comparison group had 2.2 fewer hospital days (95% CI, 1.1-3.3; P = .001).*	Matched control study; however also in control group telemon was applied, so this comparison makes no sense We need to be careful since this study is not comparison between TM vs non-telemon, but CACP (short admission) vs non-CACP
Llorens et al.[3]		*The ED/HH model provided potential savings per mild COVID-19 pneumonia patient, not requiring hospital admission (102 patients). Savings could reach 338.53 $/day (internal medicine admission cost 439.85 $/day versus HH cost 101.32 $/day). Direct cost per day was*	The avoided hospital days are based on the assumption that all COVID-19 patients would have been hospitalized in case of

		reduced 77% through HH, due to the costs of home care entails 23% of the expenses generated by a conventional hospital stay. The total number of stay days in HH avoiding hospital admission was 789. *the Alicante ED/HH model provided a potential to reduce direct costs due to admission by more than 75%*	no RPM. This is certainly not the case with the low risk patients that they included in the RPM group. Furthermore, it is unclear to what extent medication costs are included in the hospital and home care costs (99% of the RPM patients received hydroxychloroquine plus antibiotics.
LUSCII-Grutters et al.[95, 266]	posthosp	*Grutters_2021: Mean±SD reduction in length of hospitalisation was 5.1±3.4 days, and for patients with oxygen therapy 6.4±3.2 days* *Grutters_2020: Estimated total reduction in length of hospitalization was 134 days with an average of 5.0 (63.8) days per patient. For patients with oxygen therapy the estimated reduction was 6.5 (63.4) days, without oxygen therapy 1.3 (60.4) days. [...]In our institution, home telemonitoring is cost effective. The costs for the application and staff are approximately 4-fold lower than the estimated costs of the saved admission days.*	The assumption that they make for this claim is that all patients who receive oxygen posthosp should normally be in hospital in case of absence of RPM; in our opinion this a false claim since oxygen is no hard indication for hospitalization (also not in the Netherlands). Furthermore, for the patients not receiving oxygen, the shortening of hospital length of stay was based on a subjective estimation of an MD.
LUSCII-Mentink et al.[127]	Posthosp	*Het verblijf van een patiënt in het ziekenhuis wordt met zo'n vier tot vijf dagen ingekort.*	They refer to the study of Grutters et al.[95]
LUSCII-van Herwerden et al.[168]	posthosp	*De mediane duur van zuurstoftoediening thuis was 11 dagen en in totaal werd gedurende 616 dagen zuurstof toegediend (zie tabel 2). Daarmee werd de totale potentiële ligduurbesparing berekend op 616 dagen. In tabel 5 staat een weergave van de kostenbatenanalyse. De uitkomst hiervan is dat de thuisbehandeling van dit cohort resulteerde in een totale kostenbesparing van € 146.746, waarbij de zorgverzekeraar € 184.800 bespaarde en het ziekenhuis gedurende de studieperiode € 38.064 aan niet vergoede kosten maakte. Door invoering van het zorgpad werden in een periode van 5 maanden 49 patiënten vervroegd ontslagen na een mediane opnameduur van 40 uur, wat in totaal 616 potentiële ligdagen in het ziekenhuis bespaarde*	The assumption that they make for this claim is that all patient that receive oxygen posthosp should normally be in hospital in case of absence of RPM; in our opinion this a false claim since oxygen is no hard indication for hospitalization (also not in the Netherlands).
LUSCII-Vie Curi[48]	Posthosp	*De winst is duidelijk: ze kunnen enkele dagen eerder naar huis en herstellen vaak beter in hun eigen omgeving. Tegelijk komt er ook eerder een bed vrij in het ziekenhuis voor nieuwe patiënten*	No method presented

Mederi [152]	posthosp	*Op basis van de huidige gegevens kunnen gehospitaliseerde patiënten gemiddeld 2,5 dagen vroeger dan gepland naar huis dankzij deze thuismonitoring*	No method presented
Misra et al.[129]	Pre- & posthosp	*The COVID-19 HMP was associated with lower odds of hospitalization, particularly for the posthospital or ED subgroup, with no significant association with ED utilization up to 90 days after diagnosis and with higher odds of subsequent outpatient utilization.*	See appendix economic analysis
Nunan et al.[137]	Pre- & posthosp	*A cost avoidance analysis was done. Predicated on saving of bed days, the initial setting up costs of the saturation probes and ongoing staffing wages, a monthly cost avoidance spread over 6 months would be £'640,000 or £'106,700 per month.* *It is safe, feasible and cost effective to set up a triage system with remote oximetry monitoring for patients with COVID-19 and overwhelmingly patients find it a positive experience*	The calculation is based on the assumption that each day of RPM replaces an in-hospital day (that cost 200 pound per day, and with a mean length of RPM of 4 days, comes this 800 pound per RPM patient savings). This may hold true however if RPM is only given to high risk patients, as is the case in this study. Further the calculation is based on 30 patients in RPM per week, what is not sure.
Owens et al.[141]	prehosp	*In the first month of operation, 33 patients enrolled, saving more than 300 hospital stays*	No method presented. The claim is based on the assumption that in case of non-existence of RPM, every patient would have been hospitalized. Moreover it is unclear how 33 patients can save 300 hospital stays
Padula et al.[212]	Prehosp & posthosp	*At-home monitoring presented a cost-savings of approximately $11472 per patient, at a gain of 0.013 QALYs per patient on average. The incremental NMB per patient at a cost effectiveness threshold of $100 000 per QALY was $12 809*	See appendix economic analysis
Pritchett et al.[145]	prehosp	*Even within the constraints of this focused analysis, a significant reduction in hospital admission rate directly attributable to RPM enrollment was observed in patients who were initially monitored in the outpatient setting. Although ED visits occurred at a relatively comparable rate among patients, fewer of those enrolled in RPM were subsequently admitted. Importantly, when hospitalized, the RPM patients experienced a shorter duration of stay and fewer prolonged*	This claim seems to be fair; analysis was done using a propensity weight comparison. However, it remains a small scale study (71 RPM vs 116 control) and is about a special population of patients with cancer and covid. As the authors themselves state, further research is needed to confirm the findings.

		hospitalizations, ICU admissions, and deaths, although further research is needed to confirm these trends.	
Shah-Sachin et al.[155]	posthosp	*The total time spent on phone calls for all 56 patients in cohort 2 (patients monitored via mobile app and telephone) was 31.73 hours. Based on the mean phone call time, the total time spent on phone calls for 56 patients in the cohort 1 (patients monitored by telephone only) model would be 79.33 hours. This equates to a 60% (47.60 hours) reduction from cohort 1 to cohort 2. During this period, 7 clinicians monitored the 56 cohort patients. In terms of health economics, we observed a reduction of 3.30 FTE (ie, the number of clinicians reviewing these 56 patients). Each clinician spent an average of 10.9 minutes a day reviewing data of patients in cohort 2, resulting in a total time of 38.68 hours spent on the clinician dashboard. The FTE adjusted for time spent reviewing data was 1.1 per 100 patients; that is, for every 100 patients monitored in cohort 2, 1 less clinical personnel was needed compared to cohort 1*	No data are given on number of patients in cohort 1 and no data are given on the phone time in cohort 2, making that calculations are made in an obscure way.
Sitammagari et al.[4, 67]	prehosp	*all 160 virtual acute care unit (VACU) patients who did not require transfer to a brick and-mortar hospital can be viewed by extension as traditional hospital beds saved.*	This assumes that otherwise in absence of RPM all those patients would have required hospitalization.
Swift[195]	posthosp	*In November 2020, immediately prior to the launch of the virtual ward, the mean length of stay for patients who did not access high dependency care or oxygen was 5.5 (+/-1.3) days. The mean length of stay in patients discharged into the virtual ward thereafter was 3.3 (+/-0.4) days; relative reduction, 40.3% (p<0.001).* *The costs associated with a stay in the virtual ward were robust. For the virtual ward to be cost-neutral, it would need to have reduced one bed day for every 4.0 patients referred into it. It seemed to reduce the average number of bed days per patient per hospital admission by 2.2. The gulf between what seemed to have been achieved is 9.5 times greater than what would have been required to be cost neutral*	No details given on comparison group (N, characteristics, etc), and the group in RPM was small (n=65)
Watford's virtual hospital [108, 167]	Prehosp & posthosp	*Under the current circumstances it is difficult to comment upon how much 'time in hospital' has been saved by this scheme.* *However, we estimate that on average at least one complete day has been saved for all of the high risk patients and approximately 2-4 hours*	It is only an estimation and as authors themselves state ' it is difficult to comment upon how much 'time in hospital' has been saved.

		in the Acute Admissions Unit (AAU) department for each of the low-risk patients (in addition to follow-up visits). This equates to 290 bed days saved over a 21-day period (approximately 14 beds at any one time). *In phase 1, nearly 400 patients were monitored through phone calls from a team of clinicians, including consultants, respiratory physiologists, and physiotherapists not involved directly with frontline care. This saved nearly 300 bed days over a three week period at the height of the covid-19 outbreak.*	
Ye et al.[175]	posthosp	*Compared to patients not referred, patients referred for remote monitoring had fewer ED visits (8.3% vs 14.1%; OR 0.60, 95% CI 0.31–1.15, p = 0.12) and readmissions (6.9% vs 8.3%; OR 1.15, 95% CI 0.52– 2.52, p = 0.73).* *While referral to remote monitoring was not associated with a statistically significant reduction in 14-day readmissions, referral was associated with a trend toward an approximately 40% reduction in patients returning for an ED visit*	There are no significant differences

Appendix 4.4. Results of the economic studies

This appendix has been written by dr. Sophie Gerkens, economist at KCE.

Appendix 4.4.1. Results of the search strategy

Four cost comparisons[3, 137, 168, 195] and one full economic evaluation[212] were identified in the literature research[h]. While usually only full economic evaluations, i.e. studies comparing at least two alternative treatments in terms of costs and outcomes and reporting incremental cost-effectiveness ratio (ICER) are selected in KCE reports, economic studies without incremental cost-effectiveness ratio (ICER)) were also included here to increase the number of selected studies.

Appendix 4.4.2. Data extraction and quality assessment

The five selected studies were summarized in an in-house data extraction sheet (see appendix 1.4.6). These data extraction sheets are working documents that provide the basis for the description of the selected studies and their critical appraisal performed below.

Appendix 4.4.3. Overview of methodological aspects

In this section, an overview of the retrieved studies is done, with a focus on their methodological aspects. Results and conclusions are then discussed in the next section.

General characteristics

Table 50 gives an overview of the general characteristics of the 5 economic studies identified (design, analytical technique, conflict of interest, countries, population and perspective). Four studies[3, 137, 168, 195] were cost comparisons (often without real comparators) and one study[212] was a cost-utility analysis. No study mentioned conflict of interests and only one study perceived a funding (Padula et al.[212]) but mentioned this did not influenced the analysis. No analysis was performed in Belgium. Countries in which analyses were performed were Spain, United Kingdom (UK), the Netherlands and the United States (US). The perspective of the study was only mentioned in one study (Padula et al.[212]) but it seems all studies adopted either the health care payer perspective or the health care provider perspective (because direct non-health care costs or indirect costs such as productivity losses were not included).

Two studies concerned moderately ill patients with COVID-19 being hospitalized and being candidate for an earlier discharge (post-hospitalization telemonitoring programme, i.e. Swift et al.[195] and van Herwerden et al.[168]), one study[3] concerned moderately ill patients with COVID-19 presenting at the ED (pre-hospitalization hospital at home programme), one study[137] concerned both moderately ill patients with COVID-19 being hospitalized and being candidate for an earlier discharge or moderately ill patients with COVID-19 presenting at the ED (both pre- or post-hospitalization telemonitoring programme), and one study[212] concerned all patients with COVID-19 (moderately or severely ill) presenting at the ED and either requiring an hospitalization or being telemonitored at home (Pre-hospitalization telemonitoring programme).

[h] No literature research specific to economic evaluations (i.e. with specific Mesh terms and keywords) was done but as no restriction was done on the study design (e.g. limiting the research to RCTs or reviews) it can be expected that no economic studies are missed.

Table 50 – General characteristics of retrieved economic studies

Reference - Year (country); CoI	Analytic technique - Design			Population	Time horizon (Discount rate)	Perspective
	CUA	Cost Comparisons	Design			
Llorens et al. 2021[3] (Spain), no CoI		x	Retrospective cohort study	Moderately ill patients with COVID-19 presenting in the ED	2 months (not discounted, <1year)	Not specified
Nunan et al. 2020[137] (UK), no CoI		x	Retrospective cohort study	Moderately ill patients with COVID-19, either presenting in the ED or being hospitalized (candidate for earlier discharge)	2.3 months (extrapolated to 6 months) (not discounted, <1year)	Not specified
Swift et al. 2021[195] (UK), no CoI		x	Retrospective cohort study	Moderately ill patients with COVID-19 being hospitalized (candidate for earlier discharge)	20 days (not discounted, <1year)	Not specified
van Herwerden et al. 2021[168] (The Netherlands), no CoI		x	Retrospective cohort study	Moderately ill patients with COVID-19 being hospitalized (candidate for earlier discharge)	5 months (not discounted, <1year)	Not specified
Padula et al. 2021[212] (United States), no CoI, Funding	x		Markov model (daily cycles)	Moderately and severely ill patients with COVID-19 presenting in the ED	3 weeks (not discounted, <1year)	Health care sector perspective (health insurers and hospitals)

CoI: Conflict of interest; CUA: cost-utility analysis; US: United States.

Intervention and comparator

Table 51. Interventions differed between the studies and the way telemonitoring was performed was not detailed. It should also be noted that in the study of Llorens et al., it was not clear if a remote follow-up of some parameters was performed (such study is therefore maybe out-of-scope). Oxygen therapy at home was possible in two studies[3, 168].

Three studies[3, 137, 168] had no real comparator but assumed that without the intervention, the patients would have been hospitalized. The study of Swift

Interventions and comparators are described in

et al. used similar patients hospitalized before the implementation of the virtual wards as comparator.

The study of Padula et al.[212] modelized the possibility of being "telemonitored at home" if no hospitalization is required compared to standard care without the possibility of being "telemonitored at home" (i.e. all patients are hospitalized).

Table 51 – Description of interventions compared

	Intervention	Comparator
Llorens et al. 2021[3]	**Pre-hospitalization HAH programme:** Hospital at home (HAH) medical care model, oxygen therapy possible	Patients assumed hospitalized during the same time period
Nunan et al. 2020[137]	**Both pre- or post-hospitalization telemonitoring programme:** Follow-up in a virtual ward	Patients assumed hospitalized during the same time period
Swift et al. 2021[195]	**Post-hospitalization telemonitoring programme (earlier discharge):** Follow-up in a virtual ward	Similar patients hospitalized before the implementation of the virtual ward
van Herwerden et al. 2021[168]	**Post-hospitalization telemonitoring programme (earlier discharge):** Oxygen therapy at home and telemonitoring	Patients assumed hospitalized during the same time period
Padula et al. 2021[212]	**Pre-hospitalization telemonitoring programme:** either hospitalization (for severely ill patients) or at-home telemonitoring, with a remote pulse oximetry (pulse-ox) telemonitoring	Standard care: Hospitalization without possibility of remote monitoring

Cost parameters

In the four cost comparisons, results depended on the assumptions done concerning the per diem cost per patient in a "telemonitoring programme" and the per diem cost per patient in a hospital (see Table 52). While the assumed per diem hospital cost was clearly stated in the four studies (see Table 52), the assumed per diem cost in an "telemonitoring programme" was estimated as followed:

- The study of **Llorens et al**.[3] reported that the per diem 'hospital at at home' cost was 77% lower than the per diem hospital cost (hospitalisation in an internal medicine department), i.e. $101.32. Nevertheless, no details on the cost items and values included in the calculation were given. It is therefore not possible to determine if such an assumed 77% reduction is valid. It was also not clear why results are expressed in dollars while the study seems to be performed in Spain (no details were given on any currency exchange rate).
- The study of **Nunan et al**.[137] reported a total cost for the virtual ward for a sixth month period, i.e. £92 875, including £57 175 for the staff (salaries of the clerical support, the physician assistants and the medical students) and £35 700 for consumables (£35 700 for 6 months corresponding to 500 finger-tip pulse oximeters). The cost of the senior physician (£ 60 000 for 6 months) and the cost of the project lead and project manager were nevertheless not taken into account. The total of £92 875 corresponded to 133 patients per month during 6 months, followed-up during 4 days on average, given an average per diem cost of £29 per patient.
- In the study of **Swift et al**.[195], the average cost of the virtual ward reported, i.e. £133.26 per patient, included both the costs of human resources (i.e. specialist respiratory nurses and physiotherapists, with an average of £93.52 per patient) and the cost of the virtual monitoring on CliniTouch Vie (i.e. £39.74 per patient). Because the average time per patient in the virtual ward was 3.3 days, the assumed per diem cost per patient was around £40.4.
- The study of **van Herwerden et al.**[168] reported a total cost of €99 664 for the following cost items: delivery of oxygen (€61 600), the application for the telemonitoring (€5 500), the nurse specialized in pulmonary care (0.4 FTE , €11 664), the purchase of 30 saturation meters (€900), and implementation costs (€20 000). This total cost corresponded to 49 patients followed during an average of 12.57 days (616 patient-day), given a per diem cost of €161.8 per patient.

As shown in Table 8, important differences can be noted in the assumed per diem costs between the studies. These estimates are programme and country specific and are not transferable to the Belgian setting. As an example, it can nevertheless be noted that the Belgian guidelines for economic evaluations reported a Belgian weighted average of the 100% per diem hospital prices for acute care of €445 in 2013.

Moreover, probably because of the perspective adopted, some cost items were not considered (e.g. materials owned by the patient such as tablets, the cost of informal care givers implied, etc.). Moreover, none studies took into account eventual complication costs.

It should also be noted that the per diem cost of 'telemonitoring programmes' were particularly low compared to those in hospitals, while the savings are based on such a difference. It is therefore important to consider all cost items in the calculation and not enough details were given to determine to what extend it was not the case.

Table 52 – Per diem costs assumed in the cost comparisons

Authors	Per diem cost per patient in a telemonitoring programme	Per diem cost per patient in hospitals	Difference
Llorens et al.[3]	$101.32	$439.85	-$338.53 (own calculation)
Nunan et al.[137]	+/- £29 (own calculation, only total cost reported)	£200	-£171 (own calculation)
Swift et al.[195]	+/-£40.4 per day (own calculation, only total cost reported)	£532	-£491.6 (own calculation)
van Herwerden et al.[168]	Not reported: +/- €161.8 (own calculation, only total cost reported)	€400	-€238.2 (own calculation)

In the cost-utility analysis of Padua et al.[212], only total cost per episode of care were reported. As shown in Table 53, a high difference was assumed between "telemonitoring at home" and "hospitals" costs per episode of care, which greatly influenced the results. Even if it was stated that these estimates were based on real world data in the university hospital of Cleveland, not enough details were reported to assess the validity of such estimates. It should also be noted that the lower cost for hospitalizations in intensive care unit (critical episode of care) compared to general hospitalizations is doubtful (see Table 53).

Table 53 – Total cost per episode of care in the study of Padua et al.[212]

Episode of care	Base case estimates	Lower and upper bound (sensitivity analysis)
In the ED	$26 095	$17 913 - $40 801
Telemonitoring at home	$114	$91 - $137
In the hospital (general care unit)	$43 917	$35 134 - $52 701
In an intensive care unit (critical care)	$21 040	$16 832 - $25 249

Outcome parameters

Cost comparisons only included outcomes that were considered as out-of-scope for this economic part, such as patient satisfaction. Only the study of Padula et al.[212] is therefore detailed in this section.

To assess the impact of the intervention on the quality-adjusted life-year, assumptions were done on transition probabilities between the modelled health states and on utilities associated to each health state. Nevertheless, these assumptions were again doubtful. For example, the sum of transition probabilities from the health state "Hospitalized" to others health states ("critical state", "recovery", or "death") was superior to 1 (not appropriate). There was also no transition possibility between the health state "telemonitoring at home" and the health state "death".

Concerning utilities, they were based on a Canadian study that assessed, using the HUI-3 instrument, other health states than in the study of Padua et al.[212] (SARS in Outpatients: 0.25 – Hospitalized patients: 0.05 and Contacts: 0.50) and the assessment (the descriptive part) was done by a panel of 4 specialist physicians rather than by the patients themselves (as recommended in the Belgian guidelines for economic evaluations). The difference assumed between the health state "hospitalized" (with an utility of 0.25) and the health state "telemonitoring at home" (with an utility of 0.50) seems therefore not justified and overestimated (see Table 54).

Table 54 – Utilities associated with the health states in the study of Padua et al.[212]

Health Sate	Base case estimates	Lower and upper bound (sensitivity analysis)
In the ED	0.50	0.40-0.60
Telemonitoring at home	0.50	0.40-0.60
In the hospital (general care unit)	0.25	0.20-0.30
In an intensive care unit (critical care)	0.05	0.04-0.06
Recovered	0.76	0.61-0.91

Table 56 Given the numerous concerns exposed in the methodological section above, the validity of these results can nevertheless be questioned.

Assessment of uncertainty

Only two studies assessed the uncertainty, i.e. the study of van Herwerden et al.[168] and the study of Padula et al.[212]. The study of van Herwerden et al.[168] only performed an univariate sensitivity analysis and the ranges tested were not justified. The study of Padula et al.[212]. performed both an univariate sensitivity analysis and a probabilistic analysis. Nevertheless, because the base case estimates were doubtful (see the previous sections), the ranges tested around these base-case estimates were also doubtful.

Appendix 4.4.4. Results

A synthesis of the results of the economic studies is presented in Table 55 and

Cost comparison studies

Three cost comparisons[3, 137, 168] based their results on the assumption that otherwise, patients would have been hospitalized. Savings were therefore based on the average duration of their follow-up, considered as the average hospital days avoided per patient.

The study of Swift et al.[195] compared the mean length of the hospital stays of similar patients before the implementation of the virtual ward with the mean length of stays of patients within the virtual wards, resulting in 2.2 hospital days avoided.

As shown in Table 55, discrepancies can be observed between the studies concerning both the per diem cost avoided (between -€201 and -€554.5) and the average hospital days avoided (between -2.2 days and -12.6 days), given high variations between estimated average cost-savings per patient (between - €804 and -€2995).

It should also be noted that in the study of Swift et al.[195] one patient died, which would greatly influenced the results if they were reported in terms of incremental cost per life-year gained (as in full economic evaluations).

Table 55 – Results of the cost comparison studies

Authors	Interventions	Per diem costs avoided per patient	Average hospital days avoided per patient	Average incremental costs per patient
Llorens et al.[3]	**Pre-hospitalization programme**: 1. Intervention: Hospital at home (HAH) medical care model; vs 2. Comparator: Patients assumed hospitalized during the same time period	3. HAH: $101.32 4. Hospital: $439.85 5. Incremental per diem cost: -$338.53 per day per patient (around €299)*	-7.238 days (789 days for 109 patients)	Cost-savings: - $2450 (own calculation) (around -€2165)
Nunan et al.[137]	**Pre- or post-hospitalization programme**: 6. Intervention: Follow-up in a virtual ward 7. Comparator: Patients assumed hospitalized during the same time period	8. Virtual ward: not reported +/- £29 (own calculation) 9. Hospital: £200 10. Incremental per diem cost: -£171 per patient per day (own calculation) (around -€201*)	-4 days	Cost-savings: -£684 (own calculation) (around -€804*)
Swift et al.[195]	**Post-hospitalization programme (earlier discharge):** 11. Intervention: Follow-up in a virtual ward 12. Comparison: Similar patients hospitalized before the implementation of the virtual ward	13. Virtual ward: £133.26 for 3.3 days	-2.2 days (Intervention group: 3.3 (+/-0.4) days; Comparator: 5.5 +/-1.3 days)	Cost-savings: £133.26-(2.2*£532)= -£1047 (around -€1230)
van Herwerden et al.[168]	**Post-hospitalization programme**: 14. Intervention: Oxygen therapy at home and telemonitoring; 15. Comparator: Patients assumed hospitalized during the same time period	16. Oxygen therapy at home and telemonitoring: +/- €161.8 per day (own calculation, only total cost reported) 17. Hospital: €400 18. Incremental per diem cost: -€238.2 per patient per day (own calculation)	-12.6 days (median: -11 days)	Cost-savings: -€2994.6

**Because the cost year was not mentioned, the conversion is approximative.*

Cost-utility analysis

Table 56. According to results of

Table 56, the introduction of a pre-hospitalization remote monitoring programme would be a dominant strategy compared to standard care without remote monitoring. The probabilistic sensitivity analysis confirmed these results. Nevertheless, the internal and predictive validity of the model is questioned (see also the previous sections). Such model results in an number of deaths which is 4 times higher in patients without remote monitoring possibilities and there is no clinical reasons that could justify such results. Such overestimation seems mostly due to the errors done in the

Results of the study of Padula et al.[212] are summarized in

assumptions concerning transition probabilities explained in the previous section (see outcomes parameters). It should also be noted that even if the authors reported savings of -11 471 per patient, we wonder if these results are not rather for 1000 patients (as for the clinical findings). However, we do not have enough information to confirm this.

Table 56 – Results of the cost-utility analysis Padula et al.[212]

	Clinical findings (per 1000 patients)		Economic findings				
	Hospital admission	Deaths	Cost	Incremental cost	QALYs	Incremental QALYs	ICER
No remote monitoring (all patients hospitalized)	823	26	51 183		0.019		
Remote monitoring programme	104	6	39 711	-11 471	0.032	0.013	Dominant strategy

QALYs = Quality-adjusted Life-Years; ICER = Incremental cost-effectiveness ratio

Appendix 4.4.5. Discussion

In these pandemic times, researches related to COVID are published as soon as possible to quickly inform the rest of the world, sometimes at the detriment of quality. The authors of the economic studies selected for this report themselves acknowledge that their results were still preliminary and should be used with caution. Because of the low level of quality of these studies, no concrete conclusion can be done, except the fact that if telemonitoring really allows to avoid hospitalization and if the cost of such a telemonitoring is inferior to hospital costs, then savings could be made, at least initially. However, it would need to be further investigated whether there are more complications in telemonitored patients than in hospitalised patients, which could lead to higher costs in the long run. More studies are therefore needed and telemonitoring must currently mostly be seen as an alternative if hospitals are overcrowded than as a cost-effective strategy.

Appendix 4.4.6. Data extraction sheet template

Table 57 – Data extraction sheet template

1	Reference (including all authors)
2	Conflict of interest and/or study funding
3	Country
4	Study question
5	Type of analysis (analytic technique) 19. e.g. cost-effectiveness analysis, cost-utility analysis, …
6	Design 20. e.g. Markov model, decision tree, …
7	Population
8	Intervention
9	Comparator
10	Time horizon
11	Discount rate 21. For costs and/or effects
12	Perspective
13	Costs 22. Cost items included 23. Measurement of resource use 24. Valuation of resource use 25. Data sources 26. Currency and cost year 27. Other aspects…
14	Outcomes 28. Endpoints taken into account and/or health states 29. Valuation of health states 30. Treatment effect and Extrapolation 31. Utility assessment (Quality of Life) 32. Data sources for outcomes 33. Other aspects…
15	Uncertainty 34. Scenario analysis 35. Sensitivity analysis
16	Assumptions
17	Results 36. Cost-effectiveness and/or cost-utility (base case) 37. Scenario analysis 38. Sensitivity analysis 39. Other aspects…
18	Conclusion of the authors
19	Reported limitations
20	Own remarks

Appendix 4.5. Quotes patient experiences

Below quotes regarding patient experiences are listed.

- Annis et al.[41]: patients have been extremely grateful and positive about their experience using the tool and feel it has helped them stay safe at home.
- Bajracharya et al.[223]: All patients expressed satisfaction.
- Bouabida et al.[217]: Overall, the satisfaction rate for quality and safety of care for the two platforms was 80%. Over 88% of the users on each platform considered the platforms' services to be engaging, useful, user-friendly, and appropriate to their needs. Users appreciated four aspects of these telehealth approaches: (1) the ease of access to services and the availability of care team members; (2) the user-friendliness of the platforms; (3) the continuity of care provided, and (4) the wide range of services delivered. Users identified some technical limitations and raised certain issues, such as the importance of maintaining human contact, data security, and confidentiality. Improvement suggestions include promoting access to connected devices; enhancing communications between institutions, healthcare users, and the public on confidentiality and personal data protection standards; and integrating a participatory approach to telehealth platform development and deployment efforts
- Byteflies[60]: patients overwhelmingly reported that CC@H gave them peace of mind, especially vital sign monitoring and direct communication with healthcare provider features (Byteflies
- Cheng et al.[66]: Across 35 interviews (response rate of 66%), three main themes were identified the program provided emotional support (a sense of security, reduced feelings of depression and loneliness, and decreased fear and anxiety);was informative (taught patients COVID-19-related precautions, instructed patients on how to self-monitor COVID-19 symptoms, and informed patients about self-care when coping with COVID-19), and motivated patients to self monitor and self-manage (facilitated self management, prompted self-management, and encouraged self monitoring).
- Dallabrida et al.[230]: this study demonstrates that participants found it "very easy" and convenient to report on their COVID-19 symptoms using an app on their personal smartphone
- Ferrua et al.[82] (cancer patients): Patients expressed very positive interest in the CAPRICOVID intervention, and 96.7% of patients reported that the frequency of calls from the NNs was adequate. On the general impression of the CAPRI-COVID intervention (open-ended question), patients highlighted the importance of human contact and being listened to. They felt the monitoring was very reassuring in the context of the pandemic
- Ford et al.[264]: Across all survey questions, 90% of patients report high program satisfaction (agree or strongly agree). Patients indicate feeling isolated during COVID-19 and emphasize that the program provided reassurance and guidance. Many of those who signed up for the patient portal appreciated the two-way communication it afforded them with RPM nurses and other providers
- Grutters et al.[266]: Home monitoring was rated as user-friendly by 93%. It took 73% less than 10 min daily to take the measurements and complete the relevant details in the app. In, respectively, 14% and 83% of cases it was mostly or always clear what to do when low oxygen saturation was measured. 98% would recommend home monitoring to acquaintances
- Horton et al.[234]: Of the 133 patients who have completed the survey to date, the vast majority reported high satisfaction with their encounters with the COVID-19 physician, with a mean score of 4.8 or higher on all six questions (on a scale of 1 to 5).
- Jourdain et al.[210] : la satisfaction des patients et de leurs proches est très forte avec un taux de satisfaction de 94 % et un taux de recommandation de 93 %.

- Kagiyama et al.[236]: we showed that (a) the telemedicine-based self-vital sign check system was easy enough that all including elderly patients (56% were over 70 years old) successfully learned how to use the device from a 10-minute lecture without any trouble, even in the acute phase of illness,
- Kent Surrey Sussex Academic Health Science Network[197]: 95% of respondents felt the app was easy to use; 76% of respondents felt happy to use this form of care again; "Reassuring" was the most common word selected to describe the app
- Lejeune et al.[242] : 127 répondants au questionnaire final, 93,6 % ont déclaré avoir été rassuré par le dispositif, 93,6 % ont considéré qu'ils ont pu facilement obtenir les informations nécessaires et suffisantes pour gérer leur situation médicale et le confinement ; 69,9 % ont estimé qu'ils auraient consulté aux urgences en l'absence du dispositif.
- Lwin et al. [118]: Emotional support by the HITH COVID team has been highly appreciated and valued by patients and their family during home isolation.
- Mederi[152]: De patiënten die aan dit project deelnemen, vinden het veel comfortabeler om thuis te kunnenuitzieken in plaats van op een covidafdeling. 89% van de deelnemende patiënten gaf aan dat zowel het gevoel van veiligheid als het comfort sterk verhoogd was . Bijna alle patiënten (97%)zouden telemonitoring aanbevelen aan andere patiënten. (MEDERI
- Memorial Sloan Kettering Cancer Center (cancer patients)[74, 75, 120, 146]: Ninety-three percentage of respondents interacted with the clinical team through the patient portal, and of those, 91% found it helpful; 94% interacted through the telephone, and 88% found it helpful; finally, only 36% of respondents had a televisit (defined as a video visit), and 83% found it helpful. Of respondents who were given a home pulse oximeter, 94% found it helpful to monitor their oxygen level Patients did not find it a burden to participate in a RPMP with 91% of respondents agreeing (25%) or strongly agreeing (66%) that the time and effort it took to report symptoms was worth it. From a symptomatology perspective, respondents felt that participation was an important part of their care for COVID-19 (87% agreed or strongly agreed), led to a feeling of being better able to manage their COVID-19 symptoms (76% agreed or strongly agreed), and helped them understand how their symptoms compare with others who have COVID-19 (66% agreed or strongly agreed). Beyond physical symptoms, patients also endorsed that the RPMP provided psychosocial benefits and helped them cope with their COVID-19 diagnosis (73% agreed or strongly agreed), made them feel connected and safe with the CCMT (87% agreed or strongly agreed), made them feel connected with the healthcare institution (87% agreed or strongly agreed), and made them feel their COVID-19 care was being coordinated with their oncology care (77% agreed or strongly agreed). From a healthcare resource utilization perspective, 59% of patients agreed (23%) or strongly agreed (36%) that participation in the RPMP helped prevent visits to the emergency room and urgent stand-alone monitoring center. Qualitative analysis of free-text responses identified three primary themes regarding patient-perceived value of the RPMP. The identified themes were (1) security: patients appreciated that the RPMP provided a clinical safety net; (2) connection: patients appreciated the link to their clinical team during a period of isolation; and (3) empowerment: patients appreciated that the RPMP provided education on the virus and symptom management.
- Miller et al.[245]: the initial 941 patients in the hospital at home program, the IU Health team noted overall greater patient satisfaction than that of inpatients
- Nunan et al. [137]: On the question 'On a scale of 1 to 5 how reassured and safe did you feel being called daily and having the pulse oximeter at home with you?', 151 (81.8%) gave a response of 1; 30 (16.2%) gave a response of 2; 2 (1.1%) gave a response of 3; and 2 (1.1%) gave a response of 4.
- Panicacci et al.[142]: Patients with advanced clinical syndrome and significant lung involvement have gained great reassurance from intensive monitoring of their vital parameters, thanks to the fact that they have been continuously followed by the doctors also without visits and

phone calls. The video call feature has been really appreciated, because patients do not feel alone and left to themselves.

- Raffan et al.[198]: Overall, COVID-19 patients reported a positive experience with the virtual care they received. The majority of patients rated their overall care as good or very good. Patients also felt confident knowing that their symptoms were being monitored virtually and felt that the technology used by rpavirtual improved their access to care and treatment. The majority of patients also reported a positive experience with their care needs being met and the information and communication they received
- Timmers et al.[253]: 718 users answered the question about their satisfaction with the information in the app. Users in all three groups indicated that they were very satisfied with the information
- Vella et al.[257]: the patient experience of the program was quite positive. Many reported that they felt supported as the program also delivered many tailored non-clinical benefits that enabled patients to successfully quarantine to limit the spread of infection and to adhere to COVID regulations
- Walsh et al.[258]: All 10 respondents rated the receipt of a daily well-being call as the most helpful aspect of the service, and that they were happy with the level of support they received from the service while at home. Eight patients (80%) reported a preference for home monitoring and 9 patients (90%) found the mobile application and pulse oximeter easy to use
- Ye et al. [175] : of 105 patients that completed a program satisfaction question, 86.7% reported they would be very likely to recommend the monitoring program to others (score of 9 or 10), 10.5% scored the program a 7 or 8, and 2.8% scored the program < 7.

Appendix 4.6. RPM in special patient populations

Appendix 4.6.1. RPM in patients with cancer and COVID-19

We identified 7 projects (15 documents[71, 74, 75, 82, 96, 120, 133, 144-146, 148, 151, 163, 189, 235]) concerning RPM in oncology patients with COVID-19:

- Inova Schar Cancer Institute (USA)[163]: patients with cancer were offered free enrolment in the RPM program if they had mild symptoms and were stable. They were educated on the program parameters and provided with an automatic blood pressure cuff, oral thermometer, finger pulse oximeter, and a configured Apple iPad to enter vital results. 26 patients were enrolled to the RPM, most of whom were on active anticancer therapy, with patients in the program for an average of 16 days. There was a high participation or engagement rate, with 97% of patients entering results at least once per day and 67% of patients entering results three times per day while in the program. While enrolled, only one patient was admitted for worsening respiratory symptoms, found to be a bacterial pneumonia, and two were hospitalized for non-COVID complications.
- Levine Cancer Institute (USA)[148]: 974 oncology patients were screened with a tool for surveillance and treatment needs. A score of 0-2 prompted phone assessment every 48-72 hours, and score of 3-5 required every 24-48 hour calls with physician involvement when appropriate. 488 patients were followed in a hospital at home trajectory by a nurse navigator; 3% of navigated patients died. With the embedded nurse navigation team's specialized attention along with enhanced physician oversight and close collaboration with AH HAH, opportunities for care escalation or adjustments in cancer-focused care were promptly identified.
- Mayo Clinic Cancer Center (USA)[96, 133, 144, 145]: the patient receives a technology package composed of a cellular-enabled tablet preloaded with vended clinical RPM software (Resideo Life Care Solutions, WI) and preconnected, Bluetooth-enabled devices (blood pressure cuff and monitor, pulse oximeter, thermometer, and scale) to passively collect

physiologic data. Key to the RPM program is the clinical care model that includes a centralized team of RPM nurse care coordinators who provide daily monitoring, education, and health coaching; complete clinical evaluations in response to alerts; use decision trees and protocols for interventions; and escalate care as necessary to the appropriate regional physician and advanced practice provider COVID-19 care teams. The standard program duration is approximately 21 days with extension as needed to support recovery for patients who remain symptomatic. Patients were eligible for enrollment if they had one or more of the following risk factors for severe COVID- 19 illness, as defined by the Centers for Disease Control and expert consensus24: age . 65 years, diabetes, current smoker, body mass index . 40, chronic liver disease, chronic lung disease, congestive heart failure, active cancer therapy, bone marrow or solid organ transplant, other immunocompromised state, and end-stage renal disease. 109 patients were enrolled in the RPM program, that could be compared by a propensity weighting to 115 patients that were not enrolled. The estimated risk of hospital admission without RPM was 13% (95% CI, 6.9 to 18.3), whereas the estimated risk of hospital admission with RPM was 2.8% (95% CI, 20.06 to 5.7). Thus, independent of measured baseline covariates, the RPM program was associated with an approximately 10% absolute risk reduction and 78% relative risk reduction in hospital admission. Furthermore, although ED visit rates were similar between groups (10% RPM and 16% non-RPM), conversion to hospital admission occurred less frequently for patients who were enrolled in RPM (42.9% v 83.3%). Additionally, when hospitalized, the RPM patients experienced shorter length of stay (median 3 days v 6 days) and were also less likely to experience prolonged hospitalization (0% v 5%). The use of a novel RPM program and centralized virtual care team was associated with a significant reduction in hospital admission rate and lower overall acute care resource utilization among cancer patients with COVID-19.

- Memorial Sloan Kettering Cancer Center (USA)[74, 75, 120, 146]: Oncology patients who tested positive for COVID-19 were eligible. In total, 1,721 patients were enrolled in the program from March 25, 2020 to December 22, 2020.Among these, 210 were deemed high risk patients who received a pulse oximeter in addition the daily symptom questionnaire. Over this period, 27% of patients triggered an alert from an electronic symptom questionnaire, and 63% of patients with a pulse oximeter triggered an alert from their device. Among patients who triggered an alert of any kind, 3% were triaged to a higher level of care. Enrolled patients received a daily electronic COVID-19 symptom assessment, and a subset of high-risk patients also received a pulse oximeter. Monitoring was provided by a centralized team and was discontinued 14 days after a patient's positive test result and following 3 days without worsening symptoms. Patients who completed at least one assessment and exited the program were sent a patient engagement survey to evaluate the patient's experience with remote patient monitoring for COVID-19. 257 patients responded. Most patients agreed that the remote patient monitoring was worthwhile, enabled better management of their COVID-19 symptoms, helped them to cope with their COVID-19 diagnosis, made them feel more connected to their healthcare team, and helped prevent emergency room visits. Identified themes regarding patient-perceived value of remote monitoring included (1) security: patients appreciated that remote monitoring provided a clinical safety net; (2) connection: patients appreciated the link to their clinical team during a period of isolation; and (3) empowerment: patients appreciated that remote monitoring provided education on the virus and symptom management.
- University of Pennsylvania Health System (USA)[71]: a feasibility study was conducted with the Cancer COVID Watch, an automated COVID-19 symptom monitoring program with oncology nurse practitioner-led triage among patients with cancer between April 23 and June 30, 2020. Oncology clinicians enrolled 34 patients who tested positive for COVID-19 or were experiencing symptoms concerning for COVID-19. Enrolled patients received twice daily automated text messages over 14 days that asked "How are you feeling compared to 12 hours ago? Better, worse, or the same?" and, if worse, "Is it harder than usual for you to breathe?" Patients who responded "worse" and "yes" were contacted within 1 hour by an oncology nurse practitioner to determine next steps

in management. One patient was advised to present to the ED, and 3 were managed in the outpatient setting. 7 (21%) patients presented to the ED for infectious symptoms within 14 days of enrolment, and 2 (6%) were admitted for worsening COVID-19 symptoms. Participant satisfaction was high. Intensive remote symptom monitoring and rapid nurse practitioner triage for worsening symptoms is feasible for outpatients with cancer and suspected/confirmed COVID-19infection. Patients with concerning symptoms were adherent with Cancer COVID Watch and mostly managed in the outpatient setting.

- Gustave Roussy Cancer Institute (France)[82, 151]: The objective of the CAPRI-COVID intervention was to keep patients with COVID-19 at home as much as possible while remotely monitoring the daily evolution of COVID-related symptoms to limit irrelevant visits to the hospital and anticipate hospital visits when necessary. Furthermore, Nurse Navigators (NNs) supervised the discharge of patients from an inpatient unit to their homes with primary care providers to promote continuity of care. Symptom monitoring was conducted in patients via telephonic interaction (with NNs) or via the CAPRI mobile application. Remote monitoring of six COVID-19-related symptoms (temperature, cough, breathing discomfort, drowsiness, digestive disorders, and any new symptoms since last evaluation) was conducted and data was collected daily, either by the patient via the CAPRI App or by NNs via telemonitoring. Each contact was traced on a track sheet; for each symptom, the presence/absence and severity are reported. In cases of worsening or emergence of symptoms, an automated alert was sent to the platform; NNs then assessed the clinical condition and consulted an emergency physician when necessary. The monitoring duration was set at a minimum of 14 days (including at least 2 days with complete regression of symptoms). 130 patients with COVID-19 were monitored; Ten (7.8%) patients were hospitalized (excluding scheduled hospitalization), and 23 (17.1%) were admitted to the ED at least once; 30 patients required medical consultation from an emergency physician . A satisfaction questionnaire was sent and 62 patients completed the survey, with a response rate of 48.1%. Patients expressed very positive interest in the CAPRICOVID intervention, and 96.7% of patients reported that the frequency of calls from the NNs was adequate. On the general impression of the CAPRI-COVID intervention (open-ended question), patients highlighted the importance of human contact and being listened to. They felt the monitoring was very reassuring in the context of the pandemic. The majority of patients monitored with CAPRI-COVID were maintained at home during the first wave of the COVID-19 pandemic. The monitoring program helped to ensure safe cancer care pathways during this period by avoiding unnecessary visits to the hospital while ensuring the monitoring of symptoms. NNs played an essential role in addition to the use of the CAPRI App. They provided personalized care to the patients by managing the course of COVID-19 symptoms and contributed to a global approach in patient management. NNs were able to identify vulnerabilities and implement preventive measures.
- Oncology Department of Lausanne University Hospital [235]: N=254; Le développement du télésuivi a permis d'apporter un soutien supplémentaire aux patients atteints de cancer et de Covid-19, confrontés à l'isolement dû à la quarantaine. Cette démarche a également rendu possible le soutien à l'autogestion des patients à domicile.

In conclusion, RPM in oncology patients with COVID-19 shows to be feasible, is appreciated by patients and gives them reassurance and from the study of Mayo Cancer Clinic Center there is some evidence that RPM in cancer patients with COVID-19 might lead to reduced ED-visits, hospital admissions, and shortened length of hospital stay.

Appendix 4.6.2. RPM in children with COVID-19

We identified 3 projects[76, 228, 248] in which RPM was applied to children.

- Sabara´ Hospital Infantil (Brazil)[76] :This study included children aged from 0 to 17 years with a confirmed diagnosis of COVID-19, who were sent home after visiting the ED and enrolled in the RPM program. the telemonitoring protocol was composed of two steps: (1) ‘‘first telemonitoring’’ performed within 48 h of discharge from the ED to inform the patients and their families about the positive result of the test for SARS-CoV-2 and to conduct the first clinical evaluation, and (2) ‘‘second telemonitoring’’ performed 7 days after the first telemonitoring to re-evaluate the patients’ clinical condition. 100 patients (mean age 5.5 years) who had no indications for hospitalization after the first visit to the ED of Hospital Sabara´ constituted the group of eligible children and were included in the telemonitoring group. The first telemonitoring was successfully performed in 92 patients, and the second telemonitoring in 70 patients. Clinical worsening was identified in 3 of the 92 patients who underwent the first telemonitoring, and these patients were indicated to return to the ED of Hospital Sabara´ for inperson care. Of the 70 patients who underwent the second telemonitoring, none were indicated to return to the ED. telemonitoring proved to be a useful resource for the continuity of care and identification of cases requiring hospitalization after visiting the ED of Hospital Sabara´. Telemedicine is an effective and safe alternative for monitoring children diagnosed with COVID-19.
- [228]: the study consisted of 19 children aged between 8 and 188 months who had been hospitalized. The mean length of hospitalization was approximately 10 days, with a range between 5 to 12 days. The follow up was performed through 2 calls per day to the patients’ parents. The calls had a variable length (from 2 to 10 min), influenced by numerous variables (e.g., patient conditions, parents’ questions, etc.). A specific survey was used in order to check if SARS-CoV-2 – related symptoms appeared, if any medication was administrated to the patient and if the rhino-pharyngeal swab was performed. In the case of the appearance of new symptoms, if necessary, the resident gave some management advices (e.g., administration of paracetamol in case of fever). The telephonic follow up was taken forward until two consecutive negative PCR for SARS-CoV-2 were achieved. All the 19 patients were contacted during the followup period and 7 of these patients presented new onset symptoms, described in literature as expression of SARS-CoV-2 infection, such as sore throat, conjunctivitis, cough, abdominal pain, fever, headache, myalgia and facial rash (1 for each child). Most of the symptoms were mild and healed in a few days. Two patients were re-hospitalized for complications related to SARS-CoV-2 infection.
- Servicio de Pediatría, Hospital Universitario La Paz, (Madrid, Spain) [248]: included all paediatric patients (N=72) with a confirmed or probable diagnosis of COVID-19 managed in the telephone follow-up clinic whose parents or who themselves, in case they were mature enough, consented to participation and excluded cases in which telephone follow-up was not possible. Telephone follow-up appointments were conducted using a structured questionnaire that explored symptoms and treatment, and responses were entered in the electronic health records. The phone calls were made by a paediatrician of the Department of Paediatric Infectious Diseases specifically trained for the purpose. During the follow-up, calls were scheduled every 24---72 hours for as long as the patient had active symptoms or was receiving specific treatment, and subsequently every 5---7 days until the patient had been asymptomatic for 14 consecutive days. Thirty patients (41.7%) reported development of new symptoms during the follow-up. Our study describes satisfactory and safe follow-up by telephone based off a tertiary care hospital in 72 paediatric patients. The salient findings were the long duration of symptoms, with a median of 25.5 days, and the worsening reported by 19 of the patients (26.4%), of who 14 (19.4%) required a new in-person assessment. These circumstances explain the long duration of follow-up and the performance of a median of 6 followup phone calls per patient. Notwithstanding, readmission was very infrequent and associated with the presence of comorbidities, and all patients had favourable outcomes

In conclusion, these studies demonstrate that RPM is feasible for children with COVID-19.

Appendix 4.6.3. RPM in pregnant/postpartum women with COVID-19

We identified 5 projects[180, 190, 233, 250, 255]:

- Public and Maternal and Child Health, School of Medicine, Complutense University of Madrid (Spain)[233]: included 211 patients with RT-PCR-confirmed COVID-19 during pregnancy or delivery. Of all the patients, 60 women (28.4%) were asymptomatic and 97 (46%) presented mild symptoms. Fifty-one women (24.2%) were admitted to our hospital for specific treatment because of moderate or severe symptoms. We had no missed cases and a good adherence. The mean number of calls per patient was 2.3. We performed 55 in-person visits. One patient was identified as needing hospitalization and we did not record major morbidity. Telemedicine programs are a strong and reproducible tool to reach to pregnant population affected by COVID-19, to assess its symptoms and severity, and to record for pregnancy-related symptoms both in an outpatient regime and after discharge from hospital.
- Department of Obstetrics and Gynecology, NewYork-Presbyterian Hospital / Columbia University Irving Medical Center, New York (USA)[180]: 94 patients, 92 of whom were pregnant and two of whom postpartum at the time of testing, with suspected for confirmed COVID-19 were referred and enrolled. Telehealth visits were conducted every 24 to 72 hours based on the severity of symptoms and care was escalated to in person when necessary. The outcome of the majority (96.1%) of telehealth visits was to continue outpatient management. With regard to escalation of care, 25 patients (26.6%) presented for in person evaluation and five patients (5.3%) required inpatient admission. A virtual telemonitoring clinic for obstetric patients with mild COVID-19 offers an effective surveillance strategy as it allows for close monitoring, direct connection to in person evaluation, minimization of patient and provider exposure, and scalability.
- Division of Maternal Fetal Medicine, University of Pennsylvania, Philadelphia, (USA)[190]: 142 pregnant women with suspected or confirmed COVID-19 were enrolled in a remote symptom monitoring program; 18 postpartum women diagnosed through universal screening on delivery admission were also included. Women received automated twice-daily text messages to assess symptoms and were escalated to a Maternal Fetal Medicine provider for worsening dyspnea or a text of “worse” at any time. The managing provider evaluated the patient via telephone and triaged to continued outpatient surveillance or referral to the ED. One hundred thirty women (81%) responded to at least one text each day, with 98 (61.3%) managed without escalation. Automated escalation occurred in 32(20%) women, with 28 directed to continue self-monitoring at home and 4 directed to an ED. Of those directed to the ED, 2 (50%) women were admitted due to hypoxia. None of the asymptomatic postpartum women worsened after discharge. Automated text-messaging was effective in remotely monitoring pregnant and postpartum women with confirmed or suspected COVID-19, thereby improving the efficiency and reducing resources needed for follow up. The majority of pregnant women were able to remain outpatient while appropriately identifying patients with worsening disease severity
- Division of Maternal Fetal Medicine, Department of Obstetrics and Gynecology, Beth Israel Deaconess Medical Center, Boston (USA)[250]: implemented a multidisciplinary telemedicine surveillance model with obstetrical physicians and nurses to standardize ambulatory care for obstetrical patients with confirmed or suspected COVID19. A total of 135 patients were enrolled in the multidisciplinary telemedicine model of whom 130 were pregnant and 5 were recently postpartum. 86% of the patients were managed solely in the outpatient setting and did not require an in-person evaluation; 9 patients were ultimately admitted after ambulatory or urgent evaluations, and 10 patients were observed after hospital discharge. Patients were enrolled in the telemedicine model for a median of 7 days (interquartile range, 4e8) and averaged 1 phone call daily. A multidisciplinary telemedicine surveillance model for outpatient management of obstetrical patients with COVID-19 symptoms and exposures is feasible and resulted in rates of ambulatory management similar to those seen in nonpregnant patients. A centralized model for telemedicine surveillance of obstetrical patients

with COVID-19 symptoms may preserve inpatient resources and prevent avoidable staff and patient exposures, particularly in centers with multiple ambulatory practice settings.

- Division of Maternal Fetal Medicine, Department of Obstetrics and Gynecology, New York University Langone Medical Center, (USA)[255]: 83 pregnant women were followed; they received a series of phone calls based on their illness severity and were periodically assessed until deemed stable. During their illness course, seven patients were assigned an illness severity of unstable and directed to present for evaluation following a routine call. Of those seven who presented, six (86%) were admitted due to need for oxygen supplementation. There were no maternal or fetal deaths.

  In conclusion, these studies demonstrated that RPM is feasible for pregnant/postpartum women with COVID-19.

Appendix 4.6.4. RPM in liver transplant patients with covid

We identified one paper[249] from Peru in which RPM was applied in 300 liver transplant patients, of which 10 were infected by COVID-19.

Appendix 4.7. Examples of barriers and facilitators in implementing RPM

Below some of the facilitators and barriers in implementing RPM for patients with COVID-19 mentioned in the literature.

- Facilitators:
  - Pressure on acute hospital beds and shortage of PPE facilitated the development of RPM [4, 93, 96, 136, 145]
  - Disaster management command and control was identified as the key mechanism for achieving rapid design and implementation.[150]
  - Availability of staff due to the cancellation of elective care and other activities; some members of staff were released from clinical responsibilities and could be redeployed to monitor patients remotely[4, 59, 80, 92, 93, 111, 130, 176]
  - the participation of retired senior physicians and other experienced physicians was important [136].
  - Availability of volunteers [94] medical students[92, 176]
  - commitment to a team based, inter-professional, and multidisciplinary collaboration across the health system[4, 80, 84, 91, 92, 94, 116, 145, 150]
  - effective communication between the technical and clinical teams[116]
  - Detailed, frequent, and two-way communications for all RPM – HT staff and programs across VA were critical to the successful implementation of COVID-19-related monitoring strategies.[59]
  - Active involvement of all stakeholders, including health care professionals and patients, in the development and implementation of telemonitoring is likely to contribute to a better support base. [116, 160]

- the presence of a pre-existing joint center for digital health at the province level.[84, 91]
- support from the directive board of the Hospital [80, 94]
- training for professionals[59, 80, 94]
- Clearness in the different roles and responsibilities of the parties (physicians, patients, device manufacturers, and health care institutions) involved[59, 61, 150, 160]
- experience with the implementation of telemonitoring for other diseases,[4, 59, 61, 80, 84, 91, 96, 97, 116, 130, 134, 142, 160, 163, 179]
- having infrastructure in place and framing it in a way that provides flexibility and allows it to be scaled up in times of greater need.[59]
- existing national communications, training, resource management, and equipment distribution infrastructure it had developed since 2003 for clinical staff, Veterans, and caregivers[59]
- A shift from “traditional” to “digitally assisted” clinical practice is necessary. This requires experience, time, and adequate guidelines.[160]
- The extra workload associated with the development and implementation of a telemonitoring care pathway should be minimized, for example, through dedicated support teams and a helpdesk for technical problems. [160]
- Identifying ‘sister sites’ to assist with staff coverage if needed[59]
- it is essential that data gathered by patients are integrated into the EMR. [4, 84, 91, 160, 163]
- RPM services embedded within the care model[61]
- sufficient RPM devices[4, 59, 61, 160]
- centralized device management plan[59, 61]
- The devices and services used for telemonitoring should be user-friendly, trustworthy, validated, and approved, according to national and/or international regulations[94, 142, 160]
- low-tech (telephone-based) model of care, which kept essential service delivery requirements to a minimum[80, 150, 179]
- automatic data entering through connected devices[61, 142]
- clear patient information available in different languages and in different ways (paper, video) [4, 61, 92, 94, 130]
- Adequate institutional communications, local media, and state officials[84]
- relax or remove the licensing barriers and expanded scopes of practice for physicians and many other licensed health care professionals[96]
- CMS issued guidance to expand telehealth in the Medicare program under the CARESAct and the Section 1135 waiver authority[96, 163]
- Dedicated leaders[84]

- Barriers:
  - Given the recentness of COVID-19 and the relative inexperience with telemonitoring for managing this disease, no golden standard for how, what, and when to monitor yet exists[38, 59, 80, 91, 126, 142, 160, 163]
  - rapidly changing information for a novel disease, with an unknown disease progression[150]
  - lack of scientific evidence [80, 94, 130, 160]
  - busy inpatient providers during the rollout of the program[175]
  - confidence of primary care providers in their ability to manage a novel infectious disease at a distance was often unclear[38]
  - RPM Reimbursement policies [4, 61, 80, 84, 96, 160, 163]

- Variable patient engagement. Patients with minimal symptoms sometimes express annoyance at being contacted.[111]
- Ineffective communication between health care workers (HCWs) and patients (ie, enrollment in CoSMoS)[116]
- Low literacy regarding (digital) health could be a significant barrier to telemonitoring[4, 61, 93, 116, 160, 163]
- Inequalities in ownership of these connected devices and services (age, location, race/ethnicity, and income)[96]; Patient populations without ready access to video conferencing technologies remains an important barrier without a clear solution [38, 61, 84, 163]
- Technical challenges, lack of timely data.[111], insufficient connectivity[96, 116, 173]
- Insufficient digital storage to download the Telegram app by suspected COVID-19 patients[116]
- rural areas with mobile network coverage below the 3G standard, there were repeatedly significant delays in data transmission or even transmission failures, so that continuous data collection was not always possible[173]
- lack of familiarity with the technical requirements to facilitate virtual care and concerns for technical failures further limited provider and patient adoption[96]
- requirement of medical licensure in the state in which the patient resides prevented many health care providers from extending ongoing care across state lines.[96]
- unavailability of oxygen at home[97]
- Patient data privacy and confidentiality is often a main concern[116]