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Technology experience of solid organ transplant patients and their overall willingness to use interactive health technology

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Abstract

Background: The use of interactive health technology (IHT) is a promising pathway to tackle self-management problems experienced by many chronically ill patients, including solid organ transplant (Tx) patients. Yet, to ensure that the IHT is accepted and used, a 'human-centred design process' is needed, actively involving end-users in all steps of the development process. A first critical, pre-development step involves understanding end-users' characteristics. This study therefore aims to: 1) select an IHT platform to deliver a self-management support intervention, most closely related to Tx patients current use of information and communication technologies (ICTs), 2) understand Tx patients' overall willingness to use IHT for self-management support, and investigate associations with relevant technology acceptance variables, and 3) explore Tx patients' views on potential IHT features.

Design & Methods: We performed a cross-sectional, descriptive study between October and December 2013, enrolling a convenience sample of adult heart, lung, liver and kidney Tx patients from the University Hospitals Leuven, Belgium. Broad inclusion criteria were applied to ensure a representative patient sample. We used a 35-item newly-designed interview questionnaire to measure Tx patients' use of ICTs, their overall willingness to use IHT and their views on potential IHT features, as well as relevant technology acceptance variables derived from the 'Unified Theory of Acceptance and Use of Technology' and a literature review. Descriptive statistics were used as appropriate and an ordinal logistic regression model was built to determine the association between Tx patients' overall willingness to use IHT, the selected technology acceptance variables and patient characteristics.

Findings: Out of 139, 122 patients agreed to participate (32 heart, and 30 lung, liver and kidney Tx patients; participation rate: 88%). Most patients were male (57.4%), married or living together (68%) and had a mean age of 55.9 ± 13.4 years. Only 27.9% of Tx patients possessed a smartphone, yet 72.1% owned at least one desktop or laptop PC with wireless internet at home. On a 10-point numeric scale, asking patients whether they think IHT development is important to support them personally in their self-management, patients gave a median score of 7 (25^{th} percentile 5; 75^{th} percentile 10). Patients who were single or married or living together were more likely to give a higher score than divorced/widowed patients, patients who completed secondary education only gave a higher score than higher educated patients, and patients with prior ICT use scored higher than patients without. Tx patients also had clear preferences regarding IHT features, such as automatic data transfer as much as possible, visual aids (e.g. graphs) over text messages and personally deciding when to access the IHT.

Conclusions: By investigating Tx patients' possession and use of ICTs, we learned that computers and internet, and not smartphones, are the most suitable IHT platforms to deliver self-management interventions for our Tx patients. Moreover, Tx patients generally are open to use IHT, yet, patient acceptance variables and their preferences for certain IHT features should be taken into account in the next steps of the IHT development. Designers intending to develop or use existing IHT should never overlook this critical first step in a human-centred design.

Clinical relevance: Before considering using eHealth technology in clinical practice, professionals should always check whether patients are familiar with using information and communication technology, and whether they are willing to use technology for health-related purposes.

Introduction

Given that many chronically ill patients struggle to adhere to their medication regimen and to lead a healthy lifestyle, interventions are needed to support patients' self-management (Newman *et al.*, 2004). In recent years, interactive health technology (IHT) is increasingly put forward as an effective way to deliver such interventions (Murray *et al.*, 2005). IHT refers to technologies that allow patients to access or transmit health information and receive guidance or support on a particular health issue, and has shown to significantly improve patients' knowledge, self-efficacy, clinical and behavioural outcomes in a variety of diseases (Murray et al., 2005, Flodgren *et al.,* 2015). However, whether IHT will be effective in improving medication adherence or other health behaviours will largely depend on patients' willingness to use such technologies.

Indeed, use of technology should not be taken for granted. Unfortunately, software companies or engineers usually develop technologies using a "top-down" approach, assuming their IHT solutions will be welcomed and used by patients. Yet, without formally checking technology acceptance, or patients' openness or willingness to use these technologies in advance, it is not surprising that patients often refuse to use or abandon such technologies prematurely, with high patient dropouts in technology-related studies of up to 67.7% (Jeffs *et al.,* 2016). This can be due to a variety of reasons: because patients do not feel a need for the technology, perceive it as too intrusive, demanding or difficult, have technical problems or problems with the graphical user interfaces or have insufficient skills to use the technology (Stoop *et al.,* 2004, Williams *et al.,* 2003, Cruz-Correia *et al.,* 2007, Or & Karsh, 2009). In other words, the chasm between the developers' and the patients' view often leads to technology implementation failure.

In order to bridge this gap, and maximize technology acceptance and subsequent use, it is crucial to apply a human-centred design process. A human-centred design uses a "bottom-up" approach, and early and iteratively involves patients and relevant stakeholders in the design process, with the goal of "fully understanding and involving them" as end-users (De Vito Dabbs *et al.*, 2009). Research suggests that by applying these principles and evaluating variables that are known to influence technology acceptance throughout the process, the usability, quality and implementation of the technology in general improves, since it allows the multidisciplinary development team to accurately assess and address user requirements (Karsh, 2004).

In the PICASSO-Tx project ("Is there a preference for IHT as self-management support for solid organ transplantation (Tx)?"), we aim to develop and test the efficacy of a core 'face-to-face' self-management intervention with IHT-option, to support adult solid organ Tx patients' medication adherence, physical activity and weight control, following a state-of-the-art human-centred design. More specifically, we started from a pressing need within Tx to improve medication adherence and a healthy lifestyle. Indeed, nonadherence to the immunosuppressive regimen, insufficient physical activity and unhealthy diet are among the most prevalent Tx self-management problems, occurring in about 23, 19 and 25 cases per 100 patients per year, respectively, and are associated with a high morbidity and mortality risk (Dew *et al.*, 2007). Several risk factors have been investigated (Constantiner & Cukor, 2011). Theoretical models, like the 'Integrative model of behaviour prediction', can help to identify the most important drivers of nonadherence and lifestyle problems (Fishbein & Yzer, 2003). This model holds that a lack of intention/motivation, poor knowledge and skills, and the presence of barriers need to be addressed by self-management interventions, as these factors explain most of the variance in health behaviour. Unfortunately, few of these interventions have been tested in adult Tx, with variable efficacy, mainly due to methodological shortcomings such as the lack of a theoretical model underpinning the intervention and a poor description of the intervention, making it difficult to understand and replicate effective components (De Bleser *et al.*, 2009, Low *et al.*, 2015). Techniques that most consistently seem to work in improving health behaviours are self-monitoring, behavioural feedback, goal setting, action planning and problem solving (Michie *et al.*, 2013). Although these are typically presented during face-to-face encounters with a health professional and take place during a scheduled clinic visit, studies in other chronically ill populations demonstrated that they can also be used on a more continuous basis, in patients' daily life, by means of IHT (Murray et al., 2005). Unfortunately, IHT for self-management support in Tx is still in its infancy and deserves further testing. (Dew *et al.*, 2004, DeVito Dabbs *et al.*, 2016). However, *before* designing and testing the IHT in Tx, we first need to understand which information and communication technologies (ICTs) patients already use, allowing the selection of a platform to deliver such an intervention that is most familiar to patients (De Vito Dabbs et al., 2009). Many designers ignore this step and create fancy apps, not realizing that perhaps not all patients possess a smartphone, let alone have sufficient familiarity to use one if offered for free in the context of a research project, leading to an increased risk of premature IHT abandonment (Zhou *et al.*, 2014). Second, it is crucial to evaluate Tx patients' openness to such technology, and which relevant technology acceptance variables are associated. If there would be no or low openness, all future development steps would be pointless and a waste of money. Furthermore, if subgroups of patients would be less open to IHT for self-management support (guided by characteristics known to influence technology acceptance), researchers should ensure that these patients are well represented in the next steps of the design process, to increase their eventual acceptance (Karsh, 2004). Finally, patients' opinion on suggested IHT features should be solicited early, before developing an actual technology. Their preferences can then be applied in the next steps of our human centred design, in which a) more details on Tx patients' self-management needs are collected, b) prototypes are iteratively created with a heterogeneous group of patients, c) a prototype is programmed in the IHT platform and piloted in patients' daily lives, and d) further tested on its efficacy in improving self-management.

To summarize, this study represents the first step of a human centred design process, and aims to: 1) select an IHT platform to deliver a self-management intervention that is most closely related to Tx patients' current use of ICTs, 2) understand Tx patients' overall willingness to use IHT for self-management support, and investigate associations with relevant technology acceptance variables, and 3) explore Tx patients' views on potential IHT features.

Methods

Design, sample and setting

This cross-sectional, descriptive study was conducted in the four adult solid organ Tx programs of the University Hospitals Leuven, Belgium. Leuven hosts one of the largest Tx centres within

Europe. Belgium has a compulsory health insurance system with full immunosuppressive medication cost coverage. Patients remain in lifelong follow-up with outpatient clinic visits every 3 – 6 months, depending on their medical status, organ type and time post-Tx. This study used a convenience sample and applied broad inclusion criteria to ensure a representative sample of approximately 30 patients per Tx population. A patient sample of 120 was deemed sufficient, relative to the number of variables assessed (at least 10 patients/variable; see below). Patients were eligible to participate if they were: 1) a heart, lung, liver and/or kidney transplant recipient ≥ 6 months (as most patient are passed the critical post-Tx period and presumably start taking up their "normal" life again (Patel & Paya, 1997)), 2) scheduled for a follow-up visit at the outpatient clinic of the University Hospitals Leuven during the study period (October – December 2013), 3) ≥ 18 years of age, 4) sufficiently able to express themselves orally in Dutch, and 5) willing to sign an informed consent form. Patients were excluded if they were physically and/or cognitively unable to participate, as judged by the treating physician (e.g. mental retardation or severe cognitive problems following stroke). Illiteracy was not an exclusion criterion, as all variables were collected via interview (see variables and measurements).

Variables and measurements

Different types of concepts and variables related to possession and use of modern ICTs, overall willingness to use IHT as self-management support, technology acceptance that might be associated with overall willingness to use and preferences for specific IHT features were selected based on theoretical and empirical evidence, or developed specifically for this study.

Possession and use of modern ICTs

Together with IT- and human-centred design-experts, the researchers constructed a list of commonly used ICTs that were considered eligible as IHT platform to deliver interventions. Patients were asked about their possession of a cell phone, smartphone, desktop, laptop and/or tablet PC (Yes/No), duration of use (< 1 month, 1 month – 1 year, 1 – 3 years, > 3 years), purpose (e.g. calling or sending text messages), frequency (never, less than once a week, multiple times a week, every day, multiple times a day) and, if applicable, reasons for non-use. Furthermore, additional questions were asked about access to and type of internet (wired/ wireless/mobile), where it was used, the purpose (e.g. e-mailing) as well as frequency of use.

Overall willingness to use IHT for own self-management support

To assess Tx patients' overall willingness to use IHT, we asked how important it was for them personally that IHT would be developed to support them in their medication taking, physical activity and weight control (10-point numeric scale, 0= not at all important, 10= very important). We also explored associations between patients' scores and relevant technology acceptance variables. These were derived from the 'Unified Theory of Acceptance and Use of Technology' (UTAUT), a widely used model that predicts the acceptance and subsequent use of a new technology. It should be noted that only variables that were deemed relevant for the purpose of this pre-development study were applied, i.e. age and gender (other variables are only important when a technology (prototype) is already designed) (Venkatesh *et al.*, 2003). Additionally, we performed a literature review, and found that the technology acceptance variables education, children, marital status, employment and prior experience with technology were worthwhile to consider in relation to patients' overall willingness to use IHT for self-management support. **Figure 1** provides an overview of all identified technology acceptance variables, and the selection that was made for this first step of our human-centred design.

Table 1-2 and **Figure 2** show the answer categories and operationalization of the variables. Based on empirical evidence, we hypothesized that younger age, male gender, higher education, having children, being married or living together, being employed and having prior technology experience would be associated with a higher overall willingness to use IHT (Or & Karsh, 2009, Venkatesh et al., 2003, Venkatesh & Morris, 2000, Duplaga, 2012, Morris *et al.*, 2005).

Patients' views on potential IHT features

Tx patients' views on possible IHT features were operationalized by asking to what extent they would see themselves using a range of common IHT options (certainly not, neutral, certainly). Options to support medication adherence, physical activity and weight control were selected during multidisciplinary brainstorm sessions (See also **Table 3** for the IHT features).

The combination of these variables resulted in a 35-item, iteratively developed questionnaire that was presented to usability experts and was subsequently pilot-tested in one patient. It was administered in a structured, 'skip-logic' interview (i.e. skip questions based on patients' answers) to limit patient burden, ensure maximal participation and provide additional information or clarify items if needed. Total time for the interview was about 20 – 30 minutes.

Procedure

The Ethics Committee of University Hospitals Leuven approved the study, which was conducted according the Declaration of Helsinki and the guideline "Good Clinical Practice".

The researchers obtained lists of all adult solid organ Tx patients who had a scheduled outpatient clinic visit during the study period (October – December 2013). These lists were acquired from and screened for eligibility by the treating physicians of the adult heart, lung, liver and kidney Tx programmes. During this visit, the researcher (JV; Master's prepared nurse not belonging to the therapeutic team) approached eligible patients in the waiting room right before or after their consultation, and informed them about the study in a standardized way. If willing to participate, patients signed the informed consent form and the interview started at a convenient time for the patient. Approximately 30 patients per Tx population was pursued. All questionnaires were de-identified to allow coded analyses.

Analyses

Descriptive statistics were used as appropriate, based on the level of measurement and distribution of variables assessed (i.e. frequencies, percentages, means ± SD, medians (IQR)).

An ordinal logistic regression model was fit to determine the association between patients' score on overall willingness to use IHT to support own self-management and the selected technology acceptance variables. Additionally, the variable 'Tx population' was included as well to explore potential differences in association across the four populations. Presence of multicollinearity between variables was assessed through linear regression. The possibility of interactions was determined between age and the other independent variables. A p-value of < 0.05 was considered statistically significant and analyses were done with SPSS version 22.

Results

Sample characteristics (Table 1)

A convenience sample of 139 heart, lung, liver and kidney Tx patients who met the inclusion criteria was invited to participate, of which 122 consented to participate (i.e. 32 heart and 30 lung, liver and kidney Tx patients; participation rate: 88%). The mean age was 55.9 ± 13.4 years, most patients were male (57.4%) and married or living together (68%) (See **Table 1**).

Possession and use of modern ICTs (Figure 2 and Table 2)

Patients most frequently owned a cell phone (70.5%); only 27.9% of patients possessed a smartphone. Desktop, laptop and tablet PCs were owned by 54.1%, 64.8% and 26.2% of patients, respectively (see **Figure 2**). A total of 113 Tx patients (92.6%) had at least internet access at home and possible other places (e.g. at work). The percentage of patients possessing at least one desktop or laptop PC was 89.3%, with all having access to internet at home and the majority having wireless internet (72.1%). Yet, not all patients who *possessed* ICTs also *used* them. For example, 13 patients did not use the internet because they found it too complicated (n = 5), because they themselves did not need it (as opposed to their partner or children) (n = 4), or a combination of both (n = 4). Hence, of the patients who owned the ICT, 95.5% used their cell phone, all patients used their smartphone and 83.4%, 86.1% and 90.9% used their desktop, laptop and tablet PC, respectively. The majority of cell phone, desktop and laptop PC and internet users had been using it for ≥ three years, while this was only the case in 18% and 10% of the smartphone and tablet PC users, respectively.

Table 2 shows the top-3 of the most frequently performed actions per technology.

Overall willingness to use IHT for own self-management support (Table 3 & 4)

The median score for patients' overall willingness to use IHT for personal self-management support on the 10-point numeric scale was 7 (25^{th} percentile, 5; 75^{th} percentile, 8; range, 10 - 0) (See **Table 3)**. Multivariable ordinal logistic regression analysis showed that patients who were single (OR 16.9; 95% CI 3.57 – 80.05) or married or living together (OR 4.11; 95% CI 1.44 – 11.70) were more likely to score higher on overall willingness to use IHT compared to patients who were divorced or widow(er). Likewise, patients who completed secondary education only (OR 3.02; 95% CI 1.30 – 7.02) were more likely to give a higher score than patients with a higher education (university college or university), and patients with prior technology use scored higher (OR 11.36; 95% CI 1.70 – 75.88) then patients without (See **Table 4**).

Patients' views on potential IHT-features (Table 3)

The majority of Tx patients (84%) would see themselves using a weight scale to monitor their weight. About half of patients (51%) would be willing to use a pedometer to monitor their physical activity, yet only 37% would see themselves using an electronic medication pillbox. Automatic data transfer to a computer (84%) or smartphone (79%) was preferred over the patient sending the data on his/her own (60% and 56% respectively). Receiving feedback via smartphone or computer was similar (66% and 62%), yet patients preferred receiving the feedback via visual aids, e.g. graphs, over text messages (62% versus 52%) (See **Table 3)**.

Discussion

To our knowledge, this is the first study in solid organ Tx that focuses on selecting an IHT platform based on ICT familiarity, overall willingness to use IHT and views on potential IHT features. We found that most Tx patients are familiar with modern ICTs, especially computers and internet, yet not with smartphones and tablets. Moreover, our Tx patients' are overall willing to use IHT to support them in taking their medication, weight control and physical activity. Yet, divorced or widowed patients, patients who attained higher education or patients with no prior technology use had a lower overall willingness to use IHT. These important findings are further discussed in view of future development and testing of an IHT.

Smartphone apps are increasingly used to deliver self-management support interventions, wrongfully assuming that all patients possess and are familiar with using smartphones (Chow *et al.*, 2016). Therefore, the importance of investigating end-users' familiarity with modern ICTs, to make optimal use of their skills, should not be overlooked in this first human-centred design step. Indeed, we found a surprisingly low number of patients who owned and used a smartphone (27.9%). This prevalence rate is even slightly lower than the range of 35-63% reported in kidney Tx studies, or compared to the general Belgian population in 2013 (46.2%) (Browning *et al.*, 2016, Sieverdes *et al.*, 2015a, Sieverdes *et al.*, 2015b, McGillicuddy *et al.*, 2013, Lockwood *et al.*, 2013, FOD Economie, 2014). Yet, these studies did not always make a clear distinction between cell phones and smartphones, nor between possession and actual use. As comparison, 93% of our patients possessed at least one cell phone or smartphone. One may wonder why our findings contrast with, for instance, the general Belgian population. This can partly be explained by the fact that Tx patients in general are older, retired or disabled, and have a lower health status, factors that are known to be negatively associated with the adoption of new technologies (Or & Karsh, 2009). Furthermore, Browning et al. (2016) revealed that although smartphones in kidney Tx increased over the past years, patients ≥ 55 years were still significantly less likely to possess one (46% vs 75%, $p < 0.001$). Even if the number of Tx smartphone users increased since our data collection, this number would still not exceed 50%. Hence, selecting smartphones as primary platform and developing an 'app' to deliver our self-management intervention would have been a suboptimal choice, as patients who do not possess a smartphone would not be eligible to participate in future trials testing the efficacy of our IHT intervention, inevitably leading to selection bias. One could consider equipping patients with a smartphone, yet this would be costly, and might lead to a high drop-out rate because of usability issues inherent to initial smartphone usage (Zhou et al., 2014). Our interviews revealed that delivering our planned self-management intervention via a computer and website was a good alternative, since 89.3% of patients owned at least one computer with internet access (of which 72.1% wireless), and the vast majority using it for > 3 years. Furthermore, comparable numbers were found in the general Belgian population (81.9%), and a recent study in kidney Tx (79.1%) (Browning et al., 2016, FOD Economie, 2014).

Apart from selecting a suitable IHT platform, this study also provided interesting insights on patients' overall willingness to use IHT. In general, Tx patients were open towards IHT development, reflected by a median score of 7 out of 10 on the 'overall willingness to use IHT' scale, with 75% of patients giving a score of ≥ 5. This positive finding is consistent with the limited evidence available in solid organ Tx literature (McGillicuddy et al., 2013, Sieverdes et al., 2015a, Browning et al., 2016). Yet, some technology acceptance variables might be associated with overall willingness to use, bearing in mind that the numbers are small as shown in the wide confidence intervals, and that the results should therefore be interpreted with care. More specifically, we found that patients who were divorced/widowed, who had attained higher education or who had no prior technology use gave lower scores. The latter is in line with other research showing an association between no or little prior technology use and lower acceptance of new technologies, given the lower ICT familiarity and skills (Or & Karsh, 2009). It is plausible that divorced/widowed patients suffer from depressive symptoms, and might therefore experience insufficient energy to adequately manage their therapeutic regimen, with or without technology (Kessler & Bromet, 2013). Yet, the underlying mechanisms for these lower scores warrant further investigation. Similarly, one can only speculate about the lower scores in higher educated patients. Perhaps these patients are more sceptical regarding IHT development and want to experience the new technology first. Yet, it seems that higher educated patients in particular might benefit from additional support, since previous research has shown that higher, and not lower education, was associated with medication nonadherence (Dobbels *et al.*, 2009). In the philosophy of a human-centred design process, these patient subgroups in particular need to be actively involved in all future steps so that they also become open to use IHT. It is nevertheless reassuring that we did not find different scores in overall willingness to use IHT for the other selected variables, like gender, employment, having children or Tx population. Surprisingly also, and in contrast to other studies, age did not correlate significantly with overall willingness to use IHT (Or & Karsh, 2009). Since the age of Tx patients is increasing, this is encouraging and suggests that a majority would be willing to embrace IHT for self-management support, irrespective of their age (Abecassis *et al.*, 2012).

Interestingly, participants provided useful information on desired IHT features for self-management support. First, patients are not eager to receive messages or reminders and want to independently decide when to access the website, despite meta-analytic evidence showing significant improvements in medication adherence by reminder systems (Fenerty *et al.*, 2012). Second, they prefer visual aids, like graphs, over text messages to receive feedback, and finally, they prefer automated data transfer between the monitoring devices and the website, rather than having to type in information themselves. These preferences will be used in the IHT development, further in our human-centred design, in order to maximize technology uptake.

Some limitations of our work should however be addressed. First, although this was a monocentric study, raising caution for generalization, the inclusion of four solid organ Tx populations from one of the largest European Tx centres can be considered a strength. Furthermore, notwithstanding the fact that convenience sampling was used and that only 30 Tx patients per group were included, the demographic characteristics of the included Tx patients closely resemble those of registry reports, ensuring a heterogeneous and representative sample (Yusen *et al.*, 2013, Lund *et al.*, 2013, Eurotransplant, 2017a, Eurotransplant, 2017b). Yet, we excluded patients who were < 18 years of age, physically or cognitively unable to participate, and patients insufficiently able to communicate in Dutch, which are groups that are often prone to health inequalities. The use of interviews further contributed to the representativeness of our sample, since it allowed inclusion of illiterate patients as well, and that items that were not well understood could be easily clarified. The use of UTAUT as theoretical model underpinning our choice of variables can be considered a strength, yet, some of its variables might be less relevant when exploring IHT openness before an actual technology is designed. For example, patients can only judge how easy a technology is to use once they can experience it. Therefore, assessing their openness, irrespective of technology-related characteristics might be more relevant in a 'pre-design stage'. The 'Technology Readiness Index' is such a questionnaire that captures patients' beliefs of new technologies, independent of their actual competence to use them, and might therefore be a valuable addition to our interview questionnaire (Parasuraman, 2000). Finally, mobile phone usage in Belgium has increased since the time of our data collection from 46.2% to 65%. However, computer possession remains much higher (82.1%), still confirming our selection of computers as primary IHT platform (FOD Economie, 2016).

In conclusion, investigating Tx patients' possession and use of ICTs showed that computers and internet are suitable IHT platforms to deliver self-management interventions in the sample and setting under study. Furthermore, Tx patients in general are positive towards the development and use of IHT. Future studies intending to develop or use existing IHT should never overlook this critical first step within a human-centred design process.

Clinical resources

More information on the PICASSO-Tx project: https://soc.kuleuven.be/mintlab/blog/projects/

More information on the human-centred design process: http://www.designkit.org/human-centered-design; http://www.designkit.org/resources

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Figures and tables

Table 1: Demographics and clinical characteristics

Characteristics	**Total sample (n = 122)**
Men, n (%)	70 (57.4%)
Age in years, mean ± SD, range	55.9 ± 13.4, 21 - 83
Native tongue, n (%)	
Dutch	115 (94.3%)
French	5 (4.1%)
Italian	2 (1.6%)
Having children, n (%)	93 (76.2%)
Marital status, n (%)	
Married or living together	83 (68%)
Single	24 (19.7%)
Divorced	9 (7.4%)
Widow/Widower	6 (4.9%)
Educational level, n (%)	
Primary school	35 (28.7%)
Secondary school	47 (38.5%)
University college	25 (20.5%)
University	15 (12.3%)
Employment, n (%)	
Employed	31 (25.4%)
Full time	19 (61.3%)
Other[1]	12 (38.7%)
Disabled	45 (36.9%)
Retired	41 (33.6%)
Unemployed	2 (1.6%)
Student	2 (1.6%)
Housewife	1 (0.8%)
Type of transplantation, n (%)	
Lung	30 (24.6%)
Heart	32 (26.2%)
Kidney	30 (24.6%)
Liver	30 (24.6%)
Time post-Tx in years, median (Q1 – Q3) range	6 (2 - 12) 27 – 0.5

SD, Standard Deviation; Tx, Transplantation; Q1, 25th percentile, Q3, 75th percentile; [1] Time employed between 50% – 80%

Table 2: Top-3 most frequent actions performed by transplant patients who actually use the ICT[1] (n = 122)

Action	N (%) Yes
I use my cell phone at least once a week to…	
receive text messages	59 (72%)
make phone calls	54 (65.9%)
send text messages	52 (63.4%)
I use my smartphone[2] at least once a week to…	
receive text messages	33 (97.1%)
send text messages	33 (97.1%)
make phone calls	31 (91.2%)
I use my desktop PC at least once a week to…	
work with a text processor	20 (36.4%)
play games	12 (21.8%)
work with a spread sheet-programme	11 (20%)
I use my laptop PC at least once a week to…	
work with a text processor	22 (32.4%)
play games	17 (25%)
work with a spread sheet-programme	13 (19.1%)
I use my tablet PC at least once a week to…	
play games	12 (41.4%)
use Bluetooth[3]	4 (13.8%)
take and/or watch photos	2 (6.9%)
I use the internet at least once a week to…	
send and/or receive e-mails	91 (91%)
read literature[4]	59 (59%)
participate in social media[5]	45 (45%)

[1] Information and Communication Technology
[2] Differences between cell phone and smartphone: the latter has a touch screen and/or full keyboard, is a combination of a cell phone and a 'personal digital assistant', uses an operating system that allows third party applications to run on and has more advanced capabilities (Joan, 2011)
[3] To connect with other devices to, for example, stream music, videos and photos.
[4] e.g. online newspaper, news site, etc.
[5] e.g. Facebook®, Twitter®, etc.

Table 3: Overall willingness of transplant patients to use IHT for personal self-management support and their views on potential IHT features (n = 122)

To what extent do you see yourself using…	Certainly: n (%)
a weight scale to monitor your weight	103 (84%)
a pedometer to monitor your physical activity	62 (51%)
a pillbox that registers your medication intake	45 (37%)
technology of which data are sent to a computer automatically	101 (83%)
technology of which data are sent to a smartphone automatically	96 (79%)
technology where you have to send data to a computer on your own	73 (60%)
technology where you have to send data to a smartphone on your own	68 (56%)
a smartphone to receive feedback	80 (66%)
a computer to receive feedback	75 (62%)
visual aids to receive feedback[1]	76 (62%)
text messages to receive feedback	63 (52%)
‘How important it is for you that technology is being developed to support you in your physical activity, weight control and medication adherence on a scale from 0 to 10?’[2], median (Q1 – Q3), range	7 (5 – 8), 10 - 0

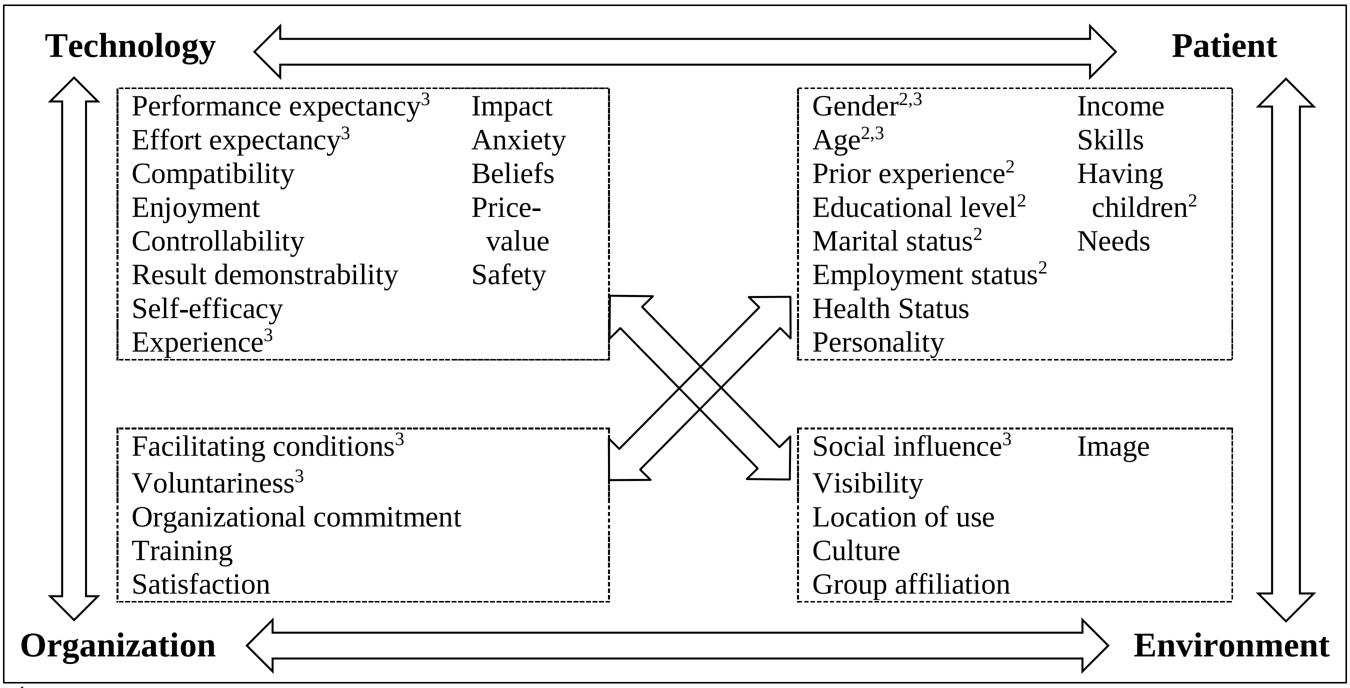
[1] e.g. graphs and tables
[2] 0 = not important at all; n = 121
Q1, 25th percentile, Q3, 75th percentile

Table 4: Ordinal logistic regression determining the association between selected technology acceptance variables and Tx population and Tx patients' overall willingness to use IHT[1] (n = 121)

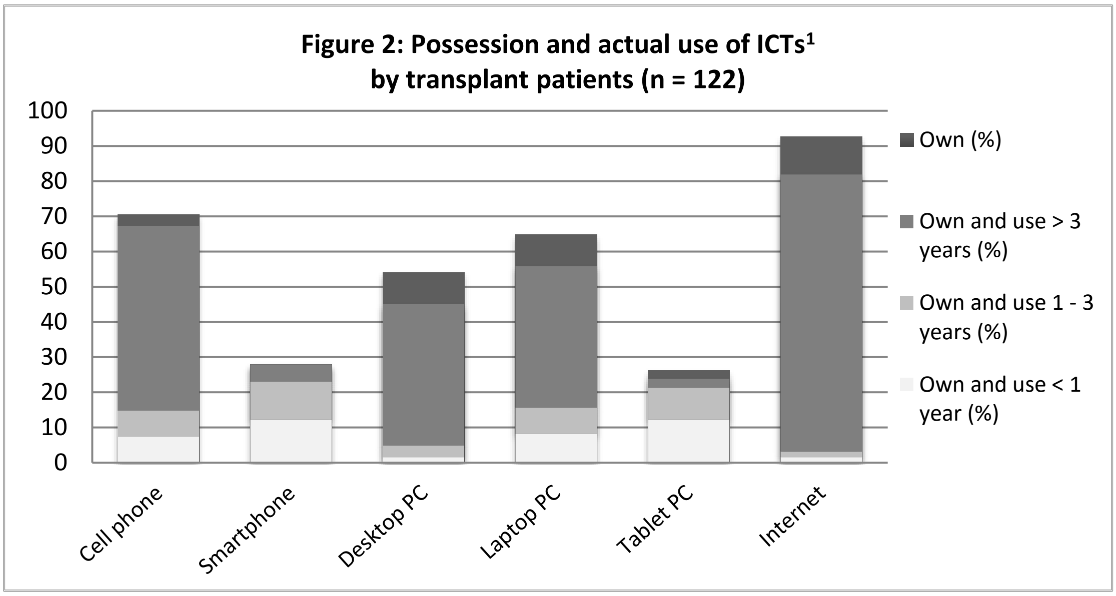
Parameter		Exp(B) OR	Sig.	95% CI for Exp(B)	
				Lower bound	Upper bound
Age		0.99	0.6384	0.96	1.02
Gender	Male	0.63	0.1948	0.31	1.27
	Female **(Ref)**	.	.	.	.
Marital Status	Single	16.90**	0.0004	3.57	80.05
	Married or living together	4.11*	0.0082	1.44	11.70
	Divorced/Widowed **(Ref)**	.	.	.	.
Educational level	Primary education	2.52	0.0644	0.95	6.71
	Secondary education	3.02*	0.01	1.30	7.02
	Tertiary education **(Ref)**	.	.	.	.
Employment	Unemployed	1.31	0.5138	0.58	2.98
	Employed **(Ref)**	.	.	.	.
Having children	Yes	0.33	0.0742	0.10	1.11
Transplant type	Lung	2.63	0.058	0.97	7.16
	Heart	1.23	0.6838	0.45	3.34
	Kidney	1.21	0.6965	0.47	3.14
	Liver **(Ref)**	.	.	.	.
Prior technology use[2]	Yes	11.36*	0.0121	1.70	75.88

Ref: this group was used reference
*Statistically significant $p < 0.05$
**Statistically significant $p < 0.001$
[1] Tx patients' overall willingness to use IHT as personal support in their medication adherence, physical activity and weight control; scale from 0 - 10
[2] Prior technology use: patients who already own and use any of the questioned ICTs
Results: Patients who were single or married or living together were more likely to give a higher score than divorced or widowed patients; Patients who completed secondary education were more likely to give a higher score than patients with higher education; Patients with prior technology use were more likely to give a higher score than patients without.

Figure 1: Overview of technology acceptance variables that can be used throughout a human-centred design process[1]



[1] Adapted figure from (Smith & Sainfort, 1989). Technology acceptance has to do with an interaction between patient-related variables (i.e. patient characteristics) and their perception of the new technology, the environment and the organization.
[2] Variable included in questionnaire of the current study.
[3] Variable is part of the 'Unified Theory of Acceptance and Use of Technology' (UTAUT); i.e. combination of patient-, technology-, organizational- and environmental-related variables that predict the acceptance and use of a new technology (Venkatesh et al. (2003))



[1] ICTs: Information and Communication Technologies
Use < 1 year: % of patients that own and use the respective technology for less than 1 year
Use 1 – 3 years: % of patients that own and use the respective technology between 1 year and 3 years
Use > 3 years: % of patients that own and use the respective technology for more than 3 years
Own: % of patients that own the respective technology, but do not use it (themselves)