KU Leuven
Biomedical Sciences Group
Faculty of Medicine
Department of Public Health and Primary Care

NURSING ASPECTS OF DELIRIUM PREVENTION AND DETECTION IN HOSPITALIZED PATIENTS

Elke DETROYER

Jury:

Promoter:	prof. dr. Koen Milisen
Co-promoter:	prof. dr. Etienne Joosten
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Jury members:	prof. dr. Philip Moons
	prof. dr. Marieke Schuurmans
	prof. dr. Mathieu Vandenbulcke
	prof. dr. Nele Van Den Noortgate

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"The most important practical lesson

that can be given to nurses is to teach them

what and how to observe ..."

- Florence Nightingale -

Dankwoord

Dit ‘boekje’ is het resultaat van vele jaren doctoraatsonderzoek. Doch, het werken aan een doctoraat is veel meer dan dit ‘boekje’. Het was een leerrijk proces, een levenservaring, een unieke kans om te evolueren als onderzoeker en als mens. Graag wil ik de mensen bedanken die mij tijdens mijn doctoraatstraject hebben bijgestaan.

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Elke

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LIST OF ABBREVIATIONS

A

ACB	Anticholinergic Cognitive Burden
APACHE	Acute Physiology and Chronic Health Evaluation
APAIS	Amsterdam Preoperative Anxiety and Information Scale
ASE	Attention Screening Examination
AUC	Area Under the Curve

B

BI	Bias Index

C

CABG	Coronary Artery Bypass Graft
CAM	Confusion Assessment Method
CAM-ICU	Confusion Assessment Method for the Intensive Care Unit
CAM-S	Confusion Assessment Method Score for Delirium Severity
CI	Confidence Interval
COPD	Chronic Obstructive Pulmonary Disease

D

DE	Difference Estimate
DI	Delirium Index
DKQ	Delirium Knowledge Questionnaire
DOSS	Delirium Observation Screening Scale
DR	Delirium Recognition
DSD	Delirium Superimposed on Dementia
DSM-5	Diagnostic and Statistical Manual of Mental Disorders, fifth edition

G

GDS	Geriatric Depression Scale
G/EC	Good/Excellent Completion

H

HADS	Hospital Anxiety and Depression Scale

I

ICDSC	Intensive Care Delirium Screening Checklist
IC	Intervention Cohort
ICU	Intensive Care Unit
IQR	Interquartile Range
IV	Intravenous

K

κ	Kappa
Katz-ADL	Katz Index of Activities of Daily Living

L

L/MC	Low/Moderate Completion

M

MMSE	Mini-Mental State Examination
MRC	Medial Research Council

N

NIC	Non-Intervention Cohort
No	Number
NPV	Negative Predictive Value

O

O	Odds Ratio

P

P_0	Proportion Observed Agreement
PCU	Palliative Care Unit
PRECEDE	Predisposing, Reinforcing and Enabling Constructs of Educational Diagnosis and Evaluation
PI	Prevalence Index
PPV	Positive Predictive Value

R

RASS	Richmond Agitation-Sedation Scale
ROC	Receiver Operating Characteristic
RQ	Research Question

S

SCDI	Strain of Care for Delirium Index
SD	Standard Deviation
S_n	Sensitivity
S_p	Specificity
STAI	State-Trait Anxiety Inventory

V

VAS	Visual Analogue Scale

CHAPTER I

General Introduction

Delirium, derived from the ancient Greek 'L. delirare' which means 'out of the furrow', is one of the first mental disorders being described over 2000 years ago.[1] Nowadays, delirium is defined as a syndrome characterized by an acute and/or fluctuating disturbance of attention and awareness together with a disturbance in cognition or perception.[2] It can occur as hyperactive (e.g. increased psychomotor activity) or hypoactive (e.g. psychomotor retardation) states, and fluctuations between these two may be present. Delirium is a common problem in the hospital affecting 11% to 68% of surgical (i.e. cardiac and orthopaedic surgery), 29% to 64% of medical, and up to 88% of intensive care and palliative care unit patients.[3-6] These patients are at increased risk for developing poorer short and long-term complications including poor functional recovery, persistent cognitive decline, institutionalisation, higher rates of mortality and prolonged length of hospital stay, which consequently lead to additional healthcare costs.[7] In order to mitigate this common and serious syndrome, permanent investments are required.

The Complex Etiology of Delirium

Delirium is a complex syndrome, still not fully understood. However, an understanding of its etiology will give guidance to its management in daily practice. Delirium is caused by the physiopathological consequences of a medical illness, drug use or multiple causes.[2] Moreover, it can be best predicted based on a validated model that describes an interplay between different risk factors. Indeed, the onset of delirium depends on the vulnerability of patients at hospital admission (i.e. presence of predisposing factors) and the exposure to precipitating factors (i.e. acute insults) during hospitalisation.[8] Hence, one single precipitating factor might already be able to cause delirium in vulnerable patients. Conversely, patients with low vulnerability need multiple precipitating factors to become delirious.

To date, several risk factors for delirium have been identified in different hospital populations such as medical, surgical and intensive care.[3,9-12] The principal predisposing factors found to be consistent across those populations include advanced age, pre-existing cognitive impairment and the presence of comorbidities or severe illness.[3,9-11] Although most of these factors are not remediable, their recognition allows to identify medium to high risk groups of patients who need active monitoring. Precipitating factors, however, include various remediable and non-remediable conditions which vary across hospital populations. Examples of such factors are type of surgery and prolonged intubation/mechanical ventilation in surgical patients,[9,12] poly-trauma or emergency surgery prior to ICU admission, use of mechanical ventilation and metabolic acidosis in ICU patients,[3,10] and polypharmacy and use of psychoactive medication in medical patients.[3] Poor pain management and abnormal laboratory values are leading risk factors in all patient populations.[3,9-12] The last years, frailty is an

increasingly recognized concept to describe patients' vulnerability to adverse health outcomes such as poor functional and cognitive status, mortality and institutionalization.[13,14] However, little is known about frailty as risk factor for delirium and the existing studies are inconclusive.[15-18] Yet, the operationalization of the frailty concept is unclear, and several frailty tools exist each which their own strengths and weaknesses.[19-20] Further research is needed to investigate which frailty tools are considered appropriate in different hospital populations, and whether those tools are possible indicators for a population at risk for delirium during the hospitalization.[15] Therefore, the identification of individual risk factors for delirium remains most important.

Diagnosis of Delirium

The diagnosis of delirium is mainly clinical, and based on clinical history (e.g. family member), cognitive assessment (e.g. Mini-Mental State Examination,[21] short portable mental status questionnaire,[22] mini-cog[23]) and observation of its key features.[3,24] Based on the Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5), those key features include "*a disturbance in attention (i.e. reduced ability to direct, focus, sustain and shift attention) and awareness, a change in cognition (i.e. disorientation, memory deficit, disturbances in language or perception) that is not attributed to pre-existing, established or evolving dementia, and an acute onset (i.e. hours to days) and fluctuations in symptoms*".[2] In order to assess attention, simple tests such as recitation of digit spans,[25] and days of the week or months of the year backwards[26,27] were developed. For non-verbally active ICU patients, other tests such as the Attention Screening Examination (ASE) including a visual and auditory component from the Confusion Assessment Method for the intensive care unit (CAM-ICU) can be used.[28] Irrespective the existing tests for attention and cognitive assessment, delirium can be misdiagnosed because of its overlapping symptoms with dementia and depression (i.e. hypoactive delirium).

Management of Delirium

Prevention through modification of identified risk factors and detection of early signs of delirium are the cornerstones of delirium management. A variety of interventions for the prevention of delirium have been developed including unicomponent (e.g. the use of earplugs,[29] staff education[30] or protocols targeting specific risk factors[31,32]) and multicomponent (e.g. combination of staff education, protocols or reorganisation of systems) strategies both targeting risk factors for delirium. To date, multicomponent non-pharmacological intervention

strategies have been recommended because of their preventive effects on delirium in 30% to 50% of cases in medical and surgical hospital populations.[33-39] Although the number of included components may vary between two[38] and thirteen,[39] a multicomponent intervention program generally includes interventions regarding (1) education, (2) individualised care, (3) reorientation and (4) early mobilisation.

It is clear that not all delirium cases are preventable through preventive strategies. Daily observations for detection of early signs of delirium in high risk patients are a prerequisite for the proper diagnosis and early treatment of delirium.[33] To date, there is limited evidence supporting the effectiveness of delirium treatment strategies. Treatment recommendations, therefore, come from expert consensus. Well-established consensus guidelines recommend (1) the identification and treatment of all underlying causes, (2) the provision of a stable and reassuring environment with an effective communication and reorientation, and (3) the use of drugs for symptom management in case of agitation and distress in patients with diagnosed delirium.[33]

Despite the long history of delirium and the investments being made, the syndrome remains poorly prevented and frequently unrecognized or misdiagnosed (33%-72%) in daily practice.[40-44] These problems might partially attributed to the limited delirium-related knowledge or skills of healthcare workers regarding delirium management. Accordingly, they fail to systematically identify and tackle risk factors, to use screening tools for delirium detection, and still describes delirium as ‘confusion’ in notes; an unclear term which can be a diagnosis or a symptom.[42,45] Among these individual barriers, organisational and cultural barriers can be identified such as attitudes about ageing and its effect on clinical decision making,[46,47] a lack of implementation resources and the low priority of delirium in hospitals. For example, only a fourth of the Belgian hospitals have a written delirium policy at geriatric department level, and even less than a fifth of them have such a policy at hospital level.[48] Furthermore, recognition of delirium might be complicated with some features of delirium including the fluctuations of symptoms and the overlap with dementia or depression. Nevertheless, those findings highlight the importance of improving the efforts for delirium prevention and early detection in order to optimize delirium management in daily practice.

Nursing Aspects of Delirium Prevention and Detection

Although the management of delirium concerns the entire healthcare team, nurses in particular play a pivotal role in the prevention and early recognition of delirium.[37] Indeed, because of their continuous contacts with patients, they are the most strategic of all healthcare workers to identify and target risk factors and to observe early signs of delirium such as acute

disturbances and fluctuations in attention, cognition and behaviour. Optimization of a delirium management in daily practice, therefore, requires permanent investments in nursing aspects of delirium prevention and early detection. Three main aspects were identified as part of this PhD (**Figure 1.1**).

1. Risk Factors for Delirium

As indicated before, knowledge about the remediable and non-remediable risk factors for delirium is important to set up preventive strategies. Although many risk factors have been identified across hospital populations,[3,9-12] the contribution of remediable preoperative psychological factors such as anxiety or depression in the onset of postoperative delirium remains less well investigated.[49-51] Since previous studies[52-54] have reported that these psychological factors are associated with adverse patient outcomes including poorer functional recovery, increased risk for readmission and overall cognitive impairment, they might be related with delirium too. More importantly, significant relationships with delirium could open new targets in delirium prevention. Hence, more research is needed to evaluate whether preoperative psychological factors are risk factors for postoperative delirium.

2. Screening for Delirium

Since more than half of the delirium cases are not preventable,[34,35] early detection of delirium is required for its correct diagnosis and proper treatment. This can be enhanced through a systematic monitoring of patients' behaviour and cognition. For this reason, several screening tools have been developed.[55] Within this abundance of screening tools, those which are based on bedside observations of cognition and behaviour are given precedence. For their successful implementation in daily practice, however, psychometric testing of such tools based on data gathered by healthcare workers in routine care is required. The Delirium Observation Screening Scale (DOSS)[56] and the Intensive Care Delirium Screening Checklist (ICDSC)[57] are the two most common observation-based screening tools used by nurses. However, their psychometric properties and ease-of-use when performed by bedside nurses in daily care in specific risk populations are less well examined, and need further investigation.[56-62]

3. Education

A staff educational curriculum about delirium is an important element of delirium preventive and treatment strategies.[36] Such curriculum aims to improve staffs' delirium-related knowledge

and to develop their skills and attitudes to effectively prevent and manage delirium in daily care. The existing initiatives include packages with structured courses or formal presentations whether or not followed by case-based discussions, feedback, reminders and/or expert local specialist input.[34,35,63,64] Although previous research support the effectiveness of such educational initiatives on staffs' outcomes,[63,64] they are hard to implement beyond the research setting and their effect on patient outcomes is scarce.[46,47,65,66] Delirium through e-learning is hypothesised to be easier to implement in daily practice than the more traditional educational packages.[67,68] Limited evidence is, however, available regarding the effectiveness of delirium education through e-learning on nursing and patient outcomes.[69-71]

Research Objectives and Questions

This PhD dissertation aimed to fill the gaps in current research regarding these three nursing aspects of delirium prevention and detection in hospitalized patients, which were addressed in three objectives and seven research questions (**Figure 1.1**).

The first objective was to investigate if preoperative psychological factors are independent risk factors for postoperative delirium in high risk groups of surgical patients. This objective resulted in the following research questions (RQ):

RQ 1: What is the relationship between the presence of preoperative anxiety and depression, and the development of delirium after cardiac surgery in older patients? (Chapter II)

RQ 2: What is the relationship between the presence of preoperative anxiety and the development of delirium after hip fracture surgery in older patients? (Chapter III)

The second objective was to assess the psychometrics and user-friendliness of observation-based screening tools for the detection of delirium when performed by nurses in daily routine practice, which was addressed in the following research questions (RQ):

RQ 3: What is the diagnostic accuracy, concurrent validity, internal consistency, and user-friendliness of the Delirium Observation Screening Scale (DOSS)[56] when performed by bedside nurses in palliative care unit patients? (Chapter IV)

RQ 4: What is the diagnostic accuracy, concurrent validity, internal consistency and user-friendliness of the Intensive Care Delirium Screening Checklist (ICDSC)[57] when performed by bedside ICU nurses in routine daily practice? (Chapter V)

The third objective was to evaluate the impact of delirium education through e-learning on outcomes in staff and patients. Therefore, a new delirium e-learning tool has been developed as part of this PhD. A widely used framework to determine the effectiveness of an educational intervention is Kirkpatrick's four-level evaluation model.[72,73] According to this model, learning outcomes can be evaluated at four levels: 1) participants' reaction (i.e. learners' views on the educational intervention such as their satisfaction with the intervention, the usefulness and feasibility of the intervention for the learners), 2) participants' learning skills (i.e. changes in knowledge/skills of learners), 3) participants' change in behaviour (i.e. changes in clinical practice), 4) benefits to patients (i.e. changes in patient outcomes). This PhD project evaluated the impact of delirium education through the delirium e-learning tool on three of these levels, which were addressed in three research questions:

RQ 5: What is the usefulness and feasibility of a newly developed interactive delirium e-learning tool for healthcare workers? (Chapter VI)

RQ 6: What is the effect of this delirium e-learning tool on healthcare workers' delirium recognition, delirium knowledge and level of strain when caring for delirious patients? (Chapter VII)

RQ 7: What is the effect of this delirium e-learning tool on occurrence, duration and severity of delirium, and mortality in hospitalized geriatric patients? (Chapter VIII)

RISK FACTORS FOR DELIRIUM

1. Preoperative psychological factors as independent risk factors for developing postoperative delirium

RQ 1. Prospective observational study

Relationship preoperative anxiety/depression, and post cardiac surgery delirium in older patients

Chapter II

RQ 2. Secondary data analysis comprising data from a prospective non-randomized trial

Relationship preoperative anxiety and post hip fracture surgery delirium in older patients

Chapter III

SCREENING FOR DELIRIUM

2. Psychometrics and user-friendliness of observation-based screening tools for the detection of delirium in routine practice

RQ 3. Prospective observational study

Diagnostic accuracy/concurrent validity/internal consistency and user-friendliness of Delirium Observation Screening Scale (DOSS) performed by bedside palliative care unit nurses

Chapter IV

RQ4. Prospective observational study

Diagnostic accuracy/concurrent validity/internal consistency and user-friendliness of Intensive Care Delirium Screening Checklist (ICDSC) performed by bedside ICU nurses in daily practice?

Chapter V

3 NURSING ASPECTS OF DELIRIUM PREVENTION AND DETECTION

STAFF EDUCATION

3. Outcomes of delirium education through e-learning

Kirkpatricks' model
- Level 1: participants' reaction
- Level 2: participants' knowledge/skills
- Level 3: participants' behavioural change
- Level 4: patients' benefits

RQ 5. Descriptive study - *Chapter VI*

Usefulness and feasibility of delirium e-learning tool for healthcare workers?

RQ 6. Pre/posttest study - *Chapter VII*

Effect of delirium e-learning tool on healthcare workers' delirium recognition, delirium knowledge and level of strain with delirium

RQ 7. Before-after study - *Chapter VIII*

Effect of delirium e-learning tool on occurrence/duration/severity of delirium, and mortality in hospitalized geriatric patients?

Figure 1.1. Overview PhD Dissertation

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CHAPTER II

Risk Factors for Delirium after Cardiac Surgery

This chapter is published and reproduced with the kind permission of the editor:

Detroyer E, Dobbels F, Verfaillie E, Meyfroidt G, Sergeant P, Milisen K. Is preoperative anxiety and depression associated with onset of delirium after cardiac surgery in older patients? A prospective cohort study. Journal of the American Geriatrics Society 2008; 56(12): 2278-84.

Abstract

Objectives: To investigate the prevalence of preoperative anxiety and depressive symptoms and their relationship with the occurrence of postcardiac delirium and to describe the evolution of these symptoms from preoperative admission until discharge.

Design: Descriptive, prospective, longitudinal study.

Setting: The intensive care unit and two cardiac surgery units in a university hospital setting.

Participants: One hundred four patients (median age 71; 78.8% men) admitted for elective cardiac surgery.

Measurements: Anxiety measured preoperatively using the State-Trait Anxiety Inventory (STAI) and the Hospital Anxiety and Depression Scale (HADS); depression using the HADS; cognitive functioning using the Mini-Mental State Examination (MMSE); delirium using the Confusion Assessment Method (CAM), the CAM for the Intensive Care Unit (CAM-ICU), and the Delirium Index (DI); and activities of daily living using the Katz index of activities of daily living (Katz ADL scale). MMSE, CAM/CAM-ICU, and DI were obtained on postoperative days 1, 3, and 7. On day 7 and at discharge, the STAI, HADS, and Katz ADL scale were repeated.

Results: Postoperative delirium occurred in 26%; 55.8% reported preoperative state anxiety, 25.2% generalized anxiety, and 15.5% depressive symptoms, but no association was found with delirium occurrence. Based on multivariable analysis, prolonged intubation time (odds ratio (OR) = 1.10, CI: 1.05 – 1.15, p = 0.001) and a low intraoperative lowest body temperature (OR = 0.86, CI: 0.74 – 0.99, p = 0.03) were independent predictors of delirium onset. At discharge, 35.7% and 12.2% of patients reported state anxiety and generalized, and 15.3% reported depressive symptoms.

Conclusion: Despite the high prevalence of preoperative anxiety and depressive symptoms in older patients with cardiac surgery, no association was found with postoperative delirium.

Introduction

Delirium is a common psychiatric complication after cardiac surgery (incidence 3 - 47%) characterized by disturbance of consciousness; poorer ability to focus, sustain, or shift attention; change in cognition; and development of a perceptual disturbance. It occurs over a short period of time (hours to days) and tends to fluctuate over the course of the day. Although it can appear at all ages, elderly hospitalized patients are particularly at risk.[1–6]

Special attention must be paid to delirium after cardiac surgery, because the syndrome is associated with adverse outcomes, including higher rates of postoperative complications, longer hospital stay, and higher mortality.[2] Furthermore, evidence from other populations shows that delirium is associated with risk of nursing home placement and a higher dependence in activities of daily living (ADLs).[7,8]

Numerous studies have investigated pre-, intra-, and postoperative risk factors, and all concluded that the causes of delirium after cardiac surgery are multifactorial.[2–5,9] Not surprisingly, high incidence rates of preoperative anxiety (27–40.6%) and depressive symptoms (16–43%) are reported before cardiac surgery,[10–12] yet the influence of anxiety on occurrence of postoperative delirium remains controversial and has been examined in two noncardiac surgery studies[13,14] but not in cardiac surgery patients. Prior studies in non-cardiac surgery suggested that depression was a predictor of delirium, but its relationship with cardiac surgery needs to be determined.[15,16]

The aim of this study was to investigate the prevalence of preoperative anxiety and depressive symptoms and their relationship with post-cardiac surgery delirium. The evolution of anxiety and depressive symptoms during hospital stay is also described.

Methods

Design and Sample

A prospective design, starting preoperatively and continuing until discharge, was used, including a cohort of eligible consecutive patients admitted for elective cardiac surgery to the University Hospital of Leuven (Belgium) (December 2005 to March 2006). Subjects were aged 60 and older, Dutch-speaking, and verbally testable. Patients undergoing an emergency surgical procedure or having delirium at admission were excluded.

Variables

Demographics

Preoperative demographic data collected were age, sex, marital status (being married or living together vs other), education level (low = schooling up to 15 years of age, moderate = until 18 years of age, high = more than 18 years of age), and living situation (institutionalized vs living at home).

Cognitive Status

The Mini-Mental State Examination (MMSE) was used to assess presence and severity of cognitive dysfunction.[17] The total score ranges between 0 and 30, with a score of 24 to 30 indicating no cognitive impairment, 18 to 23 mild cognitive impairment, and 0 to 17 severe cognitive impairment.[18]

Delirium

Delirium was assessed using the Confusion Assessment Method (CAM) on cardiac surgery wards.[19,20] This is a diagnostic algorithm based on Diagnostic and Statistical Manual of Mental Disorders, Third Edition, Revised, and Fourth Edition (DSM-III-R and DSM-IV) criteria for delirium. The nine CAM items were completed immediately after the MMSE interview and included: (1) acute onset and fluctuation, (2) inattention, (3) disorganized thinking, (4) altered level of consciousness, (5) disorientation, (6) memory impairment, (7) perceptual disturbance, (8) psychomotor agitation or retardation, and (9) altered sleep wake cycle. For CAM Criteria 2 to 8, only symptoms observed during the interview were taken into account for scoring. For CAM Criteria 1 and 9, additional information was obtained from the nurse most closely involved in the patient's care. To diagnose delirium, it is justified to use only the four core criteria of the CAM algorithm (Criteria 1, 2, and 3 or 4), but it is often difficult during a 10- to 20-minute bedside interview to assess the fluctuating course of the syndrome (Criterion 1), even with additional information from the nurses. Therefore, this criterion was modified to ''acute onset OR fluctuating course'' instead of the ''AND'' specification, allowing greater sensitivity for detection of all possible delirium cases.[19]

Delirium in the ICU wards was assessed using the CAM for the Intensive Care Unit (CAM-ICU), a validated instrument using questions with nonverbal answers and simple commands to rate the four core criteria of the CAM algorithm in mechanically ventilated or restrained ICU patients.[21] The first step assesses the level of consciousness using the Richmond Agitation-

Sedation Scale (RASS), a 10-point scale, ranging from -5 to +4, with four levels of anxiety or agitation (+1 to +4 (combative)), one level to denote a calm and alert state (0), and five levels of sedation (-1 to -5 (unarousable)). Only patients who had a RASS-score of -3 or greater could be assessed, because they are at least minimally responsive to verbal stimuli. Second, the criterion ‘‘acute onset or fluctuation’’ was evaluated, involving again the nurses’ observations. Furthermore, fluctuation in RASS score during the previous 24 hours was considered as presence of a change in mental status. Third, ‘‘attention’’ was evaluated using the Attention Screening Examination (ASE), including a visual and auditory component. Finally, the feature ‘‘disorganized thinking’’ was assessed with four easy questions (e.g., Will a stone float on water?).[21]

Incidence and duration of delirium was defined according to the four core criteria of the CAM algorithm on at least one of the postoperative measurement points (see Procedures).

Severity of delirium was assessed using the Delirium Index (DI), which is completed based on the CAM and MMSE in the cardiac surgery wards only, and consists of seven items (inattention, disorganized thinking, altered level of consciousness, disorientation, memory impairment, perceptual disturbance, and disorder of psychomotor activity), with each item being scored on a scale from 0 (absent) to 3 (present and severe). The total score varies from 0 to 21, with higher scores indicating greater severity.[22]

Anxiety and Depression

Depressive and generalized anxiety (e.g., nervous and anxious personality) symptoms were measured using the Hospital Anxiety and Depression Scale (HADS), a selfreport scale consisting of a 7-item depression and a 7-item anxiety subscale. Symptoms occurring in the previous 2 weeks are scored on a 4-point Likert scale increasing in degree of severity (i.e., score 0–3). Total scores range between 0 and 21 for each subscale, with higher scores indicating more symptoms (0–7, no symptoms; 8–10, mild symptoms; 11–14, moderate symptoms; 15–21, severe symptoms).[23] A score of 8 or higher was used to define depressive symptoms.

State anxiety (e.g., situational anxiety) symptoms, reflecting a temporal and transient emotional state with changing intensity as a reaction to environmental stimuli, were measured using the self-report ‘‘State’’ scale of the State-Trait Anxiety Inventory (STAI).[24] This valid scale contains 20 items scored on a 4-point Likert scale (not at all, a little, much, very much). Total raw scores range from 20 to 80.[24] Based on norm tables for the general population, these raw scores were transformed into a decile score of 0 to 10. A decile rank represents the decile of

the population expected to have a score equal to or less than the observed decile rank. Patients who had decile scores of 7 or greater, corresponding to a raw score of 38 for men and 41 for women, respectively, were considered to be anxious.

Other Risk Factors

Based on state-of-the-art evidence on risk factors for delirium, the following clinical data were collected using chart review: premorbid dementia, type of cardiac surgery (coronary artery bypass graft (CABG), valve replacement, combination of valve replacement and CABG, or other), smoking, alcohol abuse, comorbidity such as diabetes mellitus and psychiatric impairment, Acute Physiology and Chronic Health Evaluation (APACHE) II score[25] at ICU admission, duration of anaesthesia (time from intubation until ICU admission in minutes), cardiac surgery under cardiopulmonary bypass, time on cardiopulmonary bypass (minutes), intubation time (hours), intraoperative body temperature (°C), systolic and diastolic blood pressure (mmHg), glycemia (mg/dL), hemoglobin (g/dL), and oxygen saturation (percentage). Only the lowest and highest values of the last five intraoperative variables were used.

Outcomes

The Katz Index of activities of daily living (ADL) measures functional status,[26] expressed as level of independence (0=independent, 1=partly dependent, 2=dependent) in performing six activities: bathing, dressing, feeding, continence, transfer, and toileting. The total score ranges from 0 to 12, with higher scores indicating more dependency. The total length of stay was measured by summing all postoperative days. The day after the operation was defined as the first postoperative day. Mortality was defined as death occurring between the first postoperative day until discharge. Finally, living situation was recorded at discharge, dichotomized as discharge to a nursing home or transferred to home.

Procedures

The senior author (KM), who has clinical and research expertise in delirium, trained two researchers (ED, EV) in performing the MMSE, the CAM, and the CAM-ICU. The interrater reliability of the researchers, calculated in a random sample of 20 paired observations of enrolled patients, was kappa = 1.00 ($p < 0.001$) for the CAM and CAM-ICU, indicating perfect reliability.

These researchers approached eligible patients on the cardiac surgery ward the evening before surgery to obtain written informed consent. Afterwards, the STAI,[24] HADS,[23] MMSE,[17] and Katz ADL scale[26] were performed. The CAM[19,20] and the DI[22] were scored immediately after the MMSE interview. Demographic and preoperative clinical data were recorded based on chart review.

In addition, information about cognitive functioning (MMSE and CAM (or CAM-ICU depending on location of the patient)) was obtained on the first, third, and seventh postoperative days using a similar interviewing methodology. Systematic measurement on the second postoperative day was excluded, because it was felt that this was too stressful for ICU patients. During their ICU stay, information was collected during the morning using the CAM-ICU. Once admitted to the cardiac surgery ward, cognitive function was assessed in the afternoon using the MMSE, CAM, and DI. Timing of assessment was chosen in order not to interfere with care activities. If the patient had delirium at one of the measurement points, the delirious status was followed up daily until a negative CAM (or CAM-ICU) score was obtained. Patients in the ICU wards who had a RASS score of −3 or less were followed up daily and were excluded after 5 days without improvement. Intraoperative data were recorded from medical files. On the seventh postoperative day and at discharge, the STAI, the HADS, and ADLs were evaluated again. The ethical committee of the University of Leuven approved this study.

Statistical Analysis

Data were analyzed using SPSS version 12.1 (SPSS, Inc., Chicago, IL). Descriptive analyses (means, standard deviations, medians, interquartile ranges (IQRs), and frequencies) were calculated as appropriate. Living situation at discharge, length of hospital stay, ADL functional status, mortality, and risk factors of delirious and non-delirious patients were compared using the chi-square or Fisher exact test for dichotomous or nominal variables, the Mann-Whitney U test for ordinal or nonnormally distributed continuous variables, and the Student t-test for normally distributed continuous variables. $P < 0.05$ was considered statistical significant.

Variables with $p \leq 0.10$ in the univariable analyses were included in multivariable logistic regression to determine which were predictors of delirium. State anxiety (total STAI raw scores), depressive, and anxiety symptoms (total HADS scores) were added to the multivariable model as variables of interest. Multicollinearity was tested, excluding variables with a Spearman rho correlation of 0.6 or greater. The correlation between preoperative state anxiety, generalized anxiety, and depressive symptoms and severity of delirium was also calculated. Severity of delirium was defined as the highest score on the DI measured in

delirious patients during their hospitalization on the ward. Finally, the evolution of STAI and HADS scores from preoperative to discharge was examined using the Wilcoxon rank test.

Results

Sample

One hundred twenty-seven consecutive patients were eligible, of whom 17 (13.4%) refused (no interest or too anxious) and 110 gave informed consent (participation rate 86.6%). Six dropped out, because they were postoperatively nonresponsive for more than 5 days, so data from 104 patients were available for analysis. None had dementia at baseline. Demographic details of the study sample (n=104) are shown in **Table 2.1**.

Patients who refused to participate were more likely to be female (n = 12/17, 70.6% vs n = 22/104, 21.2%; p = 0.001) but were similar in age (median 72 (IQR = 17) vs 71 (IQR = 8), p = 0.20).

Incidence and Duration of Postoperative Delirium

Twenty-seven (26%) patients had delirium at some point postoperatively (Day 1 = 9.2%, Day 3 = 14.1%, Day 7 = 8.2%). Median duration of delirium was 2 days (IQR = 4).

Clinical Outcomes in Patients with and without Delirium

Two patients died during hospitalization (1.9%), of whom one had a delirium. Patients with delirium were hospitalized significantly longer than those without (15 days (IQR = 8) vs 11 days (IQR = 5); p = 0.001); more frequently discharged to another hospital, nursing home, or rehabilitation center (54.5% vs 45.5%, p = 0.009); and had worse ADL scores at discharge (median 2 (IQR = 4) vs median 1 (IQR = 2); p = 0.01).

Table 2.1. Preoperative Predictors of Delirium After Cardiac Surgery

Preoperative Predictor	Total Population N=104	Non-Delirious n=77	Delirious n=27	Test Value	p-Value
Demographic factors					
Age, median (IQR)	71 (8)	69 (8)	72 (10)	U=973.5†	0.62
Age, n (%)					
60–64	21 (20.2)	15 (19.5)	6 (22.2)	U=966.5†	0.57
65–69	28 (26.9)	24 (31.2)	4 (14.8)		
70–74	26 (25.0)	17 (22.1)	9 (33.3)		
≥75	29 (27.9)	21 (27.3)	8 (29.6)		
Male, n (%)	82 (78.8)	61 (79.2)	21 (77.8)	χ^2=0.025‡	0.87
Married or living together, n (%)	88 (84.6)	67 (87.0)	21 (77.8)	χ^2=1.310‡	0.25
Education (years)§				U=1,008.5†	0.88
Low (<15), n (%)	48 (46.6)	36 (47.4)	12 (44.4)		
Moderate (15–18), n (%)	38 (36.9)	27 (35.5)	11 (40.7)		
High (>18), n (%)	17 (16.5)	13 (17.1)	4 (14.8)		
Living situation				χ^2=7.98‡	0.01*
Independent, n (%)	99 (95.2)	76 (98.7)	23 (85.2)		
Institution, n (%)	5 (4.8)	1 (1.3)	4 (14.8)		
Clinical variables					
Type of surgery				χ^2=11.82‡	0.008*
CABG, n (%)	52 (50.0)	44 (57.1)	8 (29.6)		
Valve replacement, n (%)	20 (19.2)	9 (11.7)	11 (40.7)		
Combination valve replacement and CABG, n (%)	24 (23.1)	18 (23.4)	6 (22.2)		
Other, n (%)	8 (7.7)	6 (7.8)	2 (7.4)		
Smoking				χ^2=5.24‡	0.07
Yes, n (%)	4 (3.8)	1 (1.3)	3 (11.1)		
No, n (%)	60 (57.7)	46 (59.7)	14 (51.9)		
Stopped, n (%)	40 (38.5)	30 (39.0)	10 (37.0)		
Alcohol use				χ^2=5.52‡	0.06
Yes (1 glass a day), n (%)	17 (16.3)	9 (11.7)	8 (29.6)		
No, n (%)	54 (51.9)	44 (57.1)	10 (37.0)		
Sometimes (<1 glass a day), n (%)	33 (31.7)	24 (23.1)	9 (33.3)		
Diabetes mellitus, n (%)	23 (22.1)	14 (18.2)	9 (33.3)	χ^2=2.66‡	0.10

Psychiatric impairment in anamnesis, n (%)	1 (1.0)	0 (0.0)	1 (3.7%)	χ^2=2.88‡	0.26
Mini-Mental State Examination score, median (IQR)	29 (2)	29 (2)	29 (3)	U=978.0†	0.63
Activity of daily living, median (IQR)	0 (0)	0 (0)	0 (0)	U=1,010.5†	0.59
Anxiety and depressive symptoms					
State-Trait Anxiety Inventory, median (IQR)	39.5 (16)	42 (17)	38 (16)	U=950.0†	0.52
Hospital Anxiety and Depression Scale score, median (IQR)§					
Anxiety	5 (6)	5 (6)	4 (5)	U=990.5†	0.79
Depression	3 (6)	3 (5)	3 (5)	U=908.0†	0.37

* Statistically significant (p = 0.05).
† Mann-Whitney U test for comparison of ordinal or nonnormally distributed continuous data.
‡ Chi-square (χ2) test for comparison of dichotomous or nominal data.
§ Information was missing for one patient.
IQR = interquartile range; CABG = coronary artery bypass graft.

Presence of and Evolution in Anxiety and Depressive Symptoms

Approximately half (55.8%) of the patients had state anxiety symptoms preoperatively, and 25.2% had mild, moderate, or severe generalized anxiety scores. At discharge, 35.7% of patients had state anxiety symptoms, and 12.2% had generalized anxiety. Preoperative depressive symptoms occurred in 15.5%, and 15.3% had depressive symptoms at discharge. Differences in sex are shown in **Table 2.2**. A significant decrease in anxiety scores from preoperative assessment to discharge for the STAI (median 39.5 (IQR = 16) vs median 33 (IQR = 20); p = 0.001) and the HADS subscale (median 5 (IQR = 6) vs median 3 (IQR = 5); p = 0.001) was found. No significant changes in depressive state were noted (median score 3 (IQR = 6) vs median 4 (IQR = 4); p = 0.62).

Table 2.2. Presence, Severity, and Evolution of Anxiety (State and Generalized Anxiety Symptoms) and Depressive Symptoms

Variables	Total Population N=104	Men n=82	Women n=22	p-*Value*
Preoperative assessment				
State anxiety symptoms as measured according to STAI				
Median (IQR)	39.5 (16)	37 (16)	51.5 (15)	<0.001*
Presence of anxiety symptoms, decile, n (%)				0.007*
<7†	46 (44.2)	42 (51.2)	4 (18.2)	
≥7‡	58 (55.8)	40 (48.8)	18 (81.8)	
Generalized anxiety symptoms as measured according to HADS anxiety§				
Median (IQR)	5 (6)	4 (5)	9 (6)	<0.001*
Severity of anxiety symptoms, n (%)				<0.001*
No symptoms	77 (74.8)	70 (86.4)	7 (31.8)	
Mild symptoms	13 (12.6)	6 (7.4)	7 (31.8)	
Moderate symptoms	9 (8.7)	3 (3.7)	6 (27.3)	
Severe symptoms	4 (3.9)	2 (2.5)	2 (9.1)	
Depressive symptoms as measured according to HADS depression§				
Median (IQR)	3 (6)	3 (5)	5 (5)	0.01*
Severity of depressive symptoms, n (%)				0.04*
No symptoms	87 (84.5)	71 (87.7)	16 (72.7)	
Mild symptoms	11 (10.7)	6 (9.9)	3 (13.6)	
Moderate symptoms	3 (2.9)	2 (2.5)	1 (4.5)	
Severe symptoms	2 (1.9)	0 (0)	2 (9.1)	
Postoperative assessment at discharge				
State anxiety symptoms as measured according to STAI‖				
Median (IQR)	33 (20)	32 (17)	46 (19)	0.004*
Presence of anxiety symptoms, decile, n (%)				0.04*
<7†	63 (64.3)	53 (69.7)	10 (45.5)	
≥7‡	35 (35.7)	23 (30.3)	12 (54.5)	
Generalized anxiety symptoms as measured according to HADS anxiety‖				
Median (IQR)	3 (5)	3 (4)	4.5 (8)	0.02*
Severity of anxiety symptoms, n (%)				0.001*
No symptoms	86 (87.8)	71 (93.4)	15 (68.2)	
Mild symptoms	5 (5.1)	4 (5.3)	1 (4.5)	
Moderate symptoms	6 (6.1)	1 (1.3)	5 (22.7)	
Severe symptoms	1 (1.0)	0 (0)	1 (4.5)	
Depressive symptoms as measured according to HADS depression‖				
Median (IQR)	4 (4)	4 (4)	5.5 (8)	0.05
Severity of depressive symptoms, n (%)				0.01*
No symptoms	83 (84.7)	68 (89.5)	15 (68.2)	
Mild symptoms	8 (8.2)	6 (7.9)	2 (9.1)	
Moderate symptoms	3 (3.1)	1 (1.3)	2 (9.1)	

Variables	Total Population N=104	Men n=82	Women n=22	p-*Value*
Severe symptoms	4 (4.1)	1 (1.3)	3 (13.6)	

* Statistically significant (p<0.05).

†No anxiety symptoms.

‡ Anxiety symptoms.

§ Information was missing for one patient.

‖ Information was missing for six patients.

IQR = interquartile range; STAI = State-Trait Anxiety Inventory; HADS = Hospital Anxiety and Depression Scale.

Risk Factors for Delirium

Although some preoperative variables were significantly different between patients with and without delirium, preoperative anxiety and depressive symptoms were not (**Table 2.1**). There was also no relationship between severity of delirium and preoperative state anxiety (rho = 0.277; p = 0.17), generalized anxiety symptoms (rho = 0.073; p = 0.72), and depressive symptoms (rho = 0.071; p = 0.73).

With regard to intraoperative and postoperative variables, patients with delirium seemed to spend more time on cardiopulmonary bypass (median 85 minutes (IQR = 145) vs median 0 minutes (IQR = 30); p = 0.005), had a lower intraoperative lowest body temperature (median 32.8°C (IQR = 8.4) vs median 36.1°C (IQR = 1.1); p = 0.006), and had a longer intubation time (median 39.3 hours (IQR = 35) vs median 21 hours (IQR = 9); p = 0.001) than patients without delirium. No differences between patients with and without delirium were found for duration of anesthesia, intraoperative highest body temperature, lowest and highest systolic and diastolic blood pressure, glycemia, hemoglobin, oxygen saturation, and APACHE II score at ICU admission and at discharge (data not shown).

Multivariable Analysis

The variables living situation, time under cardiopulmonary bypass, smoking, alcohol, body temperature, glycemia, hemoglobin, APACHE II score at ICU admission, intubation time, state anxiety, and depressive symptoms were included in the multivariable logistic model. Generalized anxiety, surgery under cardiopulmonary bypass condition, and type of cardiac surgery were not included in the model because of high multicollinearity.

Only prolonged intubation time (odds ratio (OR) = 1.10, 95% confidence interval (CI) = 1.05–1.15, p = 0.001) and a low intraoperative lowest body temperature (OR = 0.86, 95% CI = 0.74–

0.99, P = 0.03) were associated with delirium onset. These variables explain 48.4% of the variance.

Discussion

To the authors' knowledge, this is the first study examining the influence of preoperative anxiety and depressive symptoms on onset of delirium after cardiac surgery, controlling for other known risk factors. The strengths of this study lay in its prospective design; the use of validated and internationally standardized instruments to diagnose delirium, anxiety, and depression; and the repeated assessments during hospitalisation.

It was discovered that one in four patients developed delirium, which is comparable with incidences (12.5–33.6%) found in other studies in older patients after cardiac surgery using similar methodology.[2,4–6] It is even possible that delirium was underreported. First, presence of delirium was measured only once daily. Possible cases might have been missed, given the well-known fluctuating course of delirium throughout the day, but measuring delirium continuously was not feasible, because it is burdensome to patients. Second, the study excluded ICU patients who were nonresponsive for more than 5 days. It is not known whether these patients developed delirium during their hospitalization. Congruent with previous research,[2,7] the current study showed that delirious patients had poorer clinical outcomes, including a longer hospitalization, greater institutionalization at discharge, and more ADL dependence.

Numerous studies have already examined the risk factors for delirium after cardiac surgery, but not in combination with anxiety and depressive symptoms.[2,4,5,9] A lower intraoperative lowest body temperature and longer intubation time were independent predictors in multivariable analysis, which is consistent with previous findings.[2,5,9] The latter factor could be indicative of greater intraoperative and postoperative complexity, which may in turn affect neurological outcomes, including onset of delirium.[3,5] Baseline cognitive dysfunction and older age are well-known risk factors for delirium,[2,5] but those variables were not associated with delirium, possibly because of the small sample size and the use of medical record data for diagnosing pre-existing dementia, the latter of which could have led to misclassification.

Despite the large number of patients with preoperative anxiety and depressive symptoms, no association was found between these symptoms and occurrence or severity of delirium. This relationship has been studied in non-cardiac populations in only a few studies that have yielded inconclusive results. The following hypotheses may stimulate further research. First, other definitions of anxiety and depression have been suggested, but repeating the analyses using

STAI decile of 8 or greater and HADS of 16 or greater did not change the results. Second, symptoms of anxiety and depression, and not psychiatric disorders, were measured. It is possible that only a psychiatric disorder, as in a previous study,[6] predicts delirium. Furthermore, patients who underwent an emergency surgical procedure were excluded. The unexpectancy of surgery may have a tremendous effect on delirium onset, possibly due to lack of psychological preparation and subsequent high anxiety.[14] Finally, selection bias may have occurred, because patients did not give informed consent, because they were too anxious (4 patients) or had no interest (13 patients). The latter can be a symptom of underlying depression. It is not known whether they experienced delirium.

Because of the small sample size, the lack of statistical power, and the investigation of all types of cardiac surgery patients, the generalizability of the results may be questioned. Based on trends in the current HADS and STAI data analysis, the sample size should be 515 and 1,084 patients, respectively, to find a significant result with a certainty of 80% ($\alpha = 0.05$), but lack of a relationship does not imply that anxiety, depressive symptoms, and delirium can be ignored. Because of its relationship with poor clinical outcomes, delirium should be identified and treated immediately.[27] Moreover, although anxiety symptoms decreased postoperatively, 12% and 36% of patients reported generalized and state anxiety symptoms at discharge. The incidence of depression at discharge remained stable (15%), congruent with previous research (19%),[10] suggesting that depression is not solely related to the surgical procedure. Screening of depressive and anxiety symptoms at admission and discharge and referral for treatment is warranted, because several studies[28,29] have indicated that these symptoms are associated with poor outcomes, such as greater pain, poorer functional recovery, greater likelihood of readmission, higher cardiac-related and all-cause mortality, and poorer quality of life.

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CHAPTER III

Risk Factors for Delirium after Hip Fracture Surgery

This chapter is published and reproduced with the kind permission of the editor:

Van Grootven B, Detroyer E, Devriendt E, Sermon A, Deschodt M, Flamaing J, Dubois C, Milisen K. Is preoperative state anxiety a risk factor for postoperative delirium among elderly hip fracture patients? Geriatrics and Gerontology International 2016; 16(8): 948-955.

Abstract

Aim: To determine if preoperative state anxiety is a risk factor for postoperative delirium in older hip fracture patients.

Methods: A secondary data analysis comprising data from a prospective non-randomized trial including 86 patients with a hip fracture aged 65 years and older was carried out. State anxiety was measured preoperatively using the State-Trait Anxiety Inventory. Delirium and its severity was measured pre- and postoperatively (day 1, 3, 5, 8) by trained research nurses using the Confusion Assessment Method and Delirium Index.

Results: A total of 24 patients (27.9%) developed delirium postoperatively. Preoperative state anxiety (State-Trait Anxiety Inventory) was not associated with postoperative delirium (r_b = 0.135, p = 0.353), duration of postoperative delirium (rho = 0.038, p = 0.861) or severity of postoperative delirium (rho = 0.153, p = 0.160). Independent predictors of postoperative delirium were lower MMSE scores (OR 0.75, 95% CI 0.60-0.95, p = 0.015), osteosynthesis surgery (OR 3.66, 95% CI 1.02-13.15, p = 0,047) and lowest intraoperative diastolic blood pressure (OR 0.92, 95% CI 0.85-0.99, p = 0.031).

Conclusion: No relationship between state anxiety and postoperative delirium was found, but significant methodological hurdles were observed and discussed providing important groundwork for further research in this area. Further research should focus on reliable measurement of state anxiety in cognitively impaired older populations.

Introduction

Delirium is characterized by an acute and fluctuating disturbance in attention and awareness with a change in cognition or the development of a perceptual disturbance.[1] Its incidence has been found in up to 53% of older hip fracture patients.[2,3] Several risk factors for delirium have been identified but other contributing factors, such as state anxiety, have been less well investigated.[3]

To the best of our knowledge, just three studies previously investigated this association using the State-Trait Anxiety Inventory (STAI) among hospitalized older adults, but no significant relationship was found.[4–6] However, two studies used less reliable instruments (i.e. Mini-Mental State Examination [MMSE], critical flicker fusion frequency, reaction time, nurse's form for recording delirium signs) for the measurement of delirium.[4,6] In a secondary analysis of pediatric cohort studies, preoperative anxiety did increase the odds of emergence delirium and new-onset postoperative maladaptive behavioural changes.[7] This relationship between anxiety and postoperative cognitive functioning might be relevant for the older population as well.

Control of preoperative anxiety could present a new target for preventive strategies in order to reduce postoperative delirium, as its development correlates with the number of risk factors.[8] In this context, two Cochrane reviews suggest anxiety-reducing interventions, such as preoperative music therapy and education.[9,10] If a relationship between anxiety and delirium exists, further investigation could then focus on integrating these strategies in successful multicomponent preventive interventions.[11]

Because of the inconclusive results in previous studies and the clinical relevance of preoperative anxiety; that is, it is detectable and remediable, further investigation between preoperative state anxiety and postoperative delirium seems warranted. The aim of the present secondary data analysis was therefore to investigate if preoperative state anxiety is a risk factor for postoperative delirium in older hip fracture patients.

Materials and Methods

Design and Sample

The present secondary data analysis comprises data from a non-randomized trial, testing the effects of a multidisciplinary geriatric consultation in older adults undergoing surgery for a traumatic hip fracture between February and December 2007.[12,13] The study included 171 native Dutch speaking verbally testable older adults (age 65 years or older) consecutively admitted to the emergency department with a non-pathological hip fracture. Patients with

polytrauma, having a life expectancy of less than 6 months, not admitted to the traumatology wards for postoperative care, who refused to participate in the study or having missed premorbid assessment, were excluded. This primary study was carried out in the Leuven University Hospitals, Belgium. All patients who developed preoperative delirium or patients without a preoperative state anxiety or postoperative delirium assessment were additionally excluded from this secondary data analysis.

Variables

Demographics

Demographic data, collected using patient interview and chart review, were age, sex, level of education (low = schooling up to age 15 years, moderate = up to age of 18 years, high = schooling beyond age of 18 years), marital status (married or living together vs other) and living situation (at home vs institutionalized).

Anxiety

State anxiety reflects a temporary, acute anxious reaction with feelings of tension and apprehension,[14] and was measured using the six-item Dutch version of the State scale of the STAI.[15] The sum score varies between 6 and 24, with higher scores indicating higher levels of state anxiety.[16]

Delirium

Delirium was assessed using the Confusion Assessment Method (CAM) after trained research nurses completed the 12-item MMSE.[17,18] Validity and reliability with excellent psychometric properties after formal training has previously been shown for the CAM.[17] Using the sensitive CAM algorithm, delirium was diagnosed if (acute onset OR fluctuating course) AND inattention AND (disorganized thinking OR altered level of consciousness) was recorded postoperatively.

The incidence of postoperative delirium was determined by a positive CAM score on day 1, 3, 5 or 8 postoperatively. Duration of delirium was counted as the number of days from the first positive CAM score until the day before a negative CAM score was obtained (e.g. if patients had a positive CAM score on day 3 and were reassessed on day 5, having a negative CAM score, they were assumed to have had delirium for 2 days; see procedures).

The severity of delirium was assessed using the Delirium Index (DI). This instrument is based on seven CAM-items (inattention, disorganized thinking, altered level of consciousness, disorientation, memory impairment, perceptual disturbances, psychomotor activity). Total scores vary between 0 and 21, with higher scores indicating greater severity.[19]

Delirium Risk Factors

Cognitive functioning was assessed with the 12-item version of the MMSE, which correlates very strongly with the full MMSE.[18] An optimal cut-off score of ≤9, indicating cognitive impairment, was identified for the 12-item MMSE with total sum scores varying between 0 and 12.[18]

Functional status was measured with the Katz index of Activities of Daily Living (ADL), which measures (in)dependency for six basic human functions (bathing, dressing, toileting, transfer, continence, feeding).[20] A two-point scale (completely independent vs dependent) was used. Sum scores vary between 6 and 12, with higher scores indicating a higher level of dependence.[21]

Preoperative pain was assessed using the Visual Analogue Scale (range 0–10) by patient interview. The following intraoperative risk factors were assessed using chart review: type of operation (arthroplasty, osteosynthesis, other), the time from hospital admission to surgery in hours (<24 h, 24–48 h, 48–72 h, >72 h), duration of anesthesia (min), intubation time (min), body temperature (°C), systolic and diastolic blood pressure (mmHg), glycemia (mg/dL), hemoglobin level (g/dL), and oxygen saturation (%). Furthermore, medical files were reviewed to determine the body mass index, the number of home medications prescribed before hospital admission by the general practitioner and the number of medications prescribed postoperatively by the treating physician. The presence of diabetes mellitus and dementia was determined by a documented diagnosis in the patient's medical file.

Prescribed medications were assessed specifically for polypharmacy (≥5) and use of benzodiazepines. The anticholinergic burden was assessed with the Anticholinergic Cognitive Burden scale.[22] This three-point scale awards 1 point for possible anticholinergic properties, 2 points for established anticholinergic properties and 3 points for anticholinergic properties associated with delirium. A score of 3 or higher is considered to be clinically relevant, but has not been validated.

The 10-item version of the validated Geriatric Depression Scale was used to screen for the presence of depressive symptoms.[23] Scores were dichotomized to "having versus not having depressive symptoms" based on the validated cut-off value of ≥4.[24]

Comorbidity was assessed using the Charlson Comorbidity Index by patient interview and/or chart review.[25] Scores vary between 0 and 37, with higher scores indicating more comorbidity.

Procedure

Demographic and medical data, anxiety (STAI), depressive symptoms (Geriatric Depression Scale), cognitive functioning (MMSE), delirium (CAM, DI) and functional status (Katz ADL) were measured within the first 24 h after emergency admission, but before surgery by trained research nurses using patient interview or chart review. Perioperative variables were assessed by chart review. Postoperatively, the MMSE, CAM and DI were measured once a day on day 1, 3, 5 and 8. Research nurses underwent a 3-h training session and follow-up sessions learning to use the assessment tools by a clinical and research expert in geriatric assessment and delirium (KM), and were not involved in patient care. The primary study was approved by the medical ethics committee of the Leuven University Hospitals (B322201112405), and informed consent was obtained before inclusion. The medical ethics committee of the Leuven University Hospitals approved this secondary data analysis.

Statistical Analyses

The database from the primary study was assessed for missing data, database coding and extreme values. Variables exceeding 5% of missing data (i.e. intraoperative glycemic values, hemoglobin values and body temperature, body mass index and intubation time) were excluded, and a listwise deletion approach was used to manage the remaining missing data.

Variables were explored using descriptive statistics. Categorical data were expressed as the number of cases and percentages. Continuous data were expressed as means with standard deviations for normally distributed data and medians with interquartile ranges (IQR) for non-normally distributed data.

A univariate risk analysis was carried out testing variables between non-delirious and delirious older adults using binary logistic regression. Significant variables ($p < 0.1$), as determined by univariate analysis and state anxiety (STAI), were included in a multivariate logistic regression analysis using a forced entry model, and were assessed for multicollinearity (variance inflation factor, tolerance).

The association between STAI and postoperative delirium was tested using biserial correlation. The association of STAI with the duration of postoperative delirium and the severity of

postoperative delirium (highest score on DI in delirious patients) was tested using the Spearman's correlation coefficient.

A post-hoc analysis was carried out on all excluded cases to determine significant differences in age, sex and postoperative delirium incidence. A post-hoc analysis was carried out on missing STAI scores, which were dichotomized (i.e. having a missing STAI score/not having a missing STAI score). Analyses were carried out to determine if patients with a missing STAI differed significantly with respect to preoperative delirium, MMSE, dementia and the presence of depressive symptoms.

All post-hoc analyses were carried out using the $\chi 2$-test for dichotomous variables, the Mann–Whitney U-test for ordinal variables and the unpaired t-test for continuous data. The sample size was determined by the availability of patients in the primary study. Data was analyzed using SPSS version 20 (SPSS, Chicago, IL, USA). Statistical significance was determined at $p < 0.05$ with all tests being two-tailed.

Results

Sample

A total of 171 patients were available for secondary analysis, of which 85 had to be excluded. First, 37 patients were excluded because of presenting with preoperative delirium, then an additional 46 patients because of having missing data on the STAI assessment and then an additional two patients because of having missing data on the CAM assessment (see **Figure 3.1**).

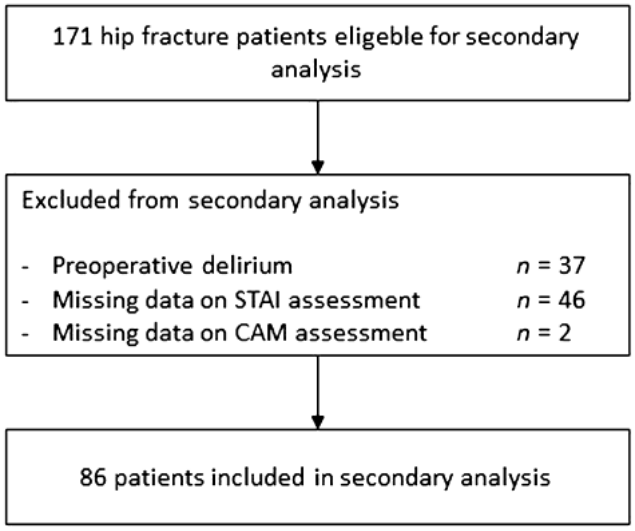

Figure 3.1. Flowchart.

CAM, Confusion Assessment Method; STAI, State-Trait Anxiety Inventory.

This resulted in 86 hip fracture patients being available for analyses, of which the sample characteristics are described in **Table 3.1**. As compared with the patients included in the analysis, excluded patients did not differ in age (80.1 ± 6.79 vs 81.6 ± 7.19 years, p = 0.151) or sex (21 vs 24% male, p = 0.571, respectively), but did develop postoperative delirium more often (62.8% vs 27.9%, p < 0.001). Patients with a missing STAI score had significantly more dementia (37.0% vs 8.1%, p < 0.001) and a lower median MMSE (5 [IQR = 9] vs 9 [IQR = 6], p = 0.001), but did not have more preoperative delirium (22.0% vs 21.4%, p = 0.838) or depressive symptoms (63.0% vs 63.4%, p = 0.967). Dichotomizing MMSE (MMSE ≤ 9), indicating cognitive impairment, resulted in a trend towards a non-significant difference between included and excluded patients (69.1% vs 53.6%, p = 0.064).

Table 3.1. Sample Characteristics

Sample characteristics	Sample (*n* = 86)
Mean age (years) ± SD	80.1 ± 6.8
Male, *n* (%)	21 (24.4)
Marital status, *n* (%)	
Married/living together	35 (40.7)
Other	51 (59.3)
Living situation, *n* (%)	
Home	71 (82.6)
Institution	15 (17.4)
Level of education, *n* (%)	†
Low (≤15 years-of-age)	41 (50.6)
Moderate (15–18 years-of-age)	33 (40.7)
High (>18 years-of-age)	7 (8.6)
Mean STAI (range 6–24) ± SD	12.3 ± 2.1
Postoperative delirium, *n* (%)	24 (27.9)
Median duration of postoperative delirium (IQR)	2 (1)
Delirium Index, median (IQR) (range 0–21)	4 (3)
Median MMSE, IQR (range 0–12)	10 (4)‡
Cognitive impairment (≤9 MMSE), *n* (%)	39 (45.9)‡
Median Katz ADL, IQR (range 6–12)	7 (2)
Median preoperative pain (VAS), IQR (range 0–10)	3 (5)
Type of surgery, *n* (%)	
Arthroplasty	34 (39.5)
Osteosynthesis	47 (54.7)
Other	5 (5.8)
Emergency admission, *n* (%)	86 (100)
Duration from admission to surgery, *n* (%)	‡

<24 h	28 (32.9)
24–48 h	33 (38.9)
48–72 h	17 (20)
>72 h	7 (8.2)
Mean duration of anesthesia (min) ± SD	111.9 ± 37.4§
Median lowest diastolic blood pressure (IQR)	50 (10)¶
Median highest diastolic blood pressure (IQR)	70 (20)¶
Median end diastolic blood pressure (IQR)	60 (18.8)¶
Median lowest systolic blood pressure (IQR)	95 (28.8)¶
Median highest systolic blood pressure (IQR)	140 (30)¶
Median end systolic blood pressure (IQR)	120 (23.8)¶
Median lowest oxygen saturation (IQR)	97 (4.5)†
Median highest oxygen saturation (IQR)	99 (1)†
Median end oxygen saturation (IQR)	99 (2)†
Diabetes mellitus, *n* (%)	17 (19.8)
Dementia, *n* (%)	5 (5.9)‡
Mean no. home medications ± SD	5.4 ± 3.6‡
Mean no. hospital medications ± SD	13.1 ± 4.2
Polypharmacy, *n* (%)	40 (48.8)††
Benzodiazepines, *n* (%)	24 (27.9)
Depressive (GDS), *n* (%)	53 (61.6)
Median Charlson Comorbidity Index, IQR (range 0–37)	2 (2)
Median ACB (IQR)	1 (2)
ACB ≥ 3, *n* (%)	18 (20.9)

The duration of postoperative delirium was measured in days. The duration of anesthesia was measured in minutes. Blood pressure and oxygen saturation were assessed intraoperatively. "Highest" refers to the highest value measured during the operation, "lowest" to the lowest value measured and "end" to the value measured at the end of the operation. †Five missing cases. ‡One missing case. §Three missing cases. ¶Two missing cases. ††Four missing cases. ACB, anticholinergic cognitive burden; ADL, activities of daily living; GDS, Geriatric Depression Scale; IQR, interquartile range; MMSE, Mini-Mental State Examination; SD, standard deviation; STAI, State-Trait Anxiety Inventory; VAS, Visual Analogue Scale; No., Number.

Incidence and Duration of Postoperative Delirium

A total of 24 (27.9%) patients developed delirium postoperatively. Postoperative delirium occurred in 12.2% of patients on day 1, 15.3% on day 3, 6.1% on day 5 and 4.5% on day 8. The median duration of postoperative delirium was 2 days (IQR = 1).

Delirium Risk Factors

Preoperative state anxiety (STAI) was not associated with postoperative delirium ($r_b = 0.135$, $p = 0.353$), duration of postoperative delirium (rho = 0.038, $p = 0.861$) or severity of postoperative delirium (rho = 0.153, $p = 0.160$).

Univariate logistic regression identified MMSE (OR 0.75, 95% CI 0.63–0.90, p = 0.002) and highest intraoperative systolic blood pressure (OR 0.97, 95% CI 0.95–1.00, p = 0.032) as significant predictors of postoperative delirium (**Table 3.2**).

Table 3. 2. Predictors of Postoperative Delirium: Univariate Logistic Regression

Variables	**OR (95% CI)**	***p*-value**
Age	1.05 (0.98–1.13)	0.193
Male	0.35 (0.09–1.32)	0.121
Marital status		
Married/living together	1.06 (0.41–2.75)	0.909
Other	0.95 (0.63–2.46)	0.909
Living situation		
Home	1.08 (0.31–3.79)	0.906
Institution	0.93 (0.26–3.26)	0.906
Level of education		
Low (≤15 years-of-age)	†	0.239
Moderate (15–18 years-of-age)	0.39 (0.13–1.15)	0.086
High (>18 years-of-age)	0.69 (0.12–4.03)	0.683
STAI	1.12 (0.89–1.41)	0.349
MMSE	0.75 (0.63–0.90)	*0.002*
Katz ADL	1.09 (0.85–1.40)	0.490
Preoperative pain (VAS)	0.96 (0.80–1.15)	0.659
Arthroplasty surgery	0.53 (0.19–1.47)	0.225
Osteosynthesis surgery	2.59 (0.94–7.12)	0.065
Duration from admission to surgery		
<24 h	†	0.786
24–48 h	0.68 (0.11–4.43)	0.688
48–72 h	1.25 (0.21–7.51)	0.807
>72 h	1.04 (0.15–7.28)	0.967
Duration of anesthesia	1.0 (0.99–1.01)	0.764
Lowest diastolic blood pressure	0.95 (0.90–1.00)	0.066
Highest diastolic blood pressure	0.99 (0.95–1.02)	0.451
End diastolic blood pressure	0.98 (0.94–1.03)	0.451
Lowest systolic blood pressure	0.99 (0.96–1.01)	0.303
Highest systolic blood pressure	0.97 (0.95–1.00)	*0.032*
End systolic blood pressure	0.99 (0.96–1.01)	0.202
Lowest oxygen saturation	0.97 (0.86–1.09)	0.570
Highest oxygen saturation	1.04 (0.71–1.52)	0.848
End oxygen saturation	1.12 (0.85–1.49)	0.425
Diabetes Mellitus	0.49 (0.13–1.89)	0.299
Dementia	1.87 (0.29–12.00)	0.508

No. home medications	1.05 (0.92–1.20)	0.467
No. hospital medications	1.02 (0.91–1.13)	0.803
Polypharmacy	1.75 (0.65–4.70)	0.264
Benzodiazepines	1.44 (0.52–3.99)	0.486
Geriatric Depression Scale	2.31 (0.81–6.62)	0.118
Charlson Comorbidity Index	1.03 (0.82–1.29)	0.807
ACB scale	0.91 (0.67–1.24)	0.554
≥3	0.99 (0.31–3.16)	0.989

Univariate logistic regression analyses were carried out to determine appropriate predictors for a multivariate analyses. †Was used as the indicator variable. ACB, anticholinergic cognitive burden; ADL, activities of daily living; MMSE, Mini-Mental State Examination; STAI, State-Trait Anxiety Inventory; VAS, Visual Analogue Scale; No., Number.

Independent predictors of postoperative delirium were lower MMSE scores (OR 0.75, 95% CI 0.60–0.95, p = 0.015), osteosynthesis surgery (OR 3.66, 95% CI 1.02–13.15, p = 0.047) and lowest intraoperative diastolic blood pressure (OR 0.92, 95% CI 0.85–0.99, p = 0.031), identified by a multivariate logistic forced entry regression model. Moderate level of education (OR 0.61, 95% CI 0.14–2.62, p = 0.506), state anxiety (OR 1.18, 95% CI 0.89–1.56, p = 0.250) and highest intraoperative systolic blood pressure (OR 0.97, 95% CI 0.94–1.00, p = 0.064) were not statistically significant in this model. The tolerance and variance inflation factor were >0.1 and <10.0 for all variables, respectively. (**Table 3.3**).

Table 3.3. Forced Entry Multivariate Logistic Regression Model

Variables	**OR (95% CI)**	***p*-value**
Moderate level of education	0.61 (0.14–2.62)	0.506
State-Trait Anxiety Inventory	1.18 (0.89–1.56)	0.250
Mini-Mental State Examination	0.75 (0.60–0.95)	*0.015*
Osteosynthesis surgery	3.66 (1.02–13.15)	*0.047*
Lowest diastolic blood pressure	0.92 (0.85–0.99)	*0.031*
Highest systolic blood pressure	0.97 (0.94–1.00)	0.064

Significant variables ($P < 0.1$) in the univariate logistic regression analysis (see Table 2) and state anxiety were included in a multivariate logistic regression analysis using a forced entry model. The tolerance and variance inflation factor were >0.1 and <10.0 for all variables, respectively.

Discussion

The present secondary data analysis aimed to investigate if preoperative state anxiety is a risk factor of postoperative delirium in older hip fracture patients. Overall, preoperative state anxiety

did not increase the odds of having postoperative delirium, and was not associated with its incidence, duration or severity.

In our study, the odds of having postoperative delirium increased with decreasing MMSE scores, decreasing intraoperative diastolic blood pressure values and if patients had osteosynthesis surgery. Cognitive impairment has been consistently cited as a predisposing risk factor in previous research, as the brain has less cognitive reserve to cope with noxious insults.[3] Lower blood pressure values result in hypoperfusion of the central nervous system and hypoxia, which have been cited as causational factors for delirium.[3] Although hemiarthroplasty surgery has been found to increase the risk of the overlap syndrome of depressive symptoms and delirium, no previous study has identified osteosynthesis surgery as a risk factor for delirium.[26] We therefore carried out a post-hoc analysis comparing clinical relevant variables between the osteosynthesis and arthroplasty group. However, no significant differences could be identified that explain the increased odds for delirium associated with osteosynthesis surgery. The nature of this relationship is currently unknown. Perhaps more postoperative pain and worse mobility in patients with osteosynthesis surgery, as was explained by Rogmak et al., might explain delirium being more associated with osteosynthesis surgery.[27] However, this warrants further investigation. Indeed, another review did not show differences in postoperative pain and mobility between patients with arthroplasty and osteosynthesis.[28] State anxiety was not a significant independent predictor of postoperative delirium in this model. Also, no association was found between state anxiety and the incidence, duration or severity of postoperative delirium. However, because of methodological considerations, these results should be interpreted with caution.

First, an incidence of postoperative delirium of 27.9% was observed. These frequencies might have been underestimated. Indeed, excluding patients with preoperative delirium and missing STAI or CAM scores resulted in excluding 49 cases of delirium (28.7% of total sample). Furthermore, considering the fluctuating course of delirium throughout the day, only assessing delirium on day 1, 3, 5 and 8 might have failed to detect all cases of delirium. Nevertheless, the observed incidence is within the reported ranges associated with orthopedic surgery (i.e. 12–51%).[3] Second, the STAI has not been validated in a geriatric population. Third, considerable missing data (34.5%) was observed for state anxiety. A post-hoc analysis identified these older adults as having more dementia and lower median MMSE scores at baseline. Consequently, several older adults at higher risk of developing delirium were excluded. The present study sample might therefore not be representative for older hip fracture patients with premorbid cognitive impairment. Furthermore, older adults with higher preoperative state anxiety were possibly excluded because of a missing STAI score, as a two-directional relationship seems to exist between anxiety and cognitive functioning. A narrative

review has found some support that generalized anxiety has a negative effect on cognitive abilities, but also that cognitive impairment could increase the risk of experiencing generalized anxiety.[29] Also, an interaction between generalized or trait anxiety and cognition seems to exist with comorbidity and age.[29, 30] However, it is unclear whether the same relationships exist specifically for state anxiety.[29] Fourth, the use of medical record data for the diagnosis of several variables; for example, dementia, could have led to misclassification bias. Furthermore, the majority of patients with dementia had to be excluded because of missing data on their STAI assessment. The low prevalence of dementia in our analyses (n = 5) and possible misclassification bias most likely explain why dementia, a well-known risk factor for delirium,[3] was not identified as a significant predictor in our results.

Because of inconclusive results, further research is advisable, as psychological risk factors are underexplored in delirium research. In general, the risk of developing delirium is determined by the interrelationship between predisposing vulnerability and precipitating factors.[8] Having a higher predisposing vulnerability requires fewer precipitating factors in order to develop delirium. The relationship between state anxiety and postoperative delirium might therefore be different in a sample with a high predisposing risk, such as with cognitively impaired patients, which were partly excluded from our analyses. Consideration of appropriate measurement of state anxiety is therefore important for further research and should first be addressed. Indeed, special attention should be paid to cognitively impaired older adults, as the present results indicate difficulties assessing state anxiety using the Spielberger STAI in this population, and because cognitive functioning is one of the foremost predisposing risk factors for delirium.[3] Currently, the STAI is scored using a Likert-type scale with four categorical response options. These response gradations (i.e. not at all, somewhat, moderately, very much) could be confusing to many older patients.[31] However, we could not identify a superior scale or specific scale developed to measure state anxiety in an older population. Further research focusing on a simplified self-report instrument might therefore be necessary. Using simple yes/no response options has been postulated as more appropriate for assessment in geriatric populations with cognitive disabilities.[31] Also, the Visual Analogue Scale has previously been found to correlate moderately low to relatively high (0.50 to 0.84) with the state scale of the STAI.[32] The Visual Analogue Scale is easy to administer and might prove to be less taxing, but difficulties in understanding the method of measurement have been reported.[32] Validation studies are first necessary in older cohorts and different populations.

In conclusion, we did not find a significant relationship between state anxiety and postoperative delirium, but faced significant methodological hurdles in our analysis. Further research should focus on reliable measurement of state anxiety in cognitively impaired older populations. As

we could not explain the relationship of osteosynthesis surgery with postoperative delirium, further investigation is warranted.

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CHAPTER IV

Psychometric Properties and User-friendliness of the Delirium Observation Screening Scale (DOSS) for the Detection of Delirium in Palliative Care Unit Patients

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Detroyer E, Clement PM, Baeten N, Pennemans M, Decruyenaere M, Vandenberghe J, Menten J, Joosten E, Milisen K. Detection of delirium in palliative care unit patients: a prospective descriptive study of the Delirium Observation Screening Scale administered by bedside nurses. Palliative Medicine 2014; 28 (1): 79-86.

Abstract

Background: The Delirium Observation Screening Scale (DOSS) is designed to detect delirium by nurses' observations and has shown good psychometric properties. Its use in palliative care unit patients has not been studied.

Aim: To determine diagnostic and concurrent validity, internal consistency, and user-friendliness of the Delirium Observation Screening Scale administered by bedside nurses in palliative care unit patients.

Design: In this descriptive study, psychometric properties of the Delirium Observation Screening Scale were tested by comparing the performance on the Delirium Observation Screening Scale (bedside nurses) to the algorithm of the Confusion Assessment Method and the Delirium Index (DI) (researchers). Paired observations were collected on three time points. Afterward, the user-friendliness of the Delirium Observation Screening Scale was determined by bedside nurses using a questionnaire.

Setting/participants: In total, 48 patients were recruited from one palliative care unit (PCU) of a university hospital. Of the 14 eligible bedside nurses of the palliative care unit, 10 participated in the study.

Results: Delirium was present in 22.9% of patients. Diagnostic validity of the Delirium Observation Screening Scale was very good (area under the curve = 0.933), with 81.8% sensitivity, 96.1% specificity, 69.2% positive, and 98% negative predictive value. Concurrent validity of the Delirium Observation Screening Scale with the Delirium Index was moderate ($r_{Spearman} = 0.53$, $p = 0.001$). The Cronbach's alpha for all Delirium Observation Screening Scale shift scores was 0.772. Generally, bedside nurses experienced the Delirium Observation Screening Scale as user-friendly. However, most Delirium Observation Screening Scale items (n = 11/13 items) need verbally active patients to perform the observations correctly.

Conclusion: The Delirium Observation Screening Scale can be used for delirium screening in verbally active palliative care unit patients. The scale was rated as easy to use and relevant. Further validation studies in this population are required.

Background

Delirium is a common disorder in palliative care inpatients, characterized by disturbance of consciousness, change in cognition, or development of a perceptual disturbance that occurs over a short period of time and tends to fluctuate over the course of the day.[1–4] Recognition and appropriate management of delirium in palliative care are crucial because the syndrome has negative effects on patients' and proxies' quality of life and interferes with the provided care.[5–8] Unfortunately, delirium remains often unrecognized by clinicians and is thus inadequately or undertreated.[1,9,10] Therefore, the development of screening tools for improving delirium recognition has been extensively studied.[11–13]

A recent systematic review identified 11 bedside delirium screening scales.[14] Considering their test performance, ease of use, and brevity, the authors found best evidence to support the use of the Confusion Assessment Method (CAM). However, its performance varies depending on the skills and discipline of the examiner.[14–16] When used for surveillance by bedside nurses in the real-life clinical practice, the accuracy of the CAM is poor.[15] Time required for extensive training and correct administration to achieve valid CAM assessments poses high burden and thereby limits the usefulness for bedside nursing.[17] However, nurses' clinical observations play an important role in the early recognition and monitoring of delirium. Therefore, other tools are needed for screening, which are based on bedside observations of behaviour and which can be integrated easily into daily routine care without undue response burden.[18–20]

One of the scales described in the mentioned review[14] that meets these criteria is the Delirium Observation Screening Scale (DOSS).[21] This tool has been tested in various hospital populations and can be regarded as reliable and valid for detection and measuring severity of delirium by nurses' observations during routine care.[21–24] Its ease of use and relevance for practice and the absence of response burden on patients make this scale eligible to implement in daily care.[21–23] Yet its use in the palliative care unit (PCU) population has not been studied.

The aim of this study was to examine the diagnostic and concurrent validity and internal consistency of the DOSS when applied by bedside nurses in PCU patients. In addition, its user-friendliness in monitoring this patient group was described.

Methods

Design, Setting, and Population

A prospective study was conducted in a PCU of a university hospital. Patients aged 18 years or older, Dutch-speaking, and verbally testable who were consecutively admitted to the PCU

(November 2009–June 2010) were recruited by the PCU psychologist within 24 h of admission. Patients admitted in the imminent terminal stage of life (terminal sedated/comatose) were excluded. Written/proxy informed consent was obtained. At the end of the study, bedside PCU nurses were recruited to evaluate the user-friendliness of the DOSS. Nurses who never filled out a DOSS were excluded from this usability evaluation part of the study. The study was approved by the Medical Ethics Committee of the Leuven University Hospitals.

Delirium Assessment

Delirium was independently evaluated during the first 10 days of the patients' stay at the PCU by bedside nurses and one of the three researchers (M.D., N.B., and M.P.), both blinded to each others' ratings. Bedside nurses used the DOSS[21] to rate delirium on a daily basis. The assessments were performed in enrolled patients three times a day at the end of each 8-h shift. The DOSS contains 13 observations of behaviour, each scored as absent, present, or unable. Total scores range between 0 and 13 for each 8-h shift, in which unable ratings are scored as 0. The total day score (24 h) is the mean of the three shift scores, with 13 as the highest possible day score. A score of 3 or more indicates delirium.[23]

The researchers performed a maximum of three assessments in enrolled patients on three different days. These assessments were randomly chosen within the same 8-h shift (morning or evening shift) of the bedside nurses' assessments and included completion of the diagnostic algorithm of the CAM[25,26] and the Delirium Index (DI).[27] According to the CAM algorithm, the criteria acute onset, fluctuation, inattention, and disorganized thinking or altered level of consciousness have to be positive for a diagnosis of delirium. The DI is a delirium severity tool with 7 items scored on a scale ranging from 0 (absent) to 3 (present and severe). Total score ranges from 0 to 21, in which a higher score indicates greater severity. The CAM algorithm and DI were completed after a structured cognitive assessment, which included the items "orientation in time and place," "immediate recall," and "short-term verbal memory" of the Mini-Mental State Examination (MMSE);[28] an attention test (e.g. Attention Screening Examination);[29] and questions to nurses or relatives about the acute onset of symptoms.[26]

Before the start of the study, bedside nurses and researchers were trained in performing the instruments by two research investigators (E.D. and K.M.), both having extensive research and clinical expertise in delirium. Researchers were trained according to criteria set in the manuals of CAM[26] and DI,[27] including evaluation of four clinical cases and follow-up discussions. Interrater reliability of the researchers, calculated two by two in a random sample of seven paired observations of enrolled patients, was $\kappa = 1.00$ ($p < 0.001$) for the CAM and DI. Bedside

nurses were educated in the use of the DOSS[21] during a 1-h course. The interpretation of DOSS items was explained, and an instruction form was added to each DOSS.

User-friendliness of the DOSS

At the end of the study, nurses had to complete a 25-item "usability" questionnaire, which was adapted from Van Gemert and Schuurmans.[23] In total, 23 items are scored on a four-point Likert scale (strongly disagree/mainly disagree/mainly agree/strongly agree). The questionnaire assesses the content clarity of the scale (n = 4 questions), its relevance and feasibility for practice (n = 2 questions), and the clarity of DOSS items (n =13 questions), and it evaluates nurses' perception of their competence necessary to fill out the scale (n = 4 questions). An additional question about time to complete the DOSS and an open question "Any other comments" were added.

Statistical Analysis

Data were analyzed using SPSS version 17.0. Descriptive analyses were performed to summarize the characteristics of patients and nurses and the results of the user-friendliness of the DOSS.

Paired delirium ratings of bedside nurses and researchers were compared to explore the diagnostic validity of the DOSS for the CAM algorithm, their level of agreement, and the concurrent validity between the DOSS and DI. Since CAM/DI assessments were only available for morning or evening shifts, only DOSS shift scores were included in these analyses.

Diagnostic validity of the DOSS was examined by constructing a receiver operating characteristic (ROC) curve and by calculating sensitivity, specificity, and positive and negative predictive values for different cutoff points of the DOSS shift scores. Classification of patients as "delirious" (positive CAM and DOS shift scores ≥ 3) and "nondelirious" (negative CAM and DOS shift scores < 3) was further tested by performing agreement statistics (proportion of observed agreement (P_0) and Cohen's kappa coefficients (κ)), in combination with the prevalence and bias index.[30] Moreover, P_0 is the proportion of exact agreement between two assessment methods, while κ corrects for chance. Paradoxes in the values of P_0 and κ can occur because of prevalence and bias effects.[30–32] First, the stability of κ is influenced by the variability of the sample (i.e. the prevalence of positive or negative ratings) and will be reduced if the ratings are homogeneous, indicated by the prevalence index.[30] Second, the κ can be influenced by a bias effect, indicated by the bias index,[30] which occurs when disagreement

between the assessment methods is asymmetrical. A large bias index reflects a tendency of a systematically different disagreement between the two methods, affecting the interpretation of the κ, which will be higher than when bias is low or absent. To explore concurrent validity between DOSS shift scores and total DI scores, the Spearman's rho correlation coefficient was used. Correlations were calculated for the total group and for the delirious group. Additionally, internal consistency of the DOSS was calculated based on all DOSS shift scores together using the Cronbach's alpha and item-total correlations.

Results

Sample

A total of 98 patients were admitted to the PCU, of whom 14 refused to participate, and 36 patients were excluded because participation was too burdensome according to the researchers' opinion (n = 1), because of death or comatose state before study involvement (n = 12), or because of inability to communicate (n = 23). Admission characteristics of the 48 included patients are shown in **Table 4.1**. Patients excluded or who refused to participate did not differ significantly from those included in terms of gender (men, n = 26/50, 52% versus n = 30/48, 62.5%; p = 0.315) and age (median 76 ((interquartile range (IQR) = 17) versus 72 (IQR = 11); p = 0.248).

Table 4.1. Admission Characteristics of Included Patients (n=48).

Characteristics	
Age, median years (Q1; Q3)	72 (67.25; 78)
Sex, n (%)	
Female	18 (37.5)
Male	30 (62.5)
Marital Status, n (%)	
Married	26 (54.2)
Single	4 (8.3)
Widowed	13 (27.1)
Divorced	5 (10.4)
Living situation before admittance to the palliative care unit, n (%)	
Alone at home	7 (14.6)
With partner or family at home	16 (33.3)
Acute hospital	24 (50)
Nursing home	1 (2.1)

Main diagnosis, n (%)	
Pulmonary cancer	4 (8.3)
Liver/pancreas cancer	7 (14.5)
Colorectal cancer	5 (10.4)
Genito-urinary cancer	10 (20.8)
Oesophagus cancer	1 (2.1)
Breast cancer	3 (6.3)
Brain cancer	2 (4.2)
Hematological cancer	3 (6.3)
Neuroendocrine tumor	3 (6.3)
Cancer with unknown primary location	5 (10.4)
COPD	4 (8.3)
Chronic pancreatitis	1 (2.1)

Q1: first quartile; Q3: third quartile; COPD: Chronic Obstructive Pulmonary Disease.

A maximum of 1440 DOSS (= 48 × 3 × 10) and 144 CAM (= 48 × 3) observations were expected to be completed. However, because of terminal state or death of included patients during study participation, only 1108 DOSS and 123 CAM observations were performed, generating 113 paired observations. For the other 10 observations, delirium measurements by bedside nurses and researchers were not made during the same 8-h shift. In these paired observations, all DOSS items were rated. In 6%, 1 to 3 items were rated as “unable” to score.

Of the 17 bedside nurses, 14 were eligible for DOSS usability evaluation (2 on maternity leave and 1 newly employed who never filled out a DOS); 10 of them returned the questionnaire (response rate = 71.4%). Nurses’ mean age was 44.2 years (standard deviation (SD) = 8.9 years). Their mean number of work experience as a nurse in general was 22.4 years (SD = 9.6 years) of which 9.1 years (SD = 2.2 years) with palliative care patients. Most nurses were female (n = 8/10), had bachelor’s degree (n = 7/10), and received delirium training for the last 5 years (n = 9/10).

Occurrence Rates of Delirium

Delirium (at least one positive CAM score) was present in 11 of the 48 patients (22.9%) or in 11 of the 113 paired observations (9.7%). An overall DOSS-shift score of 3 or more occurred in 131 of the 1108 DOSS observations (11.8%), indicating possible delirium.

Diagnostic and Concurrent Validity

The DOSS showed an area under the ROC curve (AUC) of 0.933 (95% confidence interval (CI): 0.819–1.000) (**Figure 4.1**).

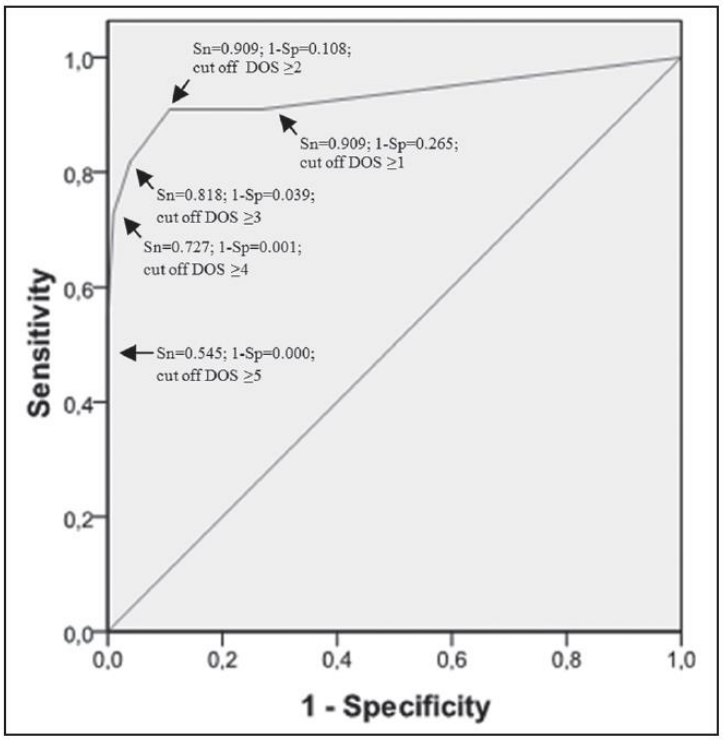

Figure 4.1. ROC Curve of DOS Shift Scores with the CAM as Reference Standard.

ROC: receiver operating characteristic; DOSS: Delirium Observation Screening Scale; CAM: Confusion Assessment Method; Sn: sensitivity; Sp: specificity.

The original cutoff point of 3 can be considered as good. Bedside nurses identified nine true-positive delirium observations and only two false-negative observations. Of the 102 observations, 4 without delirium were false positive. This results in a sensitivity of 81.8% and specificity of 96.1%. An acceptable positive predictive value and high negative predictive value were demonstrated in **Table 4.2**.

Table 4.2. Comparison of Delirium Ratings between Bedside Nurses (DOS) and Researchers (CAM) in 113 Paired Observations.

	Ratings researchers (CAM)		
	Delirium	Non Delirium	Total
Ratings bedside Nurses (DOSS)		n (%)	
Delirium	9	4	13 (11.5)
Non Delirium	2	98	100 (88.5)
Total	11 (9.7)	102 (90.3)	113 (100)

DOSS: Delirium Observation Screening scale; CAM: Confusion Assessment Method.

Sensitivity=81.8% (95% Confidence Interval (CI)=52-95); specificity=96.1% (95% CI=90-98); positive predictive value=69.2% (95% CI=42-87); negative predictive value=98% (95% CI=93-99); diagnostic accuracy=94.7% (95% CI=89-98).

Agreement between the DOSS and CAM in detecting delirious and nondelirious patients was also good (P_0 = 0.947; κ = 0.721, 95% CI: 0.509–0.932, p < 0.001). The bias and prevalence index were 0.02 and 0.79, respectively. Concurrent validity of paired DOSS shift scores with total DI scores was moderate ($r_{Spearman}$ = 0.53; p < 0.001). The mean DI score for observations with a DOSS shift score of 2 or lower was significantly lower than for observations with a DOSS shift score of 3 or more (3.16 (SD = 2.899) versus 10.08 (SD = 3.475); p < 0.001). For the delirious group (13 paired observations), the correlation coefficient between the DOS and DI was 0.73 (p < 0.01).

Internal Consistency (Table 4.3)

The Cronbach's alpha coefficient for all DOSS shift scores was 0.772. For item-total correlations, most items (e.g. items 1, 2, 4, 5, 6, 7, 8, 9, and 10) correlated moderately ($r_{Pearson}$ = 0.566–0.401) and fairly (items 3, 11, and 13) ($r_{Pearson}$ = 0.390–0.254) with the sum of the other items, while item 12 correlated weakly ($r_{Pearson}$ = 0.177) (**Table 4.3**).

Table 4.3. Pearson Item-Total Correlation Coefficients of the DOSS (n=48 Patients, 1108 Test Occasions).

DOSS Items	Corrected item-total correlations	Total alpha if item is deleted
Item 1 'dozes during conversation or activities'	0.471	0.752
Item 2 'is easily distracted by stimuli from the environment'	0.401	0.758
Item 3 'maintains attention to conversation or action'	0.390	0.759
Item 4 'does not finish question or answer'	0.533	0.743
Item 5 'gives answers which do not fit the question'	0.566	0.739
Item 6 'reacts slowly to instructions'	0.454	0.763
Item 7 'thinks to be somewhere else'	0.452	0.753
Item 8 'knows which part of the day it is'	0.430	0.756
Item 9 'remembers recent event'	0.423	0.758
Item 10 'is picking, disorderly, restless'	0.401	0.758
Item 11 'pulls IV tubes, feeding tubes, catheters'	0.254	0.771
Item 12 'is easily or suddenly emotional'	0.177	0.774
Item 13 'sees persons/things as somebody/something else'	0.318	0.766

DOSS: Delirium Observation Screening Scale; IV: intravenous.

User-friendliness (Table 4.4)

All respondents (n = 10) mainly/entirely agreed that the concepts of the DOSS items are clear, compatible with the language used in practice, and free of values and judgment. The majority (n = 9) further agreed that differences in the response options are mainly/entirely clear. Agreement about clarity (n = 9) is further reflected in all single-DOSS items (except for items 2 and 6 for which one nurse mainly disagrees). All nurses mainly/entirely agreed that they had sufficient knowledge from training and experience to evaluate the observations on the scale. However, still one nurse said that she required help from others to rate the DOSS, and one nurse disagreed that the instructions helped in choosing the correct answers. Most nurses mainly/entirely agreed that the DOSS is a handy instrument (n = 9) and adds value to their nursing practice (n = 9). Finally, the median time to score the DOSS was 1 min (IQR = 1) (**Table 4.4**).

Table 4.4. Ease of Use of the DOSS (n=10 Bedside Nurses of the Palliative Care Unit).

Items	Entirely disagree n (%)	Mainly disagree n (%)	Mainly agree n (%)	Entirely agree n (%)
Clarity of content/concepts of the scale				
The concepts of the scale were clear to me	0 (0)	0 (0)	5 (50)	5 (50)
The concepts were compatible with the language used in practice	0 (0)	0 (0)	6 (60)	4 (40)
The way in which the observations are described is free of values and judgment	0 (0)	0 (0)	4 (40)	6 (60)
There was a clear difference between the possible answers	0 (0)	1 (10)	6 (60)	3 (30)
Nurses' perception of their competence to fill out the scale				
I have sufficient knowledge from my training/experience to evaluate the observations on the scale	0 (0)	0 (0)	4 (40)	6 (60)
I could quickly make a choice between the possible answers	0 (0)	2 (20)	5 (50)	3 (30)
I requested help from others because it was not clear to me what was being asked	5 (50)	4 (4)	0 (0)	1 (10)
The instructions on the form helped me in choosing the answers[a]	1 (11.1)	0 (0)	6 (66.7)	2 (22.2)
Relevance/feasibility of the scale				
I found it a handy instrument to spot delirium symptoms	0 (0)	1 (10)	7 (70)	2 (20)
This instrument offered added value to my practice of nursing	1 (10)	0 (0)	6 (60)	3 (30)
Clarity of single DOS items				
Item 1 (dozes during conversation or activities) is clear to me	0 (0)	0 (0)	3 (30)	7 (70)
Item 2 (is easily distracted by stimuli from the environment) is clear to me	0 (0)	1 (10)	4 (40)	5 (50)
Item 3 (maintains attention to conversation or action) is clear to me	0 (0)	0 (0)	4 (40)	6 (60)
Item 4 (does not finish question or answer) is clear to me	0 (0)	0 (0)	3 (30)	7 (70)
Item 5 (gives answers which do not fit the question) is clear to me	0 (0)	0 (0)	3 (30)	7 (70)
Item 6 (reacts slowly to instructions) is clear to me	0 (0)	1 (10)	5 (50)	4 (40)
Item 7 (thinks to be somewhere else) is clear to me	0 (0)	0 (0)	3 (30)	7 (70)
Item 8 (knows which part of the day it is) is clear to me	0 (0)	0 (0)	3 (30)	7 (70)
Item 9 (remembers recent event) is clear to me	0 (0)	0 (0)	5 (50)	5 (50)
Item 10 (is picking, disorderly, restless) is clear to me	0 (0)	0 (0)	2 (20)	8 (80)
Item 11 (pulls IV tubes, feeding tubes, catheters etc.) is clear to me	0 (0)	0 (0)	2 (20)	8 (80)
Item 12 (is easily or suddenly emotional) is clear to me	0 (0)	0 (0)	3 (30)	7 (70)

Item 13 (sees persons/things as somebody/something else	0 (0)	0 (0)	3 (30)	7 (70)

[a]1 missing value; DOSS: Delirium Observation Screening Scale; IV: intravenous.

Discussion

To our knowledge, this is the first study examining the diagnostic and concurrent validity, internal consistency, and user-friendliness of the DOSS administered by bedside nurses in a PCU. The good diagnostic values of the DOSS observed in surgical and geriatric populations (sensitivity = 89%–100%, specificity = 76%–96.6%)[21–23] and its ease of use in surgical patients[23] could be confirmed in PCU patients.

The DOSS discriminates very well between delirious and nondelirious patients, with an AUC of 0.933, as compared to the CAM as reference standard. Although the sensitivity rate (81.8%) was somewhat lower than reported in earlier studies,[21–23] this result is still acceptable. More importantly, there were only two false-negative observations. The positive predictive value or the proportion of delirious patients correctly diagnosed as delirious was good and in line with the previous findings (47%–88.9%).[21–23] The negative- predictive value was high, indicating that delirium was rarely present with a DOSS shift score lower than threshold 3. This good diagnostic validity of the scale is confirmed by a substantial agreement between the DOSS and CAM, tested with kappa statistics. However, the magnitude of the κ coefficient may be reduced because of the prevalence effect, revealing that κ was influenced by homogeneity of the sample. Yet the κ was not affected by a systematically different classification pattern between the two instruments (bias index = 0.06).

Concurrent validity of the DOSS with the DI was moderate but still acceptable. Subgroup analysis with only delirious patients increased the correlation between both scales, suggesting that the DOSS is valuable for monitoring delirium severity in delirious PCU patients. In the study of Scheffer et al.,[24] where the DOSS was compared with the Delirium Rating Scale–Revised-98,[33] a slightly stronger correlation was found ($r_{Pearson}$ = 0.67). However, the use of a different statistical test (e.g. Pearson correlation) can clarify this discrepancy because our result was similar when this test was used ($r_{Pearson}$ = 0.68).

Reliability analysis showed good internal consistency. Only the item-total correlation for DOSS item “is easily or suddenly emotional” was low, but deleting the item did not change the internal consistency more than 0.002.

In line with Van Gemert and Schuurmans,[23] PCU nurses evaluated the user-friendliness of the DOSS generally as good. Despite the small sample size (n = 10), some valuable comments on the individual DOSS items were highlighted. Looking at the nurses’ ratings on clarity of

these 13 items, none of them were found to be entirely clear for all nurses. Group discussions with the nurses revealed that the perceived difficulties with DOSS items were not related with the used concepts themselves, but with the setting of palliative care. For example, some observations on the scale may mimic typical symptoms of advanced illness in palliative care (e.g. emotional, slower reaction, high levels of fatigue), which makes scoring sometimes difficult. Furthermore, most items require that patients are verbally active in order to make observations, indicating that it is difficult to use the DOSS in patients in the imminent terminal stage of life. Therefore, nurses suggested an adaptation to improve usability of the scale; for example, to add an extra section with the specific reason why assessment is impossible. Further research is warranted to investigate these adaptations.

Despite these comments, our findings suggest that the DOSS and its original threshold can be validly and reliably used for detection and monitoring of delirium severity by bedside nurses in the PCU population. Because of its time-efficiency and ease of use, the DOSS can easily be implemented in daily practice, which is an important step in improving the detection of delirium.[34]

This study has some limitations. First, only half of the patients (n = 48/98) admitted to the PCU were enrolled in the study. However, no significant differences in gender and age were found between the included and nonincluded patients. Moreover, this recruitment problem is in line with previous studies, where difficulties in recruiting PCU patients to research are well described.[16,35] Second, the reference standard for diagnosing delirium may be criticized, because it was the CAM algorithm evaluated by researchers instead of the Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV) criteria scored by an experienced physician. Nevertheless, the reliability of the reference standard was guaranteed as the researchers were extensively trained by two experts in delirium using a validated diagnostic model that we successfully used in previous studies.[15,36,37] Moreover, a recent study shows that the performance of the CAM algorithm proved well against the DSM-IV criteria in the hands of experienced clinicians.[38] Third, the validity analyses were based on 113 paired observations in 48 patients, implying that these observations were not independent, which could have potentially influenced the results. However, the main objective of this study was descriptive, not inferential, and this is not expected to be substantially affected by nonindependence. Moreover, our findings concur with previous studies on validity of the scale.[21–23] Finally, paired delirium ratings by bedside nurses and researchers were not conducted at the same moment in time. This could have biased the results, given the fluctuating course of delirium throughout the day. However, measuring delirium simultaneously was not possible, because of differences in the scoring methods of the instruments used; DOSS scores are based on observations made in the previous 8 h, and scoring of the CAM/DI is based on observations made at one moment

in time, extended by others (e.g. involving relatives'/nurses' observations for acute onset and fluctuation aspects). As a consequence, we tried to minimize the time span by using only evaluations performed within the same 8-hour shift in the analyses.

In conclusion, delirium detection in PCU patients suffering from symptoms of advanced illness is challenging. The DOSS offers bedside nurses a promising tool for screening and monitoring delirium and its severity in this population. The scale is easy to use in verbally active PCU patients (e.g. scoring requires no extensive training) and is useful in nursing practice (e.g. to score in about 1 min). However, further validation studies in this specific population are required to confirm the results of this study.

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CHAPTER V

Psychometric Properties and User-friendliness of the Intensive Care Delirium Screening Checklist (ICDSC) for the Detection of Delirium in Intensive Care Unit Patients

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Abstract

Background: The Intensive Care Delirium Screening Checklist (ICDSC) has been developed for delirium screening in intensive care unit (ICU) settings. The tool has good psychometric characteristics in research settings. However, evidence about its use for screening and monitoring delirium severity in pragmatic ICU settings is unexplored. This study aimed to determine the diagnostic accuracy, concurrent validity, internal consistency and user-friendliness of the Intensive Care Delirium Screening Checklist (ICDSC) when performed by bedside ICU nurses in routine daily practice.

Methods: In this prospective study, 77 patients from one surgical ICU of a general hospital were included. Psychometric properties of the ICDSC were tested by comparing the performance on the ICDSC (bedside nurses) to the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) and the short form of the Confusion Assessment Method Score for delirium severity (CAM-S) (researchers, gold standard). The paired observations were collected at 4 time points. Afterward, the user-friendliness of the ICDSC was determined by 34 of the 49 eligible ICU nurses using a 20-item questionnaire.

Results: Delirium occurred in 17 of the 77 patients (22.1%), or in 21 of the 143 paired observations (14.7%). Diagnostic accuracy of the ICDSC was good (area under the curve=0.843), with 81.0% sensitivity, 87.7% specificity, 53.1% positive, and 96.4% negative predictive value. Concurrent validity between the ICDSC and CAM-S was moderate ($r_{spearman}$=0.68, p<0.001). The overall Cronbach's alpha coefficient for all the ICDSC scores was 0.839. Overall, ICU nurses experienced the ICDSC as user-friendly. They were able to use the scale in most ICU patients, but some nurses (11.8%) experienced problems in rating the items 'inappropriate speech' and 'symptom fluctuation' in intubated patients.

Conclusion: The ICDSC can be used for delirium screening in ICU patients. The scale was scored as relevant and user-friendly. Given the small sample size, further validation studies with specific focus on intubated patients are required.

Introduction

Delirium, an acute and/or fluctuating disturbance in attention and awareness, together with a disturbance in cognition or perception, is a common and serious clinical syndrome in the intensive care unit (ICU).[1-3] Delirium is associated with adverse outcomes including longer duration of mechanical ventilation, prolonged ICU or hospital length of stay, and increased risk of functional decline, mortality or dementia.[2-5] Despite its clinical importance, delirium often remains unnoticed by healthcare workers and its causes are thus undertreated.[6-8] Therefore, routine delirium screening in ICU patients using a validated screening tool has been recommended.[9]

Several delirium screening tools for improving delirium recognition in the ICU have been developed. Based on a systematic review[10] and the guidelines of the Society of Critical Care Medicine Pain, Agitation and Delirium (PAD)[9], the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU)[11] and the Intensive Care Delirium Screening Checklist (ICDSC)[12] are advised for delirium screening in the ICU. Both tools are valid for delirium detection in ICU research settings. However, when CAM-ICU assessments were performed by bedside nurses in routine practice, the sensitivity of the tool is low which limits its use as a screening tool.[13] Moreover, some additional disadvantages have been identified including the fact that CAM-ICU ratings are based on observations at one time-point using additional tests (i.e. attention screening examination) and the requirement for extensive training. The ICDSC with its high sensitivity (range, 89%-99%)[14-16] and its continuous scoring system based on observations during routine care, seems to be eligible for delirium screening in daily practice. Yet, evidence about its use for screening and monitoring delirium severity in pragmatic ICU settings is unclear.[3,8,17] The aim of this study was therefore to investigate the diagnostic accuracy, concurrent validity and internal consistency of the ICDSC when performed by bedside ICU nurses in routine daily practice. Its user-friendliness in monitoring ICU patients during routine practice was described as secondary outcome.

Methods

Design, Setting and Sample

A prospective study was conducted on an 18-bed surgical intensive care unit (ICU) of a general hospital in Belgium. Dutch speaking patients who were 18 years or older and consecutively admitted to the hospital for an elective surgery with a planned ICU admission (enrolled during 6 months), were eligible for inclusion. Patients with severe hearing or visual problems, neurosurgical indications, expected ICU discharge within 24 hours, and those unable to

communicate were excluded. Furthermore, all nurses of the ICU were eligible for inclusion. The study was approved by the Medical Ethics Committee of the University Hospitals Leuven, and informed/proxy consent was obtained in patients before inclusion.

Variables and Measurements

Baseline Data

Patient baseline data included age, gender, marital status, education level, social living circumstances, type of surgery, number of medications, cognitive functioning and confirmed diagnosis of dementia. Cognitive functioning was measured using the 12-item Mini-Mental State Examination (MMSE).[18] Total score varies between 0 and 12, with higher scores indicating better cognitive functioning. Data were collected before surgery, through patient interview, requested from a family member, or based on the nursing or medical records.

Nurses' characteristics were collected through a questionnaire, and included age, gender, education level, work experience as a nurse, and received delirium training for the last 5 years.

Delirium and Delirium Severity

Delirium was both measured with the Intensive Care Delirium Screening Checklist (ICDSC)[12] and the Confusion Assessment Method for the intensive Care Unit (CAM-ICU)[11]. The ICDSC contains 8 items, including level of consciousness; inattention; disorientation; hallucinations; psychomotor activity; speech or mood disturbance; sleep disturbance; and fluctuation of symptoms, which were scored based on observations during each 8-hour shift. The level of consciousness was scored as (a) no response/coma, (b) vigorous stimulation/stupor, (c) drowsiness, (d) wakefulness, or (e) hypervigilance. In comatose or stuporose patients, there was no further delirium evaluation during that period. Only patients who were awake were considered as having a normal consciousness, and received no points on that item. The other seven items were rated as absent (0) or present (1), resulting in a total score ranging between 0 and 8. A score of 4 or more indicates delirium. The ICDSC was translated into Dutch by three of the authors (ED, AT, DS), and examined by another member of the research team (KM) and two Dutch-speaking external clinical experts with medical and psychological backgrounds. They all had good knowledge of English and an extensive clinical and research expertise in delirium.

The CAM-ICU is a diagnostic algorithm for delirium, which was completed based on a cognitive assessment using questions with nonverbal answers (e.g. Will a stone float on water?) and

simple commands (e.g. Attention Screening Examination). Accordingly, delirium was diagnosed when the criteria acute onset OR fluctuation, AND inattention AND disorganized thinking OR altered level of consciousness were rated as positive. The level of consciousness was evaluated using the Richmond Agitation-Sedation Scale (RASS)[19], a scale ranging from -5 (unarousable) to +4 (combative). In patients with RASS-score -5 or -4, there was no further delirium evaluation at that moment.

The severity of delirium was evaluated using the short form of the Confusion Assessment Method Score for delirium severity (CAM-S)[20], including the four core criteria for delirium. The items inattention, disorganized thinking and altered level of consciousness were scored as absent (0), mild (1) or marked (2), the item acute onset or fluctuating course as absent (0) or present (1). Total score varies between 0 and 7, with higher scores indicating greater severity.

User-friendliness of the ICDSC

The user-friendliness of the ICDSC for the bedside nurses was measured with a 20-item questionnaire, which was adapted from those used in two previous studies.[21,22] A total of 18 items are rated on a four-point Likert scale (i.e. strongly disagree/mainly disagree/mainly agree/strongly agree). The questionnaire evaluated the content clarity of the scale (n=4 questions), its relevance and feasibility for practice (n=2 questions), the clarity of the ICDSC items (n=8 items), and nurses' perception of their competence necessary to fill out the scale (n=4 questions). Additionally, a question about time to complete the ICDSC and an open question "Any other comments" were added.

Procedure

Patients were recruited by one of the three study nurses on the evening before surgery. Afterwards, patient baseline data were collected. Delirium was independently evaluated during the first 10 days of the patients' stay at the ICU by bedside nurses and study nurses, both blinded to the ratings of each other. Bedside nurses administered the ICDSC to score delirium on a twice daily basis (i.e. morning and evening shift). Study nurses performed four assessments (i.e. on postoperative days 2, 3, 5, 9) in enrolled patients, unless patients had an earlier ICU discharge. The assessments took place during the same 8-hour shift of the bedside nurses' assessments, and included the performance of the CAM-ICU and CAM-S, as described above. Those CAM-ICU and CAM-S assessments were considered as gold standard. At the end of the study, the bedside nurses received a questionnaire to assess their

baseline characteristics and the user-friendliness of the ICDSC. Returning a completed questionnaire was considered as informed consent.

Both bedside nurses and study nurses were trained in administering the instruments by two experts in delirium (ED and KM). Study nurses were trained according to criteria set in the manual of CAM-ICU, including evaluation of clinical cases at the bedside and follow-up discussion. Interrater reliability for CAM-ICU was κ=1.00, indicating perfect agreement (i.e. agreement of the CAM-ICU scoring for each study nurse was compared with the CAM-ICU scoring of one of the investigators (ED), and calculated two by two in a random sample of 12 paired observations of enrolled patients). Bedside nurses were educated in the use of the ICDSC during a 1-hour course (e.g. oral and written information about the ICDSC and interpretation of its items) and follow-up sessions.

Statistical Analysis

Descriptive analysis (i.e. mean/median and standard deviation/interquartile ranges, or absolute number and percentages) were calculated to summarize the patient and nursing data, and the results of the user-friendliness of the ICDSC.

Paired delirium ratings of bedside nurses and study nurses were used to examine the diagnostic accuracy of the ICDSC for the CAM-ICU, their level of agreement, and the concurrent validity between the ICDSC and the CAM-S. Diagnostic accuracy of the ICDSC was explored by creating a receiver operating characteristic (ROC) curve and by calculating sensitivity, specificity, and positive and negative predictive values for the different cutoff points of the ICDSC scores. The classification into “delirious” (positive CAM-ICU and ICDSC score ≥ 4) and “non-delirious” (negative CAM-ICU and ICDSC < 4) patients was further evaluated using the proportion of observed agreement (P_0), Cohen’s kappa coefficients (κ), the prevalence index (PI) and bias index (BI). The P_0 is the ratio of exact agreement between the two assessment methods per total number of assessments, while the κ corrects for chance. The strength of agreement for the kappa coefficient is expressed as poor (below 0.40), moderate (between 0.41 and 0.60), substantial (between 0.61 and 0.80) and almost perfect (above 0.81). Paradoxes in P_0 and κ can occur due to prevalence and bias effects. Moreover, the stability of κ is influenced by the prevalence of (positive or negative) ratings and will be reduced if the ratings are homogeneous, indicated by the PI (i.e. the absolute value of the difference between the number of cases rated as positive by both instruments, and the number of cases rated as negative by both instruments, divided by the total number of assessments). Furthermore, the κ can be influenced by a bias effect, which occurs when disagreement between the assessment methods is asymmetrical, indicated by the BI (i.e. the absolute value of the

difference between the number of cases rated as positive by instrument 1 and as negative by instrument 2, and the number of cases rated as negative by instrument 1 and as positive by instrument 2; divided by the total number of assessments). To examine concurrent validity between the ICDSC scores and CAM-S scores, the Spearman's rho correlation coefficient was used. Correlations were calculated for the total group, and for the delirious and non-delirious groups separately.

Additionally, internal consistency of the ICDSC was calculated based on all ICDSC scores together using the Cronbach's alpha and item-total correlations.

All analysis were two-sided and performed using SPSS version 17.0 (SPSS Inc., Chicago, IL). P-values < 0.05 were considered as significant.

Results

Study Sample

A total of 105 patients were consecutively admitted to the hospital for elective surgery with a planned ICU admission. Twelve patients refused to participate, and another 12 were excluded because they had an expected ICU discharge within 24 hours after ICU admission (n=6), because of severe hearing or visual problems (n=1), or inability to understand Dutch (n=1). Four patients discontinued the study because they were postoperative not responsive for more than 5 consecutive days. Baseline data of the 77 included patients are shown in **Table 5.1**. The majority of patients were admitted for coronary artery bypass grafting (CABG) (n=44, 57.1%) (**Table 5.1**).

Table 5.1. Baseline Data of Included Patients (n=77)

Characteristics	
Age, median years (IQR)	72 (13)
Sex, n (%)	
Female	14 (18.2)
Male	63 (81.8)
Marital status, n (%)	
Married	59 (76.6)
Single	2 (2.6)
Widowed	13 (16.9)
Divorced	3 (3.9)
Education level, n (%)	
Low (<15 years)	37 (48.0)
Moderate (15-18 years)	23 (29.9)
High (>18 years)	17 (22.1)
Social living circumstances before admittance to the intensive care unit, n (%)	
At home	75 (97.4)
Service flat	1 (1.3)
Residential facilities	1 (1.3)
Type of surgery, n (%)	
CABG	44 (57.1)
Valve replacement	15 (19.5)
Combination valve replacement and CABG	12 (15.6)
Thorax surgery	3 (3.9)
AAA	3 (3.9)
Number of medications, median (IQR)	4 (2.0)
Cognitive functioning	
Baseline MMSE, median (IQR)	11 (1.0)
Confirmed diagnosis of dementia, n (%)	1 (1.3)

A maximum of 1540 ICDSC (=77x2x10) and 308 CAM-ICU (=77x4) observations were expected to be performed. However, because of a shorter ICU stay or unresponsiveness of included patients during study participation, 508 ICDSC and 168 CAM-ICU observations were completed, generating 143 paired observations. For 25 paired observations, delirium assessments were not performed during the same 8-hour shift; and therefore excluded from further analyses.

Of the 49 bedside nurses, 34 of them returned the questionnaire (response rate=69.4%). Nurses' mean age was 29.8 years (±SD 6.3 years). Most of them were female (n=27, 79.4%), had bachelor degree alone (n=11, 32.4%) or with an additional degree in intensive care (n=17, 50.0%), and had more than 6 years of work experience on the intensive care unit (n=16, 47.1%). Only 4 nurses (12%) received delirium training for the last 5 years.

Occurrence Rates of Post-operative Delirium

Delirium (at least one positive CAM-ICU score) occurred in 17 of the 77 patients (22.1%), or in 21 of the 143 paired observations (14.7%). An overall ICDSC score of 4 or more was present in 104 of the 508 ICDSC observations (20.5%), indicating possible delirium.

Diagnostic Accuracy (Table 5.2)

The ICDSC yielded an area under the ROC curve of 0.873 (95% confidence interval (CI): 0.779-0.966) (**Figure 5.1**).

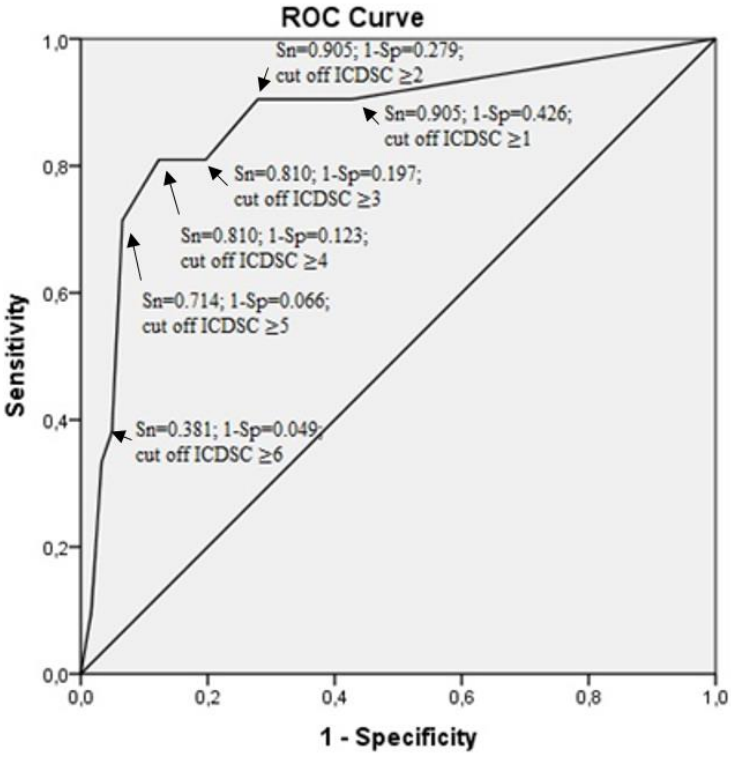

Figure 5.1. ROC Curve of the ICDSC Scores with the CAM-ICU as Reference Standard.

ROC: receiver operating characteristic; ICDSC: Intensive Care Delirium Screening Checklist; CAM-ICU: Confusion Assessment Method for the Intensive Care Unit; Sn: sensitivity; Sp: specificity

With the original cutoff point of 4, the diagnostic accuracy of the ICDSC was good with a sensitivity of 81.0% and specificity of 87.7%. Bedside nurses identified 17 true-positive delirium observations, 4 false-negative and 15 false-positive observations. This results in a median positive predictive value and a high negative predictive value (**Table 5.2**). Lowering the cutoff point to 3, did not increase the sensitivity but reduced the specificity. Increasing the cutoff point to 5, reduced the sensitivity and increased the specificity (**Table 5.2**).

Table 5.2. Diagnostic Accuracy of the ICDSC Administered by Bedside Nurses for the CAM-ICU (study nurses) as Gold Standard in 143 Paired Observations

Instruments	Cutoff	Sensitivity % (95% CI)	Specificity % (95% CI)	PPV % (95%CI)	NPV % (95% CI)	Accuracy % (95% CI)
Positive CAM-ICU						
ICDSC	2	90.5 (71-97)	72.1 (64-79)	35.8 (24-49)	97.8 (92-99)	74.8 (67-81)
	3	81.0 (60-92)	80.3 (72-86)	41.4 (28-57)	96.1 (90-98)	80.4 (73-86)
	4	81.0 (60-92)	87.7 (81-92)	53.1 (36-69)	96.4 (91-99)	86.7 (80-91)
	5	71.4 (50-86)	93.4 (88-97)	65.2 (45-81)	95 (90-98)	90.2 (84-94)

CAM-ICU: Confusion Assessment Method for the Intensive Care Unit; ICDSC: Intensive Care Delirium Screening Checklist; PPV: positive predictive value; NPV: negative predictive value.

Agreement between ICDSC and CAM-ICU

Agreement in defining delirious and non-delirious patients was moderate (P_0=0.87; κ=0.56, 95% CI: 0.38-0.74, p<0.001). The prevalence and bias index were 0.63 and 0.08, respectively.

Concurrent Validity ICDSC with CAM-S

Correlation between paired ICDSC scores with CAM-S scores was moderate both for the total group ($r_{spearman}$=0.68, p<0.001) as for the non-delirious subgroup ($r_{spearman}$=0.54, p<0.001). A non-significant correlation between those scales ($r_{spearman}$=0.41, p=0.06) was seen within the delirious group (21 paired observations).

Internal Consistency

The overall Cronbach's alpha coefficient for all the ICDSC scores was 0.839. The alpha coefficients if one of the items was deleted ranged between 0.808 and 0.837 (**Table 5.3**). The items correlated strongly (i.e. items 1, 5, 8) ($r_{Pearson}$=0.604-0.661) to moderately (i.e. items 2, 3, 4, 6, 7) ($r_{Pearson}$ =0.469-0.588) with the sum of the other items (**Table 5.3**).

Table 5.3 Pearson Item-Total Correlation Coefficients of the ICDSC (n=77 Patients; n=507 Test Occasions)

ICDSC Items	Corrected Item-Total Correlations	Total Alpha if Item is Deleted
Item 1 "Altered level of consciousness"	0.638	0.811
Item 2 "Inattention"	0.586	0.819
Item 3 "Disorientation"	0.588	0.819
Item 4 "Hallucination, delusion, psychosis"	0.507	0.829
Item 5 "Psychomotor agitation or retardation"	0.661	0.808
Item 6 "Inappropriate speech or mood"	0.575	0.822
Item 7 "Sleep/wake cycle disturbance"	0.469	0.837
Item 8 "Symptom fluctuation"	0.604	0.816

User-friendliness

Most respondents mainly/entirely agreed that the concepts of the ICDSC items are clear (n=33, 97.1%) and compatible with the language used in practice (n=32, 94.2%). The majority further agreed that the way in which the items are described is free of values and judgement (n=28, 82.4%), and differences in response options are mainly/entirely clear (n=29, 85.3%). Although most nurses mainly/entirely agreed that the ICDSC items in themselves are clear, one nurse mainly disagreed for items 3, 4, 5 and 7 (**Table 5.4**), and four nurses mainly disagreed for items 6 (inappropriate speech or mood) and 8 (symptom fluctuation). Rating the two latter items gave problems in intubated patients. All nurses mainly/entirely agreed that they had sufficient knowledge from training and experience to evaluate the items on the scale. However, eleven (32.4%) nurses indicated that they required help from others to rate the ICDSC, and some nurses disagreed that they could quickly make a choice between the possible answers (n=4, 11.8%) or that the instructions helped in choosing the correct answers (n=1, 2.9%). Although 28 nurses (82.4%) mainly/entirely agreed that the ICDSC is a handy instrument to use in practice, 14 nurses (41.2%) mainly disagreed that the instrument adds value to their nursing practice. Finally, 7 nurses (20.6%) completed the ICDSC ratings in less than 1 minute, 23 nurses (67.6%) in 1 to 2 minutes and 4 nurses (11.8%) in 3 to 5 minutes.

Table 5.4. Ease of Use of the ICDSC (n=34 Bedside Nurses of the ICU)

Items	Entirely disagree, n (%)	Mainly disagree, n (%)	Mainly agree, n (%)	Entirely agree, n (%)
Clarity of content/concepts of the scale				
The concepts of the scale were clear to me	0 (0)	1 (2.9)	16 (47.1)	17 (50.0)
The concepts were compatible with the language used in practice	1 (2.9)	1 (2.9)	13 (38.2)	19 (55.9)
The way in which the observations are described is free of values and judgement	0 (0)	6 (17.6)	11 (32.4)	17 (50.0)
There was a clear difference between the possible answers	0 (0)	5 (14.7)	15 (44.1)	14 (41.2)
Nurses' perception of their competence to fill out the scale				
I have sufficient knowledge from my training/experience to evaluate the observations on the scale	0 (0)	0 (0)	14 (41.2)	20 (58.8)
I could quickly make a choice between the possible answers	0 (0)	4 (11.8)	17 (50.0)	13 (38.2)
I requested help from others because it was not clear to me what was being asked	11 (32.4)	12 (35.3)	7 (20.6)	4 (11.8)
The instructions on the form helped me in choosing the answers	0 (0)	1 (2.9)	15 (44.1)	18 (52.9)
Relevance/feasibility of the scale				
I found it a handy instrument to spot delirium symptoms	0 (0)	6 (17.6)	21 (61.8)	7 (20.6)
This instrument offered added value to my practice of nursing	0 (0)	14 (41.2)	12 (35.3)	8 (23.5)
Clarity of single ICDSC items				
Item 1 (altered level of consciousness) is clear to me	0 (0)	0 (0)	13 (38.2)	21 (61.8)
Item 2 (inattention) is clear to me	0 (0)	0 (0)	12 (25.8)	22 (64.7)
Item 3 (disorientation) is clear to me	0 (0)	1 (2.9)	10 (29.4)	23 (67.6)
Item 4 (hallucination, delusion, psychosis) is clear to me	0 (0)	1 (2.9)	15 (44.1)	18 (52.9)
Item 5 (psychomotor agitation or retardation) is clear to me	0 (0)	1 (2.9)	13 (38.2)	20 (58.8)
Item 6 (inappropriate speech or mood) is clear to me	0 (0)	4 (11.8)	14 (41.2)	16 (47.1)
Item 7 (sleep/wake cycle disturbance) is clear to me	0 (0)	1 (2.9)	14 (41.2)	19 (55.9)

Item 8 (symptom fluctuation) is clear to me	0 (0)	4 (11.8)	13 (38.2)	17 (50.0)

Discussion

Although the ICDSC has been advised for delirium screening in the ICU, evidence about its test characteristics and user-friendliness when performed by bedside nurses is unclear.[3,8,12] This is the first study that presents evidence to support the diagnostic accuracy, concurrent validity, internal consistency and user-friendliness of the ICDSC used by bedside nurses in daily practice.

The ICDSC discriminates well between delirious and nondelirious patients, with an AUC of 0.873, as compared to the CAM-ICU as reference standard. It had good sensitivity (81.0%) and specificity (87.7%) rates when the original cutoff point was used. Lowering this cutoff to 3 would not affect the detection of delirious patients, yet would increase the number of false positives. In contrary, increasing the cutoff to 5 would detect less delirious patients, however decrease the number of false positives. Since the ICDSC is used for delirium screening, the original cutoff of 4 remains the optimal threshold for use in daily ICU practice. Yet, the sensitivity was somewhat lower than in the validation studies conducted in the research settings (89.0%-99.0%),[14-16] where a limited number of trained researchers administered the ICDSC. However, compared to the studies evaluated in daily practice (43% and 71.9%),[8,17] sensitivity was higher. This discrepancy may be due to the lack of training[12] or caused by the inclusion of other types of ICU patients (e.g. neurosurgery and/or medical patients)[8,12].

Agreement between the CAM-ICU and ICDSC was further evaluated with kappa statistics, showing a moderate kappa despite the high observer agreement between both instruments. This difference reflects bias by homogeneity of the sample (prevalence index=0.63) which reduce the kappa coefficient. However, importantly, the magnitude of kappa was not affected by a systematically different classification pattern between the two instruments (bias index = 0.08).

Concurrent validity of delirium severity between the ICDSC and the CAM-S was moderate. Correlations within the subgroups of nondelirious and delirious patients separately were somewhat lower. Yet, the ICDSC may be valuable for monitoring delirium severity in all patients. However, for use as severity instrument in delirious patients, further research testing that specific aspect is necessary. Nevertheless, the ICDSC was only tested against the CAM-S, which may be insufficiently extensive to evaluate delirium severity. On the other hand, the long form of the CAM-S includes - against the four core items - also the items disorientation, memory impairment, perceptual disturbances, psychomotor agitation/retardation and altered

sleep-wake cycles, items also found in the ICDSC. Therefore, further research testing the ICDSC against the full version of the CAM-S is necessary.

Furthermore, reliability analysis revealed good internal consistency with a value which is in line with those in previous studies (0.72-0.86). Overall, all items showed good item-total correlations and seemed to be worthy of retention.

The user-friendliness of the ICDSC was generally evaluated as good. Yet, important findings about the ICDSC were identified. First, regarding the clarity of the individual items, none of them were found to be entirely clear for all nurses but, unfortunately, no comments about the perceived difficulties were given. However, four nurses commented that the items 'inappropriate speech or mood' and 'symptom fluctuations' were difficult to rate in intubated patients. Therefore, these nurses rated the two items as mainly unclear. Hence, we can assume that the perceived difficulties with these two items were not related to the concepts themselves but with their use in a subpopulation of non-verbally active ICU patients. Yet, one could argue that using the ICDSC in intubated patients affects its psychometric properties. Indeed, a previous study revealed that its sensitivity was lower in a subgroup of non-verbally active patients compared to those in the verbally active subgroup.[8] However, because of the low amount of intubated patient observations in our study (n=12), sensitivity analysis in this subgroup was not performed. Hence, research on the ICDSC's psychometric properties within different subgroups of ICU patients is needed. Second, although all nurses agreed that they had sufficient knowledge from training and clinical experience to evaluate the ICDSC items, almost one third indicated the need for help to rate the scale. The reason for this discrepancy cannot be determined as no information regarding the content of the requested help was available. Yet, it indicates that the implementation of the ICDSC in daily practice require more than a simple educational session. Indeed, a comprehensive training session, not only before but also during the implementation process is necessary.

Last, a small majority of nurses (60%) agreed that the ICDSC adds value to their nursing practices. One possible reason could be that screening without further action is useless. Indeed, screening should be part of a global delirium management protocol which was not implemented in this study. Because of the small sample size, we were not able to compare the characteristics of nurses who agreed versus those who disagreed. Nevertheless, the importance of delirium evaluation with a screening instrument is well established. Delirium screening based on clinical impressions showed inferior sensitivity compared to screening with a screening tool.[8] Hence, this highlights the need for nursing education about the importance of standard delirium screening with screening tools and its implementation in daily practice. The optimum types of educational strategies should be explored in further research.

Some methodological limitations need to be considered in the interpretation of these findings. First, one might criticize the reference standard for diagnosing delirium, because it was the CAM-ICU rated by the study nurses instead of the Diagnostic and Statistical Manual of Mental Disorders (4th ed.; DSM-IV) criteria evaluated by an experienced physician. Yet, the reliability of this reference standard was confirmed because of the extensive training session the research nurses followed, including the use of a validated diagnostic model also successfully used in prior research.[19-21] Second, the analysis regarding accuracy, agreement and validity were based on 143 paired observations in 77 patients, indicating that these observations were not independent. This might have potentially influenced the results. However, because the study aim was descriptive and not inferential, this is not expected to be extensively affected by non-independence. Third, the paired delirium ratings of bedside nurses and research nurses were not performed at the same time point, which might result in bias because of the fluctuating nature of delirium throughout the day. However, since there are differences in the scoring methods of the used instruments; ICDSC ratings are based on observations made during the previous 8 hours and CAM-ICU/CAM-S ratings are based on observations made at one time point; evaluating delirium simultaneously with both methods was not possible. Yet, by using only the assessments performed within the same 8-hour shift in the analysis, we tried to reduce the time span between the two methods used. Last, one might criticize the used technique for the ICDSC translation into Dutch. However, no gold standard exists.[25-27] Instead of performing a back-translation, an expert panel with expertise in delirium was used to control the quality of the translation. This technique was successfully used in previous studies[25-27], and is considered to be more effective for ensuring that the translation is performed appropriately.[26,27]

In conclusion, the ICDSC seems to be a valuable tool for delirium screening and monitoring severity in daily ICU practice. However, the aspect of monitoring delirium severity requires further evaluation. Although the ICDSC is useful (e.g. scoring in 1 to 2 minutes) in daily nursing practice, it is rated as valuable to the practice in only a small majority of nurses, which may limit its actual use in daily care. Therefore, researchers and healthcare leaders should also focus their teaching on the importance of using screening tools in the detection and monitoring of delirium.

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CHAPTER VI

Usefulness and Feasibility of a Newly Developed Interactive Delirium e-learning Tool for Staff

This chapter is based on: Detroyer E, Joosten E, Milisen K. An interactive e-learning tool about delirium for healthcare providers: development and testing of feasibility. Annals of Delirium Care 2014; 13: 2-7.

Abstract

Objectives: To describe the development of an online self-directed delirium e-learning tool for healthcare workers, and to evaluate its usefulness and feasibility in daily practice.

Methods: In this descriptive study, 54 healthcare workers from a university hospital were included. The e-learning tool included 11 e-modules integrating knowledge and skill development in prevention, detection and management of delirium. After a 2-month implementation period during which participants could access the tool at any time, the healthcare workers were asked to complete a 21-item questionnaire about the usefulness and feasibility of the tool in their clinical practice.

Results: The majority of participants (90.7%) judged that the content of the tool was useful in daily practice - the included videos (77.7%) and tests for self-assessment (92.6%) in particular - and mentioned that the tool improved their perceived knowledge in delirium care (92.5%). Nevertheless, a minority (14.8%) agreed that it was feasible to use the tool during working hours. Especially time pressure and difficulties with concentration because of interactions with care activities were reported as most important barriers. The most frequently reported advantages of using the e-learning tool were: (1) flexibility for learners, (2) content divided in 11 modules of 10 minutes each to complete, (3) included videos and tests for self-assessment with feedback, and (4) the fact that the tool is based on self-active learning. The disadvantages included (1) the lack of interactivity between the teacher and learners or between learners themselves (e.g. no peer discussion; no facilitator), (2) the need for sufficient self-discipline in combination with a positive attitude towards delirium to complete all modules without supervision of a facilitator, and (3) the lack of possibilities to apply personal notes.

Conclusion: Overall, healthcare workers were positive about the e-learning tool. Although the participants mentioned that the use of this e-learning course had advantages, most participants felt it not feasible to complete the tool during working hours.

Introduction

Delirium is a common and serious complication in the hospital affecting 13% of young patients to 53% of older patients, and up to 88% of intensive care and palliative care unit patients.[1-4] Despite the evidence that delirium is preventable in 30% to 50% of cases,[5,6] risk factors are not identified and tackled systematically and many delirium cases remains undetected in clinical practice. One of the factors related to this poor delirium care has been healthcare workers' lack of knowledge and skills to effectively prevent, detect and treat delirium.[7-9]

Healthcare workers' education about delirium is a core element of delirium preventive and treatment strategies. Education aims to improve their delirium-related knowledge and skills to effectively prevent and treat delirium in routine care.[6,10,11] The existing educational strategies are, however, difficult to implement into routine care, because such initiatives are time-consuming and labour-intensive.[12,13] Furthermore, recognizing that delirium concerns all healthcare workers, we require educational innovations that enhance knowledge and skill development in delirium care for a large number of persons with mixed learning needs.[12,13]

E-learning has been described as an alternative approach to deliver education for large groups of people, providing a more flexible and cost-effective method of training than the traditional educational approaches. Its accessibility, availability, and the use of interactive feedback mechanisms and real care situations hypothesise them easier to implement.[14-16] Despite its positive effects on the knowledge, skills and behaviour change of healthcare workers in different healthcare domains, it is a rather undeveloped tool for delirium education.[12-19] Therefore, this study aimed to describe the development of an online self-directed delirium e-learning tool for healthcare workers, and to evaluate its usefulness and feasibility in daily practice.

Methods

Development of the E-learning Tool

The tool was developed by the research team, using a phased approach. Content development was based on results of a study of literature regarding effective interventions for delirium prevention and management, guidelines,[20-22] research evidence for factors associated with successful learning outcomes and changing behaviour,[16,23-25] and expert opinion. To increase accessibility and feasibility for healthcare workers, the tool was organized into 11 sub modules of 5 to 15 minutes each (see **Figure 6.1**), which can be completed on the unit during working time (e.g. free time). The estimated time to complete the entire tool is 2 to 2.5 h. It integrates

knowledge and skill development by providing information about delirium specifics (occurrence rates, clinical presentation, types, risk factors, experiences of patients), delirium prevention and treatment strategies, and information about the use of screening scales for delirium detection in combination with case studies, videos (e.g. use of screening instruments) and tests for self-assessment with feedback.

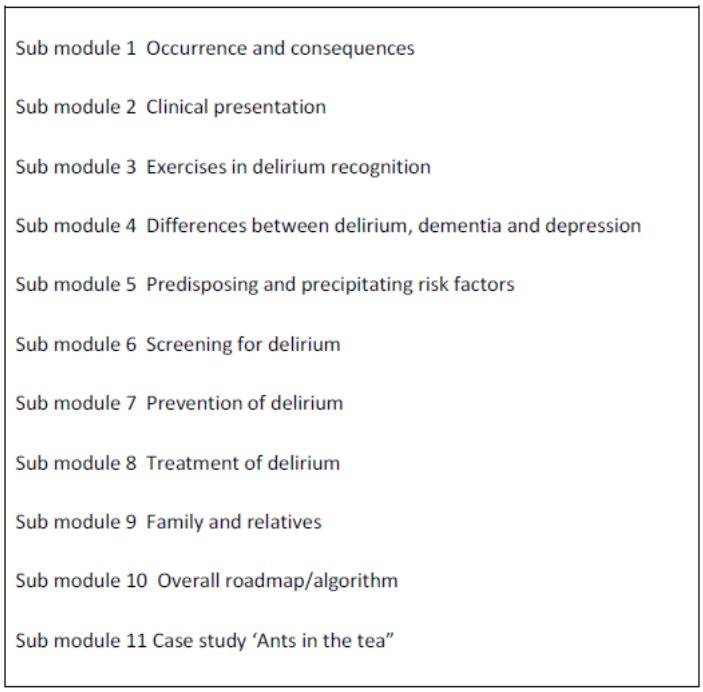

Figure 6.1. Overview of the Different Sub Modules within the Delirium E-learning Tool.

The development of the application was internet-based. To receive feedback at an early stage in the application development, the first and second prototypes of the tool were pilot-tested by nursing students (n=40) and nurses (n=4) respectively. Based on their feedback the tool was improved before testing its use in the routine clinical practice. The online delirium e-learning tool is available (in Dutch) at www.deliriummodule.be (see **Figure 6.2**; screen shot).

Figure 6.2. Screenshot of the Delirium E-learning Tool

Feasibility Testing of the E-learning Tool

A descriptive study was conducted in a convenience voluntary sample of 59 healthcare workers (i.e. all of them were nurses except for 2 physiotherapists and 2 occupational therapists being staff members of the participating units) recruited from 20 adult inpatient units of the University Hospitals Leuven. The units (e.g., medical, surgical, gerontopsychiatric and rehabilitation units) were selected based on their chief nurses' willingness to participate.

During a one-hour information session, participants got a personal log-in code to access the e-learning tool and received oral and written information about its use. Afterwards, the tool was available for 2 months during which participants were asked to access the delirium course at least once. The e-tool was based on self-active learning and participants could start, finish and re-start at any time. After one month, all participants received an e-mail reminder to encourage completion of the education tool. At the end of this period, the participants had to complete two questionnaires, including a questionnaire for demographic information (i.e. age, gender, number of years of work experience, employment status and level of education) and a 21-item questionnaire about the usability of the content of the tool and its feasibility in their clinical practice. The 'usability-feasibility' questionnaire was newly developed by the research team. Its content was evaluated by a panel of experts (i.e. one geriatrician, one psychologist, three researchers with nursing background and two nurses with master degree of which one had pedagogical knowledge) during a consensus meeting. The face validity of the questionnaire was tested in 4 nurses. The final questionnaire included 4 open and 17 structured questions to be scored on a four-point Likert scale (strongly disagree /mainly disagree/ mainly agree/ strongly agree), which assesses the expectations about the content of the tool (n=1), its usefulness in daily practice (n=1) and feasibility during working hours (n=1), the usefulness of the individual sub modules (n=11), videos (n=1) and tests for self-assessment (n=1). Finally, it

evaluates the subjective perception of the healthcare workers regarding their knowledge improvements in delirium care (n=1). The open questions assess the advantages (n=1) and disadvantages (n=1) of delirium education through the e-learning tool, and ask for times to complete the tool (n=1) and for any other comments (n=1). The study was approved by the Medical Ethics Committee of the Leuven University Hospitals.

Analysis

Descriptive analysis were performed to examine demographic data and to summarize the results of the 'usability-feasibility' questionnaire, using SPSS version 16 (SPSS, Inc., Chicago, IL). Means and standard deviations were used for continuous data, absolute numbers and percentages for categorical data.

Results

Sample

Fifty-four healthcare workers (50 nurses, 2 physiotherapists and 2 occupational therapists) filled-out the feasibility questionnaire. Healthcare workers' mean age was 39.2 ((standard deviation (SD) = 11.2 years). Their mean number of work experience as a healthcare worker was 16.7 years (SD = 11.7 years). Most healthcare workers were female (n = 49, 90.7%), had bachelor's degree (n = 32, 59.3%) and worked full-time (n=29, 53.7%).

Twenty eight (56%) healthcare workers only partially completed the e-learning tool (1 to 10 sub modules; median number of completed sub modules: 6.5 (interquartile range (IQR 4)) and 26 healthcare workers completed it entirely (11 sub modules). The mean time to complete all 11 sub modules was 132.7 min (SD 48.6). Those who partially completed the tool indicated that the time pressure during working hours was an important reason why not all sub modules were completed.

Content Usability and Feasibility of the E-learning Tool in Clinical Practice (Table 6.1)

The majority of participants mentioned that the e-learning tool answered to the expectations with regard to the content (92.6%) and improved the subjective perception of their knowledge about delirium (92.5%). A total of 90.7% mainly/strongly agreed that the content of the tool was useful in daily practice. Especially the content of the sub modules including 'precipitating and

predisposing risk factors' (93.6%), 'Family and relatives' (93.4%), 'Exercises in delirium recognition' (92.3%) and 'prevention of delirium' (92.2%) were judged as very useful by the majority of participants. Within these submodules, the included videos (77.7%) and tests for self-assessment (92.6%) with feedback were experienced as useful in clinical care. Nevertheless, only 14.8% of these healthcare workers mainly/strongly agreed that it was feasible to use the tool during working hours. Especially the time pressure and the difficulties with concentration because of interactions with care activities, such as questions of patients or family, were mentioned as the most important barrier. Furthermore, important advantages of delirium education through this e-learning tool were identified including the flexibility for the learner (e.g. could start, finish and continue the course at any time; able to educate themselves at the place and time they prefer), the possibility of self-active learning (e.g. could choose which information they need and set their own tempo), the divided content in sub modules of approximately 10 minutes, and the videos and tests for self-assessment with feedback. Important disadvantages of using the tool included the lack of interactivity between the teacher and learners or between learners themselves (e.g. no peer discussion; no facilitator), the need for sufficient self-discipline and/or a positive attitude towards delirium to complete all sub modules without supervision of a facilitator, and the lack of possibilities to apply personal notes.

Table 6.1. Feasibility of the E-learning Tool (n=54 Healthcare Workers)

Items	Strongly disagree, n (%)	Mainly disagree, n (%)	Mainly agree, n (%)	Strongly agree, n (%)
With regard to the content, the tool meet my expectations	0 (0)	4 (7.4)	27 (50.0)	23 (42.6)
The content of the tool is useful in daily practice	0 (0)	5 (9.3)	24 (44.4)	25 (46.3)
It is feasible to use the tool during working hours	32 (59.3)	14 (25.9)	4 (7.4)	4 (7.4)
The e-learning tool has increased my knowledge about delirium	1 (1.9)	3 (5.6)	26 (48.1)	24 (44.4)
The content of sub module 1 (occurrence and consequences) is useful for me	0 (0)	9 (16.6)	40 (74.1)	5 (9.3)
The content of sub module 2 (clinical presentation) is useful for me*	1 (1.9)	6 (11.3)	36 (67.9)	10 (18.9)
The content of sub module 3 (exercises in delirium recognition) is useful for me$	0 (0)	4 (7.7)	33 (63.5)	15 (28.8)
The content of sub module 4 (differences between delirium, dementia and depression) is useful for me+	0 (0)	4 (8.9)	31 (68.9)	10 (22.2)
The content of sub module 5 (Predisposing and precipitating risk factors) is useful for me±	1 (2.1)	2 (4.3)	35 (74.5)	9 (19.1)
The content of sub module 6 (Screening for delirium) is useful for me+	0 (0)	7 (15.5)	30 (66.7)	8 (17.8)

The content of sub module 7 (Prevention of delirium) is useful for me‡	1 (2.5)	2 (5.3)	27 (71.1)	8 (21.1)
The content of sub module 8 (Treatment of delirium) is useful for me¥	0 (0)	3 (9.4)	24 (75)	5 (15.6)
The content of sub module 9 (Family and relatives) is useful for me□	0 (0)	2 (6.6)	23 (76.7)	5 (16.7)
The content of sub module 10 (Overall roadmap/algorithm) is useful for meΩ	0 (0)	5 (15.2)	24 (72.7)	4 (12.1)
The content of sub module 11 (Case study 'Ants in the tea") is useful for meΩ	0 (0)	7 (21.2)	18 (54.5)	8 (24.2)
The videos are useful for me	5 (9.3)	7 (13.0)	26 (48.1)	16 (29.6)
The tests for self-assessment are useful for me	2 (3.7)	2 (3.7)	29 (53.7)	21 (38.9)

*sub module not completed by 1 learner; $sub module not completed by 2 learners; +sub module not completed by 9 learners; ±sub module not completed by 7 learners; ‡sub module not completed by 16 learners; ¥sub module not completed by 22 learners; □sub module not completed by 24 learners; Ωsub module not completed by 21 learners

Discussion

This study described the development of an online self-directed staff delirium e-learning tool which integrated knowledge and skill development in delirium prevention, detection and treatment, and its usefulness and feasibility in daily practice.

Our findings corroborate previous findings[14,18] as it demonstrated healthcare workers' positive reactions to this alternative educational approach. Indeed, its accessibility and flexibility for learners, and the division of its content in several sub modules in which the delivery is based on self-active learning, were recognized as important advantages of delirium education through this tool. Additionally, the content - the included videos and tests for self-assessment with feedback in particular - was evaluated as very useful for daily practice. However, most healthcare workers felt it not feasible to complete the tool during working hours (i.e. free time) which is a valuable finding when using this type of education in practice. Time pressure and difficulties with concentration because of interaction with care activities were important barriers, and highlight the need for further investments in additional strategies. Moreover, healthcare workers highlighted important disadvantages of using this type of delirium education including the lack of interactivity with peers and/or teacher and the need for sufficient self-discipline in combination with a positive attitude towards delirium to complete all modules without supervision of a facilitator. One possible solution to overcome these problems is using the e-learning course in combination with a delivery schedule over fixed time periods (e.g. sub module 1 to 4 completed after 3 weeks, 5 to 7 after 6 weeks, 8 to 11 after 9 weeks) and recurrent feedback sessions in group (e.g. after each fixe time period) organized by a facilitator.

Structuring education through e-learning in such a format had promising results on learning outcomes in continuing medical education.[14]

Irrespective the reported advantages and disadvantages of receiving delirium education through e-learning, it is one approach available to hospitals and researchers to improve delirium care in daily practice. Healthcare workers indicated that the e-learning tool improved their perceived delirium-related knowledge, yet, its real value for practice (i.e. nursing and patient outcomes) remains to be demonstrated.

Some methodological limitations need to be considered. First, this study was conducted at one university hospital in a voluntary sample of healthcare workers. Therefore, this limits the generalizability of the study results. Second, we used quantitative research methods to evaluate the usability and feasibility of the e-learning tool in daily practice. Inclusion of qualitative data (i.e. focus groups or interviews) would have given a more in depth view on participants' views on the content of the delirium e-learning tool and the perceived barriers in practice. Last, results were based on a 'usability-feasibility' questionnaire developed for this study. It supports good content and face validity based on expert review and pilot testing, however, additional validity testing is needed.

In conclusion, healthcare workers were positive about the delirium e-learning tool. Its accessibility and flexibility for learners, and the division of its content in several sub modules were identified as important advantages of delirium education through e-learning. However, most participants felt it not feasible to complete the tool during working hours. Important disadvantages of using this type of delirium education were mentioned, including the lack of interactivity with peers and/or teacher and the need for sufficient self-discipline to complete all modules without supervision of a facilitator. One solution to tackle these problems is using e-learning in combination with a delivery schedule over fixed time periods with feedback sessions.

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CHAPTER VII

Impact of Delirium E-learning on Nursing Outcomes

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Detroyer E, Dobbels F, Debonnaire D, Irving K, Teodorczuk A, Fick DM, Joosten E, Milisen K. The effect of an interactive delirium e-learning tool on healthcare workers' delirium recognition, knowledge and strain in caring for delirious patients: a pilot pre-test/post-test study. BMC Medical Education 2016; 16 (17): 1-10.

Abstract

Background: Studies investigating the effectiveness of delirium e-learning tools in clinical practice are scarce. The aim of this study is to determine the effect of a delirium e-learning tool on healthcare workers' delirium recognition, delirium knowledge and care strain in delirium.

Methods: A pilot pre-posttest study in a convenience sample of 59 healthcare workers recruited from medical, surgical, geronto-psychiatric and rehabilitation units of a university hospital. The intervention consisted of a live information session on how to use the e-learning tool and, a 2-month self-active learning program. The tool included 11 e-modules integrating knowledge and skill development in prevention, detection and management of delirium. Case vignettes, the Delirium Knowledge Questionnaire, and the Strain of Care for Delirium Index were used to measure delirium recognition, delirium knowledge and experienced care strain in delirium respectively. Subgroup analyses were performed for healthcare workers completing 0 to 6 versus 7 to 11 modules.

Results: The delirium recognition score improved significantly (mean 3.1 ± SD 0.9 versus 2.7 ± 1.1; $p = 0.04$), and more healthcare workers identified hypoactive ($p = 0.04$) and hyperactive ($p = 0.007$) delirium in the posttest compared to the pretest phase. A significant difference in the change of recognition levels over time between the 0 to 6 and 7 to 11 module groups was demonstrated ($p = 0.03$), with an improved recognition level in the posttest phase within the 7 to 11 module group ($p = 0.007$). After adjustment for potential confounders, this difference in the change over time was not significant ($p = 0.07$) and no change in recognition levels within the 7 to 11 module group was noted ($p = 0.19$). The knowledge score significantly improved in the posttest compared to the pretest phase (mean 31.7 ± SD2.6 versus 28.3 ± 4.5; $p < 0.001$), with a significant increased level within the 7 to 11 module group (unadjusted $p < 0.001$/adjusted $p = 0.02$). Overall, no difference between posttest and pretest phases was documented for care strain ($p = 0.46$).

Conclusion: The e-learning tool improved healthcare workers' delirium recognition and knowledge. The effect of the tool is related to its level of completion, but was less explicit after controlling for potential confounders and warrants further investigation. The level of strain did not improve.

Background

Delirium is a common disorder in older hospitalized patients, characterized by an acute and fluctuating disturbance in attention and awareness; and a disturbance in cognition or perception.[1, 2] Although delirium is potentially preventable and treatable, healthcare workers often lack the necessary knowledge, attitudes or skills to address risk factors systematically and detect or manage delirium cases effectively,[3, 4, 5, 6] which might adversely affect patient outcomes and increase clinicians' workload.[2, 7]

Educational strategies including reinforcing (i.e., use of reminders and feedback from experts) and enabling (i.e., use of guidelines, pocket cards or protocols) approaches have shown to be effective in improving delirium care, with benefits on the incidence, duration and severity of delirium, functional status and length of stay as well as on healthcare workers' knowledge, skills and workload.[8, 9, 10] However, implementing and maintaining adherence to these multifactorial educational initiatives is time consuming and labour intensive, and thus these initiatives are difficult to implement outside the research setting.[11, 12] Furthermore, given the variety of healthcare workers involved in the care for delirious patients, broader approaches to education targeting the mixed learning needs of the whole multidisciplinary team are needed.[11]

E-learning has been described as a novel approach that facilitates delivery of education for large groups of people as well as providing a more flexible and cost-effective method of training.[11, 13, 14] It can be defined as "learning facilitated and supported through the use of information and communication technology that can cover a spectrum of activities from the use of technology to support learning as part of a 'blended' approach, to learning that is delivered entirely online. Whatever the technology, learning is the vital element".[15]

A systematic review showed that e-learning improves knowledge, skills and behaviours of healthcare workers across different healthcare domains.[16] Despite its relevance, studies investigating the effectiveness of delirium e-learning tools in clinical practice are scarce. To our knowledge, only two studies have evaluated the use of delirium e-learning on nursing outcomes and revealed positive effects on delirium recognition and knowledge.[17, 18] However, some critical information was lacking regarding the instrument used to measure delirium knowledge,[17] the specific content of the intervention,[18] or compliance with using the e-learning tool.[17, 18] Moreover, those studies did not focus on other nursing outcomes (e.g., attitudes, documentation of delirium in nursing records, levels of strain when caring for patients with delirium). A descriptive study highlighted an association between delirium training and lower levels of strain of care,[19] yet no study investigated whether healthcare workers' level of burden when caring for delirious patients might be sensitive to delirium e-learning education also.

The aim of this intervention study was to determine the effect of a delirium e-learning tool on healthcare workers' knowledge about delirium, their ability to recognize delirium and subjective strain experienced when caring for patients with delirium.

Methods

Design, Setting and Population

A pilot pre-test/post-test study was conducted in a convenience voluntary sample of healthcare workers (except for 2 physiotherapists and 2 occupational therapists being staff members of the participating units, all of them were nurses) recruited from 20 adult inpatient units of a university hospital. The units (e.g., medical, surgical, geronto-psychiatric and rehabilitation units) were selected based on their head nurses' willingness to participate. All healthcare workers working on the participating units were eligible for inclusion.

Intervention

The intervention included the use of an on-line self-directed delirium educational tool for healthcare workers, which integrates knowledge and skill development in delirium prevention, detection and management. This e-learning tool was developed by the research team and is freely accessible in Dutch language at www.deliriummodule.be. More details about the development and feasibility testing have been reported previously.[11, 20]

The e-learning tool is organized in 11 modules, and provides a wide range of information about delirium specifics (occurrence rates, clinical presentation, types, risk factors, experiences of patients), delirium prevention and treatment strategies, and information about the use of screening instruments for delirium detection (**Table 7.1**). It takes between 5 and 15 min to complete one module. The estimated time to complete the entire tool is 2 to 2.5 h. To achieve a deeper understanding of delirium with integration of acquired items into practice, theory is combined with videos (e.g., examples of hypoactive and hyperactive delirium performed by actors, the use of screening instruments), case studies and tests for self-assessment composed of multiple answers (2 of more possibilities but only one answer is correct) with feedback.

Table 7.1 Overview of the Different Modules Within the Delirium E-learning Tool

Module	Themes
1 Occurrence and consequences	❖ Introduction ❖ Occurrence ❖ Consequences
2 Clinical presentation	❖ Introduction ❖ Features of delirium ❖ Motoric subtypes
3 Exercises in delirium recognition	❖ Introduction ❖ Exercises in delirium recognition
4 Differences between delirium, dementia and depression	❖ Introduction ❖ Differentiation between the three D's ❖ Exercises
5 Predisposing and precipitating risk factors	❖ Introduction ❖ Multifactorial risk model ❖ Exercises
6 Screening for delirium	❖ Introduction ❖ Screening instruments - Delirium Observation Screening Scale and its use (video) - Confusion Assessment Method (CAM) – CAM-ICU o Mini-Mental State Examination and its use (video) o Attention tests and its use (video) ❖ Systematic screening ❖ Exercises
7 Prevention of delirium	❖ Introduction ❖ Screening patients at risk & prevention strategies ❖ Early detection
8 Treatment of delirium	❖ Introduction ❖ Identification causes ❖ Treatment of delirium caused by alcohol or benzodiazepines withdrawal ❖ Treatment of delirium caused by other factors ❖ How to deal with aggressive patients

9 Family and relatives	❖ Introduction ❖ Experiences family members/how to support ❖ Experiences patients/how to support
10 Overall roadmap/algorithm	❖ Introduction ❖ Flowchart management risk patients and management delirium
11 Case study 'Ants in the tea"	❖ Introduction ❖ Case study 'Ants in the tea' - Case history - Patient anamnesis/ delirium detection in the hospital - Family anamnesis - Identification of causes - Treatment - Evaluation

The intervention started with a one-hour live information session to deliver participants a personal log-in code and to provide them with oral and written information about using the e-learning tool. Subsequently, the tool was available for 2 months during which participants were asked to access the delirium course at least once. Because the tool was based on self-active learning, participants could start, finish and re-start at any time. After 1 month, all participants received an e-mail reminder to encourage completion of the educational tool.

Variables and Measurements

Data were collected at 2 time points during the study between December 2010 and May 2011, immediately before the educational intervention and after the 2-month learning period. Baseline and follow-up data were measured using four questionnaires, including a questionnaire for demographic information and three questionnaires to assess (1) delirium recognition as primary outcome, and (2) knowledge about delirium and (3) experienced strain in caring for patients with delirium as secondary outcomes.

Demographic and Professional Data

The following data were collected: age, gender, number of years of work experience, employment status, day- or night work, level of education and education in delirium attended during the last 5 years before the start of the study.

Delirium Recognition

The ability to identify delirium was measured with standardized 'cases vignettes'.[21] These validated vignettes contain five different cases about hospitalized patients with dementia, hypoactive delirium, hyperactive delirium, hypoactive delirium superimposed on dementia (DSD) or hyperactive DSD. Four of them were used in the pretest phase (i.e., dementia, hypoactive delirium, hyperactive delirium and hyperactive DSD). In the posttest phase, the hyperactive DSD case was replaced by the case with the hypoactive DSD patient. For each case, of which all had one single correct answer, the patient's mental status had to be scored as having dementia, delirium, delirium superimposed on dementia, normal ageing, depression or none of the options. Total delirium recognition (DR) score is the sum of the correct answers, and ranges from 0 to 4.

Knowledge about Delirium

A 35-item true-false Delirium Knowledge Questionnaire (DKQ), which includes 23 of the 28 items from the 'knowledge' questionnaire of Hare et al. ,[22] was developed by the research team to assess knowledge about delirium classified into three relevant domains: 1) knowledge related to the presentation, symptoms and outcomes of delirium (n = 10 items), 2) its causes and risk factors (n = 11 items), and 3) delirium prevention and management strategies (n = 14 items) (**Table 7.2**). Total DKQ score is the sum of the correct answers and ranges between 0 and 35. Because no existing questionnaire measures all of these knowledge domains, the DKQ was developed. It was based on the questionnaire of Hare et al.,[22] which focuses on two knowledge domains: 1) delirium presentation, symptoms and outcomes, and 2) risk factors and causes. Questionnaire development comprised different steps. First, items were reproduced (items 1–10, 12–14, 16, 19–22), modified (items 11, 15, 17, 18, 23), or generated to measure all relevant aspects of knowledge about 1) delirium presentation, symptoms and outcomes, 2) its risk factors and causes, and 3) its prevention and management strategies. Second, the content of the newly developed Delirium Knowledge Questionnaire was evaluated by an independent multidisciplinary panel of experts (e.g., one geriatrician, one psychologist,

three researchers with nursing background and two nurses), and face validity was tested in 4 nurses.

Table 7.2 Proportion of Correct Answers on the Delirium Knowledge Questionnaire in Healthcare Workers in the Pretest and Posttest Phase (n=59)

Items	Pretest phase (n=59)	Posttest phase (n=59)
Items related to knowledge about the presentation, symptoms and outcomes of delirium, n correct (%)		
1. Fluctuation between orientation and disorientation is a typical feature of delirium	40 (67.8)	46 (78)
2. Symptoms of depression may mimic delirium	47 (79.7)	54 (91.5)
3. Patients never remember episodes of delirium	41 (69.5)	52 (88.1)
4. Delirium never lasts for more than a few hours	53 (89.8)	57 (96.6)
5. A patient who is lethargic and difficult to rouse does certainly not have a delirium	51 (86.4)	55 (93.2)
6. Patients with delirium are always physically and/or verbally aggressive	49 (83.1)	55 (93.2)
7. Patients with delirium have a higher mortality rate	35 (59.3)	50 (84.7)
8. Behavioral changes in the course of the day are typical of delirium	48 (81.4)	55 (93.2)
9. A patient with delirium is likely to be easily distracted and/or have difficulty following a conversation	53 (89.8)	58 (98.3)
10. Patients with delirium will often experience perceptual disturbances (e.g. visual and/or auditory hallucinations)	58 (98.3)	59 (100)
Items related to knowledge about causes and risk factors of delirium		
11. A patient admitted with pneumonia and having diabetes, visual and auditory disturbances has the same risk for delirium as a patient admitted with pneumonia without co-morbidities	31 (52.5)	44 (74.6)
12. The risk for delirium increases with age	47 (79.7)	51 (86.4)
13. A patient with impaired vision is at increased risk of delirium	36 (61.0)	55 (93.2)
14. The greater the number of medications a patient is taking, the greater their risk of delirium	31 (52.5)	41 (69.5)
15. A urinary catheter reduces the risk of delirium	49 (83.1)	49 (83.1)
16. Poor nutrition increases the risk of delirium	48 (81.4)	59 (100)
17. Dementia is an important risk factor for delirium	45 (76.3)	48 (81.4)
18. Diabetes is an important risk factor for delirium	37 (62.7)	21 (35.6)
19. Dehydration can be a risk factor for delirium	56 (94.9)	59 (100)
20. Delirium is generally caused by alcohol withdrawal	56 (94.9)	56 (94.9)
21. A family history of dementia predisposes a patient to delirium	44 (74.6)	47 (81.0)

Items related to knowledge about delirium prevention and management strategies		
22. Treatment of delirium always includes sedation	49 (83.1)	54 (91.5)
23. Daily use of the Mini-Mental State Examination (MMSE) is the best way for diagnosing delirium	36 (61.0)	35 (59.3)
24. Providing as much staff as possible to take care at the patients' bedside is an important strategy in the prevention of delirium	59 (100)	59 (100)
25. The use of physical restraints in patients at risk for delirium is the best way to ensure their safety	53 (59.8)	56 (94.9)
26. Encouraging patients to (correctly) wear their visual/hearing aids is necessary to prevent delirium	46 (78.0)	59 (100)
27. Adequate hydration is an important strategy in the prevention of delirium	55 (93.2)	59 (100)
28. The maintenance of a normal sleep-wake cycle (e.g. avoidance of sleep interruption) is an important strategy in the prevention of delirium	55 (93.2)	58 (98.3)
29. The use of haloperidol in preoperative surgical fracture patients is a way to prevent delirium	54 (91.5)	51 (86.4)
30. The stimulation of patients to perform different activities at the same time is a way to prevent delirium	59 (100)	58 (98.3)
31. Keeping instructions for patients as simple as possible is important in the prevention of delirium	50 (84.7)	52 (88.1)
32. Early activation/ambulation (e.g. getting patients out of bed as soon as possible) of patients is an important strategy in the prevention of delirium	40 (67.8)	55 (93.2)
33. Providing patients with familiar objects (e.g. photos, clock, newspaper) is important to prevent sensory deprivation	48 (81.4)	55 (93.2)
34. Avoid eye contact in the prevention of delirium because it can be seen as a threat	59 (100)	57 (96.6)
35. Keeping oral contact with the patient is an important strategy in the prevention of delirium	46 (78)	53 (89.8)

Strain in caring for delirious patients

Subjective strain in caring for delirious patients was measured with the Strain of Care for Delirium Index (SCDI).[23] This scale contains 20 characteristics of delirious behavior, presented within four subscales: hypoactive behavior (n = 3 items), hypoalert behavior (n = 4 items), fluctuating course and psychoneurotic behavior (n = 5 items), and hyperactive/hyperalert behavior (n = 8 items). The items are scored on a four-point Likert scale ranging from 'quite easy to cope with' (score 1) to 'quite difficult to cope with' (score 4). Total scores range between 20 and 80, with higher scores indicating greater difficulty in coping with delirious behaviors.

Completion of e-learning tool and time to complete

The number of modules completed by each healthcare worker was registered, and ranges from 0 to 11. Furthermore, healthcare workers were asked to give times to complete the e-learning tool.

Ethics

The study was approved by the Medical Ethics Committee of the Leuven University Hospitals.

Analysis

Only healthcare workers who did not complete the post-test questionnaires were excluded. Descriptive analysis were performed to examine demographic and professional data, and to summarize the results of the 'Case Vignettes', the Delirium Knowledge Questionnaire (DKQ) and the Strain of Care for Delirium Index (SCDI). Categorical data were expressed as absolute numbers and percentages; continuous data as means and standard deviations. Data from the 'Case Vignettes' and DKQ were not only analyzed at participant level (e.g., total delirium recognition (DR) score and total DKQ score, respectively), but also at case/item level. At this level, answers were classified as 'correct' or 'incorrect' (e.g., each case/item had a single correct answer) and proportions of correct cases/items were calculated.

First, differences in scores between the pre-test and post-test phase were analyzed for participants who completed at least one e-learning module. McNemar's tests were used to test differences in proportions of correct answers on the four 'Case Vignettes' separately. Differences in total DR scores, total DKQ scores, total SCDI scores and SCDI subscale scores were evaluated using paired t-tests for normally distributed data and the Wilcoxon Signed Rank test for non-normally distributed data. Effect sizes were calculated using Cohen's d and expressed as small (0.2–0.5), moderate (0.5–0.8), or large (>0.8) differences.[24]

Second, all participants who completed pre- and posttest questionnaires were included in the analysis. They were further categorized into two a prior subgroups: low/moderate completion subgroup (0–6 modules); good/excellent completion subgroup (7–11 modules). To examine changes in outcome variables (e.g., level of recognition, level of knowledge, level of strain of care) between these subgroups over time, three linear mixed models for repeated measures

were built. Per model, the outcome measurements were included (model 1: DR scores; model 2: DKQ scores; model 3: SCDI scores), with subgroup, time point (T1 pretest phase, T2 posttest phase) and their interaction as explanatory variables. To correct for confounding factors, two potential confounders were included in the analysis: number of years of work experience, and employment status. Because of the high correlation between 'number of years of work experience' and 'age' ($r = 0.93$), the variable age was not included in the model.

The association between the number of completed e-learning modules and the change scores (e.g., change in post – pretest scores) of the total DR scores, total DKQ scores and total SCDI scores were calculated with the Pearson's r or Spearman's rho correlation coefficient depending on the distribution of the data.

Data were analyzed using SPSS version 16 (SPSS, Inc., Chicago, IL) and SAS version 9.2 (SAS Institute Inc., Cary, NC). Statistical significance was set at $p < 0 .05$ and all tests were two-sided.

Results

Sample

Seventy-two healthcare workers agreed to participate, of whom 13 were excluded because they only completed the pretest. Characteristics of the 59 included healthcare workers are shown in **Table 7.3**. No differences were observed between excluded and participating healthcare workers.

Completion of the E-learning Tool

The low/moderate completion (L/MC, for definition see analysis section) subgroup included 19 (32.2 %) participants, of whom 2 did not start the e-learning tool. The good/excellent completion (G/EC) subgroup included 40 (67.8 %) participants. Almost half of the healthcare workers ($n = 26$; 44.1 %) finalized all the modules. For those who started using the e-learning tool, the mean number of completed modules per participant was 8.2 (SD 3.2). The mean time to complete the modules for those in the low/moderate completion subgroup was 31.8 min (SD 60.8) and 115.6 min (SD 54.6) for those in the good/excellent completion subgroup, respectively. There were no statistically significant differences in demographic data between the two completing groups, except for age, employment status and number of years of work experience (**Table 7.3**).

Table 7.3. Characteristics of the Healthcare Workers (n = 59)

	Total sample n=59	Low/median completion subgroup n=19	Good/ excellent completion subgroup n=40	p-value
Variables				
Age in years, mean (SD)	38.7 (11.2)	33.6 (10.4)	41.1 (10.8)	p=0.02[a]
Gender				p=0.13[b]
Female, n (%)	52 (88.1)	15 (25.4)	37 (62.7)	
Male, n (%)	7 (11.3)	4 (6.8)	3 (5.1)	
Years of work experience, mean (SD)	15.8 (11.8)	10.6 (10.8)	18.3 (11.5)	p=0.02[a]
Employment status				p=0.01[b]
Part-time (<100%), n (%)	27 (45.8)	4 (21.1)	23 (57.5)	
Full-time (100%), n (%)	32 (54.2)	15 (78.9)	17 (42.5)	
Type of shift work				p=0.49[b]
Day shift, n (%)	58 (98.3)	19 (32.2)	39 (66.1)	
Night shift, n (%)	1 (1.7)	0 (0)	1 (1.7)	
Educational level				p=0.18[b]
Certificate degree, n (%)	10 (17.0)	1 (1.7)	9 (15.3)	
Bachelor degree, n (%)	41 (69.5)	14 (23.7)	27 (45.8)	
Master degree, n (%)	8 (13.5)	4 (6.7)	4 (6.8)	
Delirium training last 5 years				p=0.73[b]
Yes, n (%)	8 (13.5)	3 (5.1)	5 (8.5)	
No, n (%)	51 (86.5)	16 (27.1)	35 (59.3)	

Abbreviations: SD = standard deviation

[a]ANOVA test

[b]Chi-square test

Effect of the E-learning Tool on Outcomes

Delirium Recognition (DR)

More healthcare workers in the posttest phase were able to correctly identify hypoactive (64.9 % versus (vs.) 45.6 %; p = 0.04) and hyperactive (93.0 % vs. 71.9 %; p = 0.007) delirium compared to the pretest phase, respectively. The mean total DR score also significantly improved (3.1 ± 0.9 vs 2.7 ± 1.1; P = 0.04, Cohen's d = 0.38) (**Table 7.4**).

Table 7.4. Healthcare Workers' Delirium Recognition, Their Knowledge about Delirium and Strain in Caring for Delirious Patients in the Pretest and Posttest Phase (*n* = 57[a])

Variable	Pretest phase (*n* = 57)	Posttest phase (*n* = 57)	*P*-value
Delirium recognition – ability to identify delirium			
Cases, n correct (%)			
Dementia	41 (71.9)	44 (77.2)	0.55[b]
Hypoactive delirium	26 (45.6)	37 (64.9)	0.04[b]
Hyperactive delirium	41 (71.9)	53 (93.0)	0.007[b]
Dementia + hyper-/hypoactive delirium	49 (86.0)	45 (78.9)	0.31[b]
Total DR score, mean (SD) (range 0–4)	2.7 (1.1)	3.1 (0.9)	0.04[c]
Knowledge about delirium			
Total DKQ score, mean (SD) (range 0–35)	28.3 (4.5)	31.7 (2.6)	<0.001[c]
Strain in caring for delirious patients			
Total SCDI score, mean (SD) (range 20–80)	50.9 (9.2)	51.2 (8.4)	0.46[c]
Subscore hypoactive behavior, mean (SD) (range 3–12)	7.3 (1.8)	6.9 (1.7)	0.29[c]
Subscore hypoalert behavior, mean (SD) (range 4–16)	8.9 (2.1)	8.8 (1.7)	0.84[c]
Subscore fluctuating course/psychoneurotic behavior, mean (SD) (range 5–20)	11.2 (2.9)	11.3 (3.0)	0.51[c]
Subscore hyperactive/hyperalert behavior, mean (SD) (range 8–32)	23.7 (4.2)	23.9 (4.2)	0.71[c]

Abbreviations: SD standard deviation, DR delirium recognition, DKQ Delirium Knowledge Questionnaire, SCDI Strain of Care for Delirium Index

[a]This type of analysis included only the healthcare workers who completed minimum 1 module of the delirium e-learning tool

[b]McNemar test

[c]Paired t-test

The unadjusted linear mixed model noted a statistically significant difference in the change of mean total DR scores over time between the L/MC subgroup and the G/EC subgroup ($p = 0.03$), with a difference estimate (DE) of 0.81 (95 % CI 0.05–1.57). The difference in the change of mean total DR scores over time between the two subgroups was no longer significant in the adjusted linear mixed model (DE: 0.76; 95 % CI −0.06–1.6; $p = 0.07$). The unadjusted model showed a significant increase of the mean total DR score in the posttest within the G/EC subgroup compared to the pretest phase (DE: 0.6; 95 % CI 0.17–1.03; $p = 0.007$). After controlling for potential confounders, no change in the mean total DR scores within this subgroup was noted (adjusted DE: 0.49; 95 % CI −0.26–1.24; $p = 0.19$). Both in the unadjusted and adjusted models, the other group comparison of changes over time were not statistically significant.

A weak, but significant correlation between the number of completed e-learning modules and the change scores of the total DR scores was found ($r_P = 0.3$; $p = 0.02$).

Knowledge about Delirium

The proportion of correct answers on all the DKQ items was higher in the posttest phase compared to the pretest phase, except for 7 items (items 15, 18, 20, 23, 24, 29, 34) (**Table 7.2**). Moreover, in 16 items, the difference in proportion of correct answers was minimum 10% in favor of the posttest phase. Only item 18 was answered more correctly in the pretest. The mean total DKQ score of healthcare workers in the posttest phase was statistically significant improved compared to the pretest phase (31.7 ± 2.6 vs. 28.3 ± 4.5; $p < 0.001$, Cohen's $d = 0.76$).

Both the unadjusted and adjusted linear mixed models showed no statistically significant difference in change of mean total DKQ scores over time between the L/MC subgroup and the G/EC subgroup (unadjusted DE: 1.5; 95 % CI −0.59- 3.55; $p = 0.16$ versus (vs) adjusted DE: 0.95; 95 % CI −1.26 – 3.16; $p = 0.39$). Nevertheless, within the G/EC subgroup there was a significant increase of mean total DKQ scores in the posttest compared to the pretest phase (unadjusted DE: 3.4; 95 % CI 2.20–4.55; $p < 0.001$ vs adjusted DE: 2.4; 95 % CI 0.36 – 4.40; $p = 0.02$). Within the L/MC subgroup, the mean total DKQ scores in the posttest phase were also significantly increased (unadjusted DE: 1.89; 95 % CI 0.18–3.60; $p = 0.03$), but significance disappeared in the adjusted model (DE: 1.4; 95 % CI–0.77 - 3.61; $p = 0.19$).

There was a weak, albeit significant correlation between the number of completed e-learning modules and the change scores of the total DKQ scores (rho = 0.3; $p = 0.04$).

Strain in Caring for Delirious Patients

There were no significant differences between the posttest and pretest phase in mean total SCDI scores ($p = 0.46$) and its 4 mean subscale scores (**Table 7.4**).

Also unadjusted and adjusted linear mixed model analysis revealed no statistically significant difference in change of mean total SCDI scores over time between the L/MC subgroup and the G/EC subgroup (unadjusted DE: −0.07; 95 % CI −3.33 – 3.18; $p = 0.96$ vs adjusted DE: 0.43; 95 % CI −3.05 - 3.91; $p = 0.81$). There was no significant difference in the mean total SCDI score in the posttest compared to the pretest phase within the L/MC subgroup (unadjusted DE: 0.47; $P = 0.7$ vs adjusted DE: −0.61; $p = 0.72$) and within the G/EC subgroup (unadjusted DE: 0.4; $P = 0.67$ vs adjusted DE: −0.18; $p = 0.91$).

No correlations between the number of completed e-learning modules and neither the total nor subscale SCDI change scores were detected (data not shown/available upon request from the authors).

Discussion

This is the first study investigating the effect of a delirium e-learning tool consisting of 11 modules on healthcare workers' delirium recognition, knowledge and level of delirium strain, taking into account the amount of completed modules. Consistent with previous research,[16, 17, 18, 25] our findings support that e-learning might be an effective tool for improving healthcare workers' knowledge and recognition of delirium. Moreover, the difference in total delirium knowledge scores before and after using the e-learning tool was found to be moderate and although the difference in total delirium detection levels was rather small, the e-learning tool led to a 20% to 21% higher proportion of correctly identified hypoactive and hyperactive delirium cases, respectively. Because of the well-known under recognition of delirium in clinical practice,[4, 5] those differences were not only statistically significant but also highly clinically relevant.

Although our study findings are in line with previous results indicating positive effects of e-learning on nurses' delirium recognition[18] and knowledge,[17,18] comparability of the studies is limited because of different study designs, analysis and measurement instruments. Our study expands the existing knowledge on delirium e-learning,[17,18] as it evaluated the effect of e-learning on healthcare workers' delirium strain, and investigated its effect on their recognition and knowledge about delirium by taking into account the amount of completed modules. Moreover, our findings suggest that the effect of the e-learning tool on delirium recognition and knowledge is causally related to its level of completion, highlighting the importance of motivating healthcare workers to complete the full e-learning tool. This was demonstrated by a significant association between the number of completed modules and the level of DR change scores, as well as by a significant difference in the change of DR levels over time between healthcare workers who completed 0 to 6 modules and those who completed 7 to 11 modules, in which the improvement was only statistically significant within the latter group. After controlling for potential confounding factors, the difference in the change of DR levels over time between healthcare workers in the 0–6 module subgroup and those in the 7–11 module subgroup was no longer significant. Yet, there was a trend towards borderline significance. Furthermore, there was a small but significant association between the number of completed modules and the level of DKQ change scores. Although - independent of the controlling for potential confounders - the difference in the change of DKQ levels over time between the two subgroups was not significant, the DKQ scores were significantly improved in the posttest phase compared to the pretest phase in healthcare workers who completed 7–11 modules. On the other hand, our study showed no effect of the e-learning tool on healthcare workers' strain whether or not taking into account the amount of completed modules. However, although previous research in delirium[26] and dementia[27,28] care provided evidence that

knowledge in combination with other factors, such as perceived caring climate of the ward, the possibilities to reflect about practice, staff age, emotional and management support, and communication difficulties with patients, are factors related with experienced care strain, additional studies are needed to investigate the predictors of delirium care strain and its relation to delirium education through e-learning.

Our e-learning tool holds promise in improving delirium detection and knowledge because of its flexibility regarding the time of training, its ability to standardize teaching materials, its potential to implement efficiently to large groups and its relatively low cost (development cost only). For these reasons,[11,14] e-learning has been suggested as an alternative learning method especially in busy healthcare workers. Nevertheless, a previous feasibility study revealed that the lack of interactivity and the need to have sufficient self-discipline to complete the tool without supervision were barriers to e-learning.[20] Therefore, alternative forms of e-learning should be explored. It might be necessary to use the tool in combination with a delivery schedule over fixed time periods and recurrent feedback sessions organized by a facilitator. Structuring e-learning in such a format has been shown to hold promise in medical education.[13] Furthermore, to reach real changes in delirium care in practice, e-learning needs to be seen as one component within a larger approach of interprofessional blended-learning education extended with enabling and reinforcing strategies including restructuring of practice.[29,30]

Some methodological limitations need to be considered. First, a pretest/posttest design was used, and further testing using a randomized controlled trial (RCT) design is warranted. However, RCT's are notoriously hard to conduct in education research because education is a social process and heavily influenced by contextual factors which cannot be controlled against. Therefore a large scale clustered RCT with multiple sites would be required and even then may not do the intervention justice. Second, because the study was conducted in a voluntary sample of healthcare workers, this sample might include only the most motivated people which might have induced bias and limits its generalizability. Third, quantitative data indicated the time pressure during working hours as an important reason for not completing all the modules. However, an in-depth qualitative interview might have been given more valuable information to identify why there was such a high attrition rate. Fourth, the level of knowledge of the sample in our hospital was already relatively high, which might affect transferability of the effect to other settings. Nonetheless, a change in delirium recognition and knowledge were observed. Fifth, the knowledge about delirium was assessed with the DKQ, an instrument developed for this study that supports good content and face validity based on expert review and pilot testing. However, additional validity and reliability testing is needed. Sixth, since the effects of the e-learning tool on delirium recognition, knowledge and strain in caring for delirious patients were evaluated once after a 2-month learning period, no statements about the long

term effects could be made and as a consequence future studies should also focus on the long term effects.

Despite these caveats, this study has several important strengths, including the use of validated instruments to assess healthcare workers' levels of subjective strain and delirium recognition, the detailed statistical analyses taking account of different parameters, the organization of the self-directed e-learning tool into 11 modules in which theory is combined with videos, case-studies and tests for self-assessment, its development via a robust process and feasibility testing, and the tracking of compliance with the e-learning tool.

Conclusion

In general, the on-line delirium education as delivered by the e-learning tool improved healthcare workers' delirium recognition and knowledge, but had no effect on their level of strain. The effect of this tool on healthcare workers' delirium recognition and knowledge was related to its level of completion. However, this relation was less explicit after controlling for potential confounders warranting further investigation. Nonetheless, the study findings are particularly important as potentially large numbers of healthcare workers can be trained with a relatively inexpensive tool (development cost only). Since studies have shown the impact of educational approaches on the prevention of delirium, an e-learning tool, such as ours, could potentially reduce the incidence of delirium in clinical practice. Larger scale studies are warranted to replicate our promising findings.

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CHAPTER VIII

Impact of Delirium E-learning on Patient and Nursing Outcomes

This chapter has been submitted for publication as: Detroyer E, Dobbels F, Teodorczuk A, Deschodt M, Depaifve Y, Joosten E, Milisen K. Effect of an Interactive E-learning Tool for Delirium on Patient and Nursing Outcomes: a Before-After study: submitted for publication.

Abstract

Background: Education of healthcare workers is a core element of multicomponent delirium strategies to improve delirium care and, consequently, patient outcomes. However, traditional educational strategies are notoriously difficult to implement. E-learning is hypothesised to be easier and more cost effective, but research evaluating effectiveness of delirium education through e-learning is scarce at present. Aim is to evaluate the effect of a delirium e-learning tool for nurses on: (1) in-hospital prevalence, duration and severity of delirium or mortality in hospitalized geriatric patients, and (2) geriatric nurses' delirium recognition and knowledge.

Methods: A before-after study (sequential design) in a sample of patients enrolled pre-intervention (non-intervention cohort (NIC); n=81) and post-intervention (intervention cohort (IC); n=79), and nurses (n=17) of a geriatric ward (university hospital). The intervention consisted of a one-hour information session about using the e-learning tool, which included 11 e-modules integrating knowledge and skill development in delirium prevention, detection and management, and a three-month self-active e-learning program. Key patient outcomes included in-hospital prevalence and duration of delirium (Confusion Assessment Method), delirium severity (Delirium Index) and mortality (in-hospital; 12 months post-admission); key nurse outcomes included delirium recognition (Case vignettes) and knowledge (Delirium Knowledge Questionnaire). Logistic regression and linear mixed models were used to analyse patient data; Wilcoxon Signed Rank tests, McNemar's or paired t-tests for nursing data.

Results: There was no significant difference in in-hospital prevalence (21.5% versus 25.9%; p=0.51) and duration of delirium (mean 4.2±SD 4.8 days versus 4.9±SD 4.8 days; p=0.38) between the IC and NIC, respectively. A trend towards a statistically significant lower delirium severity (IC versus NIC: difference estimate -1.59; p=0.08) was noted for delirious IC patients in a linear mixed model. No effect on patient mortality and on nurses' delirium knowledge (p=0.43) and recognition (p=1.0) was found.

Conclusion: Our study, the first in its area to investigate effects of delirium e-learning on patient outcomes, demonstrated no benefits on both geriatric patients and nurses. Further research is needed to determine whether delirium e-learning nested within a larger educational approach inclusive of enabling and reinforcing strategies, would be effective.

Background

Delirium, defined as an acute and fluctuating disturbance in attention and awareness together with a disturbance in cognition or perception, is the most common hospital complication in older patients.[1,2] Nurses in particular play a key role in the prevention and early detection of delirium. However, lack of knowledge and competencies required to prevent or manage delirium effectively and negative attitudes towards delirium care, result in adverse patient outcomes, including an increased risk of functional decline, mortality, institutionalisation or dementia.[3-7]

Evidence suggests that multicomponent delirium strategies, including educational approaches, improve delirium-related knowledge and recognition of healthcare staff as well as prevent in-hospital delirium.[8-11] Education of nurses and physicians about delirium, with packages including formal presentations or structured courses followed by case-based discussions, feedback, reminders and/or expert local specialist input, are a key element of those multicomponent strategies. Studies have demonstrated the effectiveness of delirium education in improving delirium-related knowledge and recognition skills of nurses and other healthcare staff.[10-11] Yet, evidence determining its impact on the incidence or in-hospital prevalence of delirium is rather scarce.[10,12,13]

Moreover, within routine care outside a research environment, these educational initiatives are difficult to implement. Specific challenges include to be time-consuming and labour-intensive to implement and to maintain compliance within systems of care that do not align to good delirium practice.[14-16]

E-learning has been identified as an alternative and cost-effective method of delivering education to large groups of hospital staff, and may overcome the challenges of traditional educational approaches.[17-18] It is proposed that its accessibility, availability, and the use of interactive feedback mechanisms and real care situations make e-learning easier to implement. Arguably, therefore, e-learning at a theoretical level can improve the integration of acquired knowledge into clinical practice, thereby, improving patient outcomes.[19,20]

Two large systematic reviews already evaluated the effect of e-learning education on knowledge, skills and behaviour change in healthcare workers working in the medical (e.g. on management of osteoporosis), psychiatric (e.g. on management of depression), surgical (e.g. on prevention of skin lesion) and nursing (e.g. on prevention of medication errors) field.[21,22] Though the findings were positive, only one study evaluated the effectiveness of e-learning on patient outcomes.[21-24] Moreover, despite the fact that e-learning gains growing attention in hospital settings and has direct relevance for day-to-day delirium care, no studies exist on the

effects of delirium education through e-learning on patient outcomes, and only four studies investigated its effectiveness on nursing outcomes.[25-28]

The aim of our study was to explore the effect of a delirium e-learning tool for nurses on in-hospital prevalence, duration and severity of delirium in older patients. The effect on patients' mortality, and geriatric nurses' delirium knowledge and their ability to recognize delirium were included as secondary outcomes.

Methods

Design, Setting and Participants

A before-after study (sequential design) was conducted on a geriatric ward of a university hospital in Belgium. The e-learning intervention was implemented over 3 months between 2 periods of data collection i.e. the non-intervention patient cohort (before group, consisting of usual care; enrolled during 4 months) and the intervention patient cohort (after group; enrolled during 4 months). Both cohorts had a follow-up of 12 months from time of admission to the geriatric ward. Dutch speaking patients who were 70 years or older and consecutively admitted to the geriatric ward, were eligible for inclusion. Patients with severe hearing or visual problems, very poor health condition (e.g. palliative patients, patients with unstable cardiac or respiratory problems), isolation because of infectious disease, or those unable to hold a conversation were excluded. Patients who were readmitted during the study period, or had an expected discharge within 24 hours after admission were also excluded. Furthermore, all nurses of the geriatric ward were eligible for inclusion. The study was approved by the Medical Ethics Committee of the University Hospitals Leuven, and informed/proxy consent was obtained in each patient before inclusion.

Intervention

An on-line self-directed delirium educational tool for nursing staff was developed by the research team (ED, FD, EJ, KM). This e-learning tool consists of 11 modules including information about delirium specifics, delirium prevention and treatment strategies (e.g. including a checklist of 12 risk factors), and information about the use of screening instruments for delirium detection (with possibility to download the instruments). To achieve a deeper level of learning and help translate new knowledge into practice, the tool incorporates textual information in combination with audio-visual materials, case studies and tests for self-assessment with feedback. The e-learning tool is freely accessible at www.deliriummodule.be.

Details about the content, development and feasibility testing of the tool have been reported elsewhere.[25,29]

The intervention included (1) a one-hour live information session (at the geriatric ward) to offer them oral and written information about the use of the e-learning tool, and (2) the completion of six compulsory modules (e.g. 'occurrence and consequences', 'clinical presentation', 'exercises in delirium recognition', 'predisposing and precipitating risk factors', 'screening for delirium, and 'prevention of delirium') during a 3-month learning period. The five other modules could be completed on a voluntary basis. The e-learning tool remained available until the end of the study. Because the tool was based on self-active learning, participants could access the modules at any time using their personal log-in code. It takes between 5 and 15 min to complete one module. Nurses who did not complete the six compulsory modules within two months were encouraged by the head nurse to complete the course. Additionally, a poster was displayed at the geriatric ward to act as a prompt and further enable knowledge translation.

Variables and Measurements

Baseline Data

Patient baseline data collected included age, gender, social living circumstances, education level, main diagnosis, number of medications prescribed, number of comorbidities, premorbid functional status, cognitive functioning, confirmed diagnosis of dementia and history of delirium. The number of comorbidities was retained from the modified Charlson Comorbidity Index, and varies between 0 and 13.[30] The premorbid functional status was evaluated using the Katz Index of activities of daily living (ADL),[31] indicating the level of independence in performing the following six activities scored on a 3-point scale (0=independent; 1=partly dependent; 2=dependent): bathing, dressing, feeding, continence, transfer and toileting. Total score ranges between 0 and 12, with higher scores indicating more dependency. Cognitive functioning was evaluated with the 12-item Mini-Mental State Examination (MMSE).[32] Total scores vary between 0 and 12, with higher scores indicating better cognitive functioning. Patient baseline data were collected through patient interview, requested from a family member, or based on the medical or nursing records.

Nurse characteristics were collected at the start of the intervention implementation period and included age, gender, work experience as a nurse, percentage employment, day- or night work, highest level of education and education in delirium attended in the 5 years prior to the start of the study.

Primary Outcomes

In-hospital prevalence of delirium was measured with the Confusion Assessment Method (CAM),[33,34] which was scored after a structured interview including the 12-item Mini-Mental State Examination (MMSE).[32] Accordingly, delirium was diagnosed when the criteria "(acute onset OR fluctuation), inattention, AND (disorganized thinking OR altered level of consciousness)" were rated as positive on at least one of the measurement points (see procedure).

Duration of delirium was defined as the number of days on which a positive CAM score was obtained.

Severity of delirium was assessed with the 7-item Delirium Index (DI),[35] including inattention, disorganized thinking, altered level of consciousness, disorientation, memory impairment, perceptual disturbance, and disorder of psychomotor activity. Each item was scored on a scale from 0 (absent) to 3 (present and severe) resulting in a total score varying between 0 and 21, with higher scores indicating greater severity.

Secondary Outcomes

Patients' in-hospital mortality is defined as the number of deaths occurring while being hospitalized at the geriatric unit. Twelve-month mortality includes all patients that died within 12 months after admission, including cases of in-hospital mortality.

Delirium recognition in nurses was measured with standardized 'cases vignettes',[36] including validated cases about hospitalized patients with dementia, hypoactive delirium, hyperactive delirium, hypoactive delirium superimposed on dementia (DSD) or hyperactive DSD. Before as well as after the e-learning intervention, four slightly different case vignettes were used to avoid recall bias (i.e. dementia, hypoactive delirium, hyperactive delirium and, hyperactive DSD or hypoactive DSD). The behavioral symptoms described in each case had to be scored as dementia, delirium, DSD, normal ageing, depression or none of the options, with each case having only one correct answer. Total delirium recognition (DR) was defined as the number of case vignettes answered correctly (range 0 to 4).

Delirium knowledge in nurses was assessed with the 35-item true-false Delirium Knowledge Questionnaire (DKQ).[25,37] Ten items are related to the presentation, symptoms and consequences of delirium, 11 items to the causes and risk factors of delirium, and 14 items to delirium prevention and management strategies. The total DKQ score was defined as the number of questions answered correctly and ranged from 0 to 35.

Completion of the E-learning Tool in Nurses

The number of e-learning modules completed by each nurse was registered and ranged from 0 to 11.

Procedure

Patient baseline data, premorbid functional status, number of comorbidities, cognitive functioning, delirium and delirium severity were assessed on the first day after admission to the geriatric ward. In addition, delirium and delirium severity were evaluated on the third, fifth and seventh day after admission to the geriatric ward, and on the day before discharge. From the seventh day after admission, delirium and delirium severity were assessed weekly (e.g. 14th, 21th, … day) until hospital discharge. If the patient had delirium on one of the measurement points, the patient was followed up daily until a negative CAM score was obtained. Mortality was recorded during hospitalisation and twelve-month mortality was checked by telephone contact with the patient or his proxy. Procedures for patient assessments in the non-intervention and intervention cohorts were identical. There were no service changes or changes to protocol during the entire study period.

Six study nurses with a master degree performed all assessments. They were trained (i.e. theoretical training of 4 hours) by two experts in delirium (ED and KM) according to criteria set in the manuals of MMSE and CAM,[33,34] including evaluation of four clinical cases at the bedside and follow-up discussions. Inter-rater reliability for CAM was $\kappa = 1.00$, indicating perfect agreement (inter-rater reliability refers to the agreement of CAM scoring for each study nurse compared with CAM scoring of one of the investigators (ED), and calculated two by two in a random sample of 18 paired observations of enrolled patients).

At the beginning of the one-hour live information session before implementation of the intervention and at the end of the study, nurses received the three questionnaires to assess their baseline data, their knowledge about delirium (DKQ) and their ability to recognize delirium (case vignettes), as described above. Returning a completed questionnaire was considered as informed consent.

Sample Size

According to a power analysis for two cohorts using a two-tailed test of significance with an alpha of 0.10, a beta of 0.30 and an estimated proportion of delirium of 30% for the control

cohort,[38-40] a sample size of 71 participants was required in each cohort to detect a difference of 50% in prevalence of delirium.

Blinding

Although patients were blinded to the intervention, nurses and research nurses (data collectors) could not be blinded because of the nature of this study.

Analysis

Descriptive analysis (i.e. means/median, standard deviations/interquartile ranges, or absolute numbers and percentages) for patients in the control and intervention cohorts, as well as for all included nurses were calculated as appropriate.

A chi square test was used to compare in-hospital prevalence of delirium in the control and intervention cohort. This difference was further explored using a logistic regression model in which a random effect for patient was modelled to account for clustering. Duration of delirium (in days) was compared with the Mann-Whitney U-test. Severity of delirium in the two cohorts was compared using a linear mixed model with a random effect accounting for clustering. The mortality risk was explored with a logistic regression model in all patients and in the subgroup of delirious patients. To correct for baseline differences between both cohorts, baseline functional status score and gender were included in all logistic regression and linear mixed models.

Both in the logistic regression and linear mixed models, a time by group interaction was tested first, and a main effect is estimated in case of a non-significant interaction effect. Non-linear trends of time are considered using quadratic and cubic splines-based trends. The models are likelihood-based and therefore provide valid results in case of a random drop-out pattern, this is when the drop-out chance may be associated with previous observations or covariates in the model.[41] Linear mixed models were performed by using the measurement data on the first, third, fifth, seventh, fourteenth, twenty-first days after admission and those of the day before discharge.

In nurses, delirium recognition scores and delirium knowledge scores before and after introduction of the e-learning intervention were compared using paired t-tests for normally distributed data and the Wilcoxon Signed Rank test for non-normally distributed data. McNemar's tests were used to test differences in proportions of correct answers on the four 'case vignettes'.

All tests were two-sided, with p-values <0.05 considered as significant. All analysis were performed on intention-to-treat principle using SPSS, version 21 (SPSS Inc., Chicago, IL) and SAS System for Windows version 9.2 (SAS Institute Inc., Cary, NC, USA).

Results

Study Participants

During the before and after study, 153 and 143 patients were consecutively admitted to the geriatric ward, of whom 81 consenting patients were included in the non-intervention and 79 in the intervention cohort (**Figure 8.1**). There were no significant differences in the baseline characteristics of both cohorts, except for gender and premorbid functional status (**Table 8.1**).

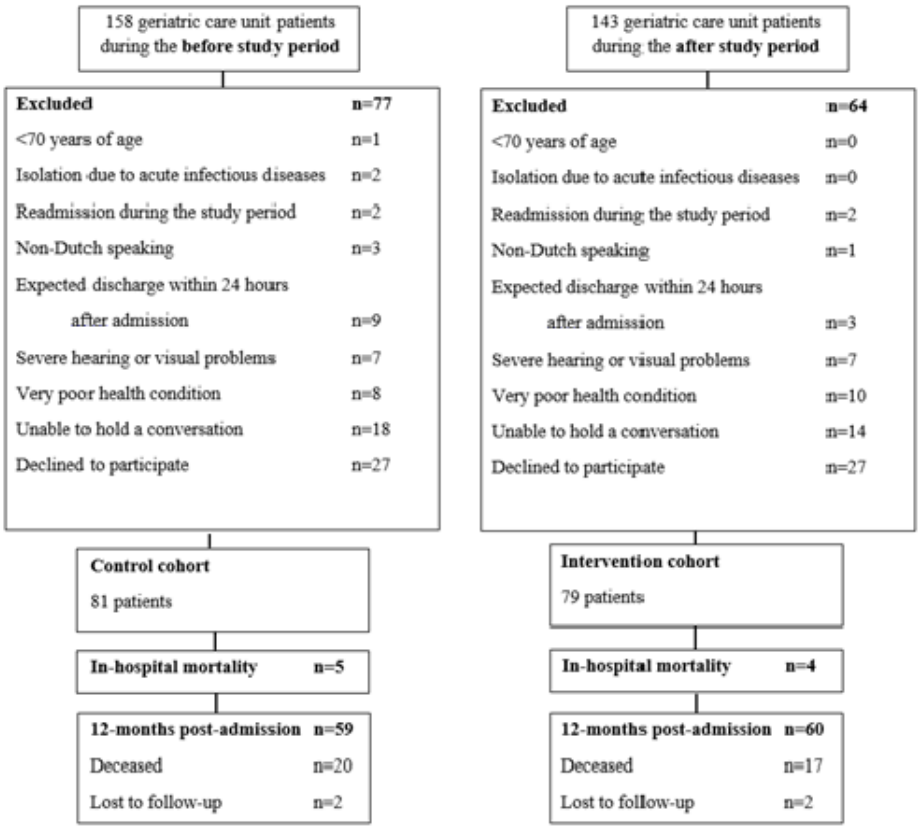

Figure 8.1. Flowchart

Table 8.1. Baseline Characteristics of Patients (n=160)

Characteristic	Control cohort (n=81)	Intervention cohort (n=79)	p-Value
Age in years, mean (±SD)	83.2 (±5.1)	83.8 (±5.6)	0.486[a]
Female, n (%)	34 (42.0%)	51 (64.6)	0.005[b]
Social living circumstances, n (%)			0.359[b]
At home, alone	30 (37.1)	32 (40.5)	
At home, with others	31 (38.3)	30 (38.0)	
Nursing home/service flat	18 (22.2)	16 (20.2)	
Other	2 (2.4)	1 (1.3)	
Main diagnosis, n (%)			0.531[b]
Heart failure and respiratory insufficiency	10 (12.4)	15 (19.0)	
Infectious disease	25 (30.9)	22 (27.9)	
Gastro-intestinal disease	14 (17.3)	10 (12.7)	
Falls-fractures-osteoporosis	21 (25.9)	15 (19.0)	
Neuropsychiatric disease	5 (6.2)	5 (6.3)	
Cancer	2 (2.5)	6 (7.6)	
Other	4 (4.9)	6 (7.6)	
Number of comorbidities, mean (±SD)	2.7 (±1.5)	2.5 (±1.6)	0.365[c]
Number of medication, mean (±SD)	3.5 (±8.0)	3.2 (±8.0)	0.839[a]
Premorbid Katz ADL score, mean (±SD) (range 0-12)	2.9 (±3.0)	4.4 (±3.5)	0.004[c]
Baseline Mini-Mental State Examination score, mean (±SD) (range 0-12)	8.4 (±3.4)	8.0 (±3.5)	0.509[a]
Dementia, n (%)	16 (19.8)	11 (13.9)	0.400[b]
History of delirium, n (%)	13 (16.1)	12 (15.4)	1.000[b]

Abbreviations: SD = standard deviation.

[a] Unpaired t-test

[b] Chi-square test

[c] Mann-Whitney U-test

A total of 22 nurses were eligible for inclusion. Five of them dropped-out because of inability to follow the e-learning course during the study period (i.e. no time or long-term sick leave; n=2) or because they were transferred to another unit (n=3). Characteristics of the 17 included nurses are shown in **Table 8.2.**

Table 8. 2. Characteristics of Nurses (n=17)

Characteristics	
Age in years, mean (±SD)	36.1 (±11.3)
Female, n (%)	16 (94.1)
Work experience in years, mean (±SD)	13.3 (±11.1)
Level of education, n (%)	
Associate degree in nursing	6 (35.3)
Bachelor degree in nursing	9 (52.9)
Master degree	2 (11.8)
Computer literate, n (%)	17 (100)

Abbreviations: SD = standard deviation.

Completion of the E-learning Tool in Nurses

Out of the 17 nurses participating, 15 completed the 6 compulsory modules during the implementation period. The remaining 2 completed the 6 modules one month after the implementation period. Moreover, 3 nurses recompleted the 6 compulsory modules plus 2 (n=1) or 5 additional modules (n=2).

Primary Outcomes

In-hospital Prevalence, Duration and Severity of Delirium

There was no significant difference in the overall proportion of delirious patients in the control (25.9%, n=21) and intervention cohort (21.5%, n=17; p=0.51; Odds Ratio (OR)=0.47, Confidence Interval (CI)=0.16-1.42; p=0.18).

The mean duration of delirium was 4.9 (SD 4.8) days in the control and 4.2 (SD 4.8) days in the intervention cohort (p=0.38).

Although the mean DI scores for delirious patients in the intervention cohort were lower than for those in the control cohort on all measurement points, except for day 1 (**Figure 8.2**), linear mixed model analysis noted a trend towards a lower severity score in the intervention cohort (intervention cohort (IC) versus control cohort (CC): Difference Estimate (DE)=-1.59; 95% CI -3.37 – 0.19; p=0.08).

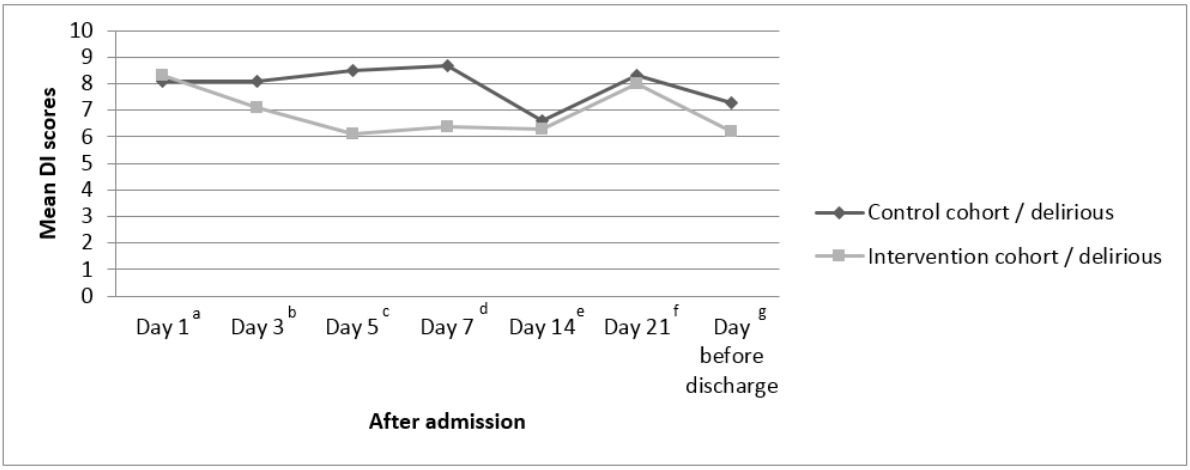

Figure 8.2. Severity of Delirium

Abbreviations: DI = Delirium Index (range 0-21).

a number of delirious patients in intervention/non-intervention cohorts day 1, n=10/n=9

b number of delirious patients in intervention/non-intervention cohorts day 3, n=6/n=7

c number of delirious patients in intervention/non-intervention cohorts day 5, n=4/n=9

d number of delirious patients in intervention/non-intervention cohorts day 7, n=6/n=10

e number of delirious patients in intervention/non-intervention cohorts day 14, n=3/n=4

f number of delirious patients in intervention/non-intervention cohorts day 21, n=2/n=6

g number of delirious patients in intervention/non-intervention cohorts day before discharge, n=1/n=2

Secondary Outcomes

Patients' Mortality

The mortality risk was calculated for all patients and for delirious patients only. The odds ratios for in-hospital mortality and twelve-month mortality between the non-intervention and intervention cohorts was 0.85 (95% CI 0.20-3.66; p=0.80) and 0.75 (95% CI 0.33-1.71; p=0.50), respectively. For delirious patients, multivariable analysis showed no significant difference in the risk for in-hospital mortality (OR=3.28; 95% CI 0.40-27.26; p=0.27) and twelve-month mortality (OR=1.00; 95% CI 0.23-4.37; p=0.99) between both cohorts.

Nurses' Delirium Recognition (DR)

There were no significant differences in the proportions of nurses who were able to correctly identify dementia (76.5% vs. 94.1%; p=0.37), hyperactive delirium (82.4% vs. 88.8%; p=0.62), hypoactive delirium (52.9% vs. 64.7%; p=1.0) and delirium superimposed on dementia (94.1% vs. 58.8%; p=0.07) before and after the introduction of the e-learning intervention, respectively. No significant improvement in the mean total DR score (3.1 (SD 0.83) vs. 3.1 (SD 0.75), p=1.0, respectively) was noted.

Nurses' Delirium Knowledge

The mean total DKQ score of nurses before introduction was not significantly different from the score after introduction of the e-learning intervention (29.3 (SD 2.6) vs. 29.9 (SD 3.2); p=0.43, respectively).

Discussion

To the authors' knowledge, this is the first study to report effects of delirium education for nurses through e-learning on patient outcomes. Nevertheless, we found no impact of the delirium e-learning tool on the in-hospital prevalence, duration and severity of delirium or mortality in patients, nor on nurses' knowledge about delirium or on their ability to recognize delirium using case vignettes. Hence, our findings do not support the assumption that e-learning facilitates knowledge acquisition and its integration into clinical practice.

In understanding the findings, important considerations should be taken into account. First, in contrast with previous research,[25,26,36,37] our geriatric nurses' baseline recognition and knowledge levels regarding delirium were already high, likely because of their specific experience with delirious patients and the prevention and management strategies not present in nurses working on non-geriatric wards. As a consequence, one could hypothesise that the effect of e-learning education on nursing and patient outcomes is potentially more favourable when implemented on wards where the clinical experience with delirium is rather limited. Second, the majority of nurses were only exposed to the 6 compulsory modules which exclusively focussed on the prevention and recognition of delirium. Although the state of the science on delirium management is not strong and prevention remains the most important strategy to address delirium,[42-44] a lack of completion of all modules available within the tool might in part explain why our e-learning tool failed to affect particularly delirium severity and duration. Third, our findings are in line with a previous study in the broader e-learning literature regarding fall prevention, who did not find an effect of e-learning on patient outcomes either.[23] Overall, studies testing the effectiveness of e-learning in clinical practice is relatively scarce at present, hence, the real value of e-learning has yet to be demonstrated.

Further studies might consider approaches to improve uptake and effect of e-learning. More specifically, educational interventions embedding enabling and reinforcing strategies (guidelines, pocket cards, reminders or feedback) appear to be effective in improving patient outcomes.[10,45] Therefore, future studies should investigate the efficacy of delirium e-learning integrated within a larger approach of blended-learning education extended with enabling and reinforcing strategies. Moreover, future research should also evaluate the extent to which

delirium e-learning can influence behaviour change and positive delirium practice. Examples of clinicians' behaviour that might optimize patient outcomes are assessing risk factors of delirium, use of screening tools, delirium detection rates, documentation of delirium in notes, or implementation of preventive/management strategies. The fact that most of our nurses did not complete all available e-learning modules indicates that there might be additional factors, such as attitudes and motivation, that could potentially hinder a successful change in clinical practice.[46]

Some methodological limitations need to be considered. First, a before/after design was used. More rigorous designs (e.g. cluster randomized trial) might potentially yield different results, although one should realize that education is a social process heavily influenced by contextual factors which cannot be controlled for completely.[47] Second, unlike previous data where post-intervention nursing outcomes were evaluated immediately after exposure to the e-learning education,[25-28] we evaluated nurses' delirium-related knowledge and recognition levels only 4 months after the education implementation period. This four-month interval between the exposure to e-learning education and the measurement of nursing outcomes might have been too long to identify statistically significant improvements in those outcomes. Nevertheless, a clinically significant 12% to 18% higher proportion of correctly identified hypoactive delirium and dementia cases were found, respectively. A lack of statistical significance in those latter nursing findings could be due to the small sample size of nurses.

Despite these caveats, this study has several strengths including its prospective design; the repeated assessments during hospitalisation; the use of validated instruments to assess patients' delirium prevalence and duration, and nurses' level of recognition; the detailed statistical analysis; the implementation of a well-designed self-directed e-learning tool, and its development via a robust process and feasibility testing.

Conclusion

Despite the delivery of a well-designed delirium educational e-learning tool, e-learning as an educational approach had neither a direct impact on the in-hospital delirium prevalence, duration and severity or mortality, nor did it improve nurses' delirium knowledge and their recognition skills. Future studies should therefore focus on evaluating patient outcomes as well as on healthcare workers' delirium knowledge, behaviour and practices using e-learning within a larger educational approach or quality improvement project with enabling and reinforcing strategies both on geriatric and non-geriatric wards.

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CHAPTER IX

General Discussion

Delirium is the most common neurocognitive complication in the hospital.[1-3] Specific risk populations have been identified including cardiac surgery, orthopaedic surgery, intensive care, palliative care, cancer and geriatric care.[1-4] Prevention through modification of identified risk factors, and a systematic screening for early signs of delirium in medium-to-high risk patients have been proposed as the most effective strategies to avoid the onset of delirium and its associated complications.[5-7] Within these strategies, nurses in particular play a crucial role.[6] Indeed, because of their regular and continuous contacts with patients, they are key in identifying and targeting risk factors and observing early signs of delirium such as acute disturbances and fluctuations in consciousness, cognition and behaviour. Despite the investments being made in delirium care over the past decades,[5,7-10] delirium remains poorly prevented and frequently unrecognized.[12-14] Permanent investments in delirium prevention and early detection are therefore crucial to optimize delirium management in daily practice.

This PhD dissertation focused on three core nursing aspects of delirium prevention and detection including risk factors for delirium, screening for delirium and staff education, which were addressed in seven research questions (Chapter I **Figure 1.1**).

First, since psychological risk factors are underexplored in delirium research,[16-18] this PhD dissertation aimed to investigate if preoperative psychological factors such as anxiety and depression are contributing risk factors for postoperative delirium in older cardiac surgery (Chapter II) and hip fracture surgery patients (Chapter III).

Second, consensus guidelines regarding delirium screening advocate the use of objective screening tools for the early detection of delirium rather than a subjective method (i.e. nurses' clinical judgement).[7,19] Tools based on bedside observations of cognition and behaviour are given priority; and psychometric testing in routine care is crucial before their implementation in daily practice.[13,20,21] However, evidence demonstrating the psychometric properties and ease of use of such tools in specific risk populations is scarce.[19,22-25] This PhD therefore intended to evaluate the psychometrics and ease-of-use of two observation-based delirium screening tools for the detection of delirium when performed by bedside nurses in routine daily practice (Chapters IV and V).

Third, staff education about delirium is a core element of multicomponent delirium prevention and treatment strategies because of its positive effects on staffs' delirium-related knowledge and skills.[5,10,11] Nonetheless, such initiatives are hard to implement beyond the research setting and its effect on patient outcomes is underexplored.[5,10,11,26-29] Delirium education through e-learning is hypothesized to be easier to implement than the more traditional educational packages.[30,31] The impact of such delirium education through e-learning on nursing and patient

outcomes is, however, less well investigated.[32-34] Therefore, the final objective of this PhD was to investigate the impact of delirium education through e-learning on nursing and patient outcomes in delirium care (Chapters VI-VIII). The outcomes were classified using Kirkpatrick's model for evaluation of educational interventions (Chapter I **Figure 1.1**).[35,36]

For this final chapter, the main results of this dissertation will be presented first, organized according to the three nursing aspects. Secondly, methodological limitations will be addressed. Then, implications for practice and avenues for further research will be discussed. Finally, overall conclusions will be presented.

MAIN RESULTS OF THE PHD PROJECT

Risk Factors for Delirium

Knowledge about the contribution of remediable and non-remediable risk factors in the onset of delirium could guide nurses and other healthcare workers in opportunities for prevention. Age, dementia and co-morbidities are well-known risk factors for delirium across populations including intensive care, medical and surgical patients.[4,37-40] Psychological factors as risk factors for delirium however, are underexplored.[16-18] Yet, since evidence demonstrated that these factors are associated with poor patient outcomes such as overall cognitive impairment, there might be a relation with delirium too.[41] As such, it could open new targets for prevention in delirium care.

Previous studies[42,43] indicate that psychological factors such as anxiety or depression occur regularly in the preoperative period in surgical patients due to waiting for surgery, discomfort or potential death. Because of the sparsity of research evaluating the relationship between preoperative psychological factors and postoperative delirium,[16-18] this PhD dissertation investigated if preoperative anxiety or depressive symptoms are risk factors for delirium in the cardiac surgery (Chapter II) and hip fracture surgery (Chapter III) population. With regard to anxiety, we limited our research focus to anxiety “symptoms”. Anxiety “disorders” classified in the Diagnostic and Statistical Manual of Mental Disorders as generalized anxiety “disorder”, post-traumatic stress disorder, social phobia or panic disorder were excluded.[44] Two types of anxiety “symptoms” were evaluated as part of this PhD including 1) generalized anxiety symptoms (e.g. nervous and anxious personality) measured with the Hospital Anxiety and Depression Scale;[45] and 2) state anxiety symptoms (e.g. temporal and transient emotional state with changing intensity as a reaction to environmental stimuli) measured with the State subscale of the State-Trait Anxiety Inventory,[46] further described as generalized anxiety and state anxiety, respectively.

Despite the high rates of preoperative state anxiety (55.8%), generalized anxiety (25.5%) and depressive symptoms (15.5%) observed in the cardiac surgery population (Chapter II), this study revealed no significant differences in preoperative anxiety and depressive symptoms between patients with and without delirium.[47] Generally, these psychological factors did not increase the odds of having postoperative delirium, nor were associated with delirium severity. This lack of relationship was also observed in our sample of hip fracture surgery patients (Chapter III).[48] Although this study only focused on state anxiety, the odds of having delirium did not increase with increasing preoperative anxiety or depressive symptoms, and the presence of state anxiety before surgery was not associated with delirium incidence, duration

and severity. Overall, these results do not support targeting those psychological factors as part of delirium prevention strategies.

Screening for Delirium

Recent meta-analysis have demonstrated that multicomponent delirium prevention strategies are able to statistically significant reduce the delirium incidence in 30% to 50%.[8,9] Despite the provision of these strategies in clinical practice, however, still a relevant proportion of patients will develop delirium during hospitalisation. Therefore, early detection of delirium is important for an adequate and early treatment of the syndrome and its negative consequences.[5] Early detection can be enhanced through systematic monitoring of patients' cognition and behaviour.[49] To screen for delirium, a variety of tools have been developed.[20] Two of the most common tools used by nurses are the Delirium Observation Screening Scale (DOSS)[50] and the Intensive Care Delirium Screening Checklist (ICDSC).[51] Yet, its use in daily routine care in specific risk populations is underexplored.[19,22-25,51] Based on the results of Chapter IV, this PhD was the first to demonstrate that the DOSS, including 13 items, and its original threshold of 3 can be validly and reliably used for delirium screening and monitoring its severity by bedside nurses in palliative care unit patients.[52] Furthermore, the findings give confidence that the DOSS is considered as easy to use by nurses and useful in their nursing practices. However, it turned out that several DOSS items require a verbal answer to correctly score the items in question. This implies that this tool is not suitable for use in patients in the imminent terminal stage of life. Moreover, we found that none of the items were entirely clear for all nurses. Indeed, some items on the scale describe an observation that may mimic typical symptoms of advanced illness in palliative care, for example being emotional, which makes scoring sometimes difficult. Further studies in this population are needed to confirm these findings in a larger group of nurses and to validate the DOSS in additional samples of palliative care unit patients. Moreover, since this PhD evaluated only one aspect of the reliability (i.e. internal consistency) of the DOSS, other aspects of reliability (i.e. interrater reliability of the DOSS when administered by bedside palliative care unit nurses) require further evaluation.

Further, we evaluated the diagnostic characteristics, internal consistency and user-friendliness of the Intensive Care Delirium Screening Checklist (ICDSC) when performed by bedside intensive care unit nurses in routine daily practice (Chapter V). Indeed, evidence about its use for screening and monitoring delirium severity in pragmatic ICU settings is unclear.[19,51] We found that this screening tool showed good sensitivity and specificity, and high negative predictive value with its original threshold of 4. So the ICDSC can be used for delirium screening in daily routine ICU nursing practice. However, although our findings indicate that

the ICDSC may also be valuable for monitoring delirium severity in ICU patients, its use as severity instrument need further investigation. First, in this PhD, the ICDSC was only tested against the short form of the Confusion Assessment Method Score for delirium severity (CAM-S),[53] which may be insufficiently extensive to evaluate delirium severity. Second, since correlations between the scores on the ICDSC and those on the CAM-S within the subgroup of delirious patients were somewhat lower than in the overall group of ICU patients, future studies should test the concurrent validity of the ICDSC in additional samples of delirious and non-delirious ICU patients. Special attention has to go to the evaluation of the ICDSC as severity instrument against other delirium severity instruments. Moreover, since the sample in this PhD dissertation included a low amount of intubated patient observations (n=12), further studies are needed in order to compare the psychometric characteristics of the ICDSC administered by bedside nurses in additional samples of intubated and non-intubated patients. Furthermore, the ICDSC was found to be easy to use by bedside nurses. Yet, in contrast with the results of the DOSS,[52] it turned out that only a small majority of the ICU nurses under study rated this screening tool as valuable to their nursing practice. Perhaps the type of setting in which the tools were evaluated - the DOSS in a university hospital setting versus the ICDSC in a general hospital setting - may partially explain this discrepancy. Importantly, we found that two ICDSC items, i.e. ‘inappropriate speech or mood’ and ‘symptom fluctuations’, were found to be difficult to rate in intubated patients. Therefore, further studies are needed in order to confirm the perceived difficulties with these two items in additional groups of ICU nurses both working in university and general hospital settings.

Staff Education

Nurses (and other healthcare workers) are supposed to have the knowledge, skills and attitudes required to ensure the quality of delirium care in the hospital. Yet, research over the past decades have demonstrated shortcomings in their level of delirium-related knowledge and skills required to prevent, recognize and treat delirium effectively,[12,13,54,55] leading to adverse patient outcomes.[56] A training gap has been identified as a major barrier of poor delirium care.[12,27,32] Although research findings support the implementation of such staff educational initiatives into daily routine practice,[10,11] these initiatives are difficult to implement outside the research setting.[26,27,28] Education through e-learning is hypothesised to be easier to implement than the more traditional learning approaches.[30,31] An online self-directed delirium educational tool for hospital staff which integrates knowledge and skill development in delirium prevention, detection and management was developed as part of this PhD and being evaluated on three

outcome levels: 1) usefulness and feasibility, 2) staff's delirium-related knowledge and skills, 3) patient outcomes.

Usefulness and Feasibility

This PhD dissertation revealed that the majority of participants evaluated the content of the e-learning tool as useful in daily practice (Chapter VI).[57] The included videos and tests for self-assessment with feedback in particular were judged as very useful. Only a minority (14.8%), however, agreed that it was feasible to take up education through e-learning during working time (e.g. free time) indicating the need for further investments in alternative strategies. One important reason was the difficulties with concentration due to interactions with routine care activities, such as questions of family or patients. Furthermore, important advantages of delirium education through this e-learning tool were recognized, including the flexibility for learners, the division of the content into 11 modules of approximately 10 minutes each to complete, the delivery of the content based on self-active learning, and the included videos and tests for self-assessment with feedback. Important disadvantages of delirium education through e-learning were identified. These included (1) the lack of interactivity between the teacher and learners or between learners themselves (e.g.no facilitator; no peer discussion), (2) the need for sufficient self-discipline in combination with a positive attitude towards delirium to complete all modules without supervision of a facilitator, and (3) the lack of possibilities to apply personal notes.

Staff's Delirium-Related Knowledge, Recognition Skills and Subjective Strain

The provision of delirium education through e-learning improved the majority of healthcare workers' (i.e. general hospital nurses except for 2 physiotherapists and 2 occupational therapists being staff members of the participating units) perceived delirium-related knowledge (Chapter VI).[57] Analyses confirmed that e-learning education statistically significant improved the total delirium-related knowledge, and had a small but statistically significant effect on the difference in total delirium recognition levels (Chapter VII).[58] Furthermore, e-learning education led to a statistically significant 20% to 21% higher proportion of correctly identified hypoactive and hyperactive delirium cases, respectively. Nevertheless, these significant improvements could not be replicated in a sample of geriatric nurses (Chapter VIII). Yet, important differences between these studies need to be emphasized. First, nurses' baseline delirium-related knowledge (DK) and delirium recognition (DR) levels were higher in the sample of geriatric nurses (mean DK: 29.3/35; mean DR: 3.1/4) compared with the sample of general hospital

nurses (mean DK: 28.3/35; mean DR: 2.7/4). The combination of higher baseline knowledge and recognition levels, and the small sample size of geriatric nurses (n=17 versus n=59 in general hospital nurses) might have been resulted in a lack of statistically significant improvements. Yet, a clinically significant 12% to 18% higher proportion of correctly identified hypoactive delirium and dementia cases were found in this sample of geriatric nurses, respectively. Second, the level of completion of the e-learning tool was smaller in the sample of geriatric nurses compared with the sample of general hospital nurses (mean number of completed modules per participant 6.7 (SD 1.7) versus 8.2 (SD 3.2)). Since we found that the effect of delirium education through e-learning on general hospital nurses' delirium recognition and knowledge was related to its level of completion (Chapter VII), this might have played a role in the non-significant nursing results found in the sample of geriatric nurses. However, the relation between module completion and general hospital nurses' delirium recognition and knowledge levels was less explicit after controlling for two potential confounding factors (i.e. number of years of work experience and employment status). Further research is needed to explore this relation in additional samples of nurses both having higher and lower levels of delirium knowledge. Last, the time interval between the exposure to the e-learning education and the measurements of nurses' delirium-related knowledge and recognition levels was smaller in the sample of general hospital nurses (immediately after exposure) compared with the sample of geriatric nurses (four-month interval). The four-month interval in this latter sample might have been too long to detect statistically significant differences in those outcomes. Evidence about the long-term effects of e-learning, however, is currently lacking.

Additionally, this PhD could not provide evidence that delirium education through e-learning affects general hospital nurses' subjective strain in caring for delirious patients (Chapter VII).[58] Yet, previous research in delirium[59] and dementia[60,61] identified knowledge as a factor that is related with experiencing care strain. Hence, additional studies should focus on the predictors of delirium care strain and its relation to delirium education.

Patient Outcomes

To the best of our knowledge, this PhD research was the first to investigate the impact of delirium education for nurses through e-learning on the in-hospital prevalence, duration and severity of delirium and mortality in patients. No statistically significant effect was found on these outcomes (Chapter VIII). However, within our sample of geriatric nurses, the baseline recognition and knowledge levels regarding delirium were already high due to nurses' specific experience with the delirium prevention and treatment strategies not present in nurses working on non-geriatric wards (Chapter VII). One could therefore hypothesise that the window of

increasing nurses' knowledge and as a consequence decreasing delirium incidence, duration or severity will be smaller than in other hospital wards. In order to expand the generalizability of these findings, future studies should investigate the effect of delirium e-learning as educational strategy on patient outcomes in non-geriatric wards. Yet, since pain and medication are strong precipitating risk factors for delirium, it would be interesting to take these factors into account in further research. Furthermore, most of our geriatric nurses were only exposed to the 6 compulsory modules which were focussed on the prevention and recognition of delirium. Since the evidence base on delirium treatment is not strong and prevention remains the most important strategy to mitigate delirium onset,[4,8,9,62] this lack of completion of all modules available within the tool might partially explain why our e-learning tool failed to impact particularly the severity and duration of delirium. Therefore, both studies testing approaches to improve uptake and effect of e-learning, and evaluating the extent to which delirium e-learning can influence behaviour change and delirium practice are required.

OVERALL METHODOLOGICAL LIMITATIONS

This PhD dissertation investigated three nursing aspects of delirium prevention and detection in seven different studies. The methodological limitations of each study were profoundly described in the discussion section of the respective chapters. This paragraph will discuss some overall methodological issues that pertain to this project at large.

First, three nursing aspects of delirium prevention and detection (i.e. risk factors for delirium, screening for delirium and staff education) were investigated as part of this PhD. Yet, other aspects deserve also to be examined in more depth including patient experience, family experience or family involvement. Second, this project except for one study was conducted in one tertiary care centre. Our results, therefore, cannot be generalized to patients or healthcare workers of other centres. Hence, multicentre research in this area is required. Third, the nursing aspects in this PhD dissertation were almost exclusively studied using quantitative research methods. Inclusion of qualitative data (i.e. focus groups or interviews) would have given added value to Chapter VI (i.e. usefulness and feasibility of the developed delirium e-learning tool) in particular. Although the quantitative data have given us valuable information, qualitative research would have given an in depth view on participants' views on the content of the delirium e-learning tool and on the advantages and disadvantages of delirium education through e-learning. Fourth, within the nursing aspect 'risk factors for delirium', preoperative anxiety and depression as risk factors for postoperative delirium were investigated in two patient populations including cardiac surgery (Chapter II) and hip fracture surgery (Chapter III) patients. Although the analysis included important cofounders, other cofounding variables such as postoperative pain, dose of benzodiazepines, urinary continence, and physical restraints were not investigated. Furthermore, since the anxiety instrument (6-item STAI)[63] used in the hip fracture surgery study had no cut-off (i.e. higher scores indicates higher levels of state anxiety), we were not able to classify patients into groups of anxious and non-anxious people. However, patients classified as not anxious because of a benzodiazepine treatment might have a higher risk of developing delirium. Hence, this need further investigation in future research. Last, within the aspect 'staff education' which was addressed in three studies, the impact of the delirium e-learning tool was thoroughly evaluated on various levels including participants' reaction regarding usefulness and feasibility, their delirium-related knowledge, skills and strain of care, and patient outcomes. However, despite behavioural change in healthcare workers is hypothesized to be important to positively change patient outcomes, the effect of the delirium e-learning tool was not evaluated on participants' behaviour, yet need further investigation.[35,36]

IMPLICATIONS FOR PRACTICE

Targeting Patients with Preoperative Anxiety or Depression

This PhD dissertation (Chapter II, III) does not provide evidence that preoperative psychological factors are risk factors for delirium in cardiac surgery and hip fracture patients. This does not mean that preoperative anxiety and depressive symptoms should be ignored. Indeed, clinically significant levels of state anxiety, and medium to high rates of patients with depressive (15.3% and 61.6%) and generalized anxiety (25.2%) symptoms during the preoperative period were observed in our samples. Since these psychological factors are known to be related with negative outcomes including pain, higher rate of readmission and poor quality of life,[41,64-66] one should active screen for their presence at admission to perform anxiety or depression-reduced interventions (e.g. preoperative music therapy or patient education) in patients.[67,68] However, so far, screening for and tackling those factors should not be included in delirium preventive and staff educational strategies.

Implementation of Observation-Based Screening Scales to Routinely Detect Delirium in High Risk Patients

About a quarter of patients in our samples (i.e. cardiac surgery, hip fracture surgery, palliative care unit, intensive care unit, geriatric care unit) had delirium. This specified a need for routinely monitoring patients' cognition and behaviour in high risk patients in order to detect and treat delirium in an early stage. In verbally active palliative care and intensive care unit patients, routinely monitoring of patients' states can be validly and reliably done by bedside nurses using the DOSS (Chapter IV) and the ICDSC (Chapter V) respectively. However, although both scales were useful in daily practice (i.e. to score in 1 to 2 minutes), data emphasise a need for adequate education of bedside nurses in using the scales during the implementation process. Especially the implementation of the ICDSC might require an additional educational follow-up. Our e-learning tool includes exercises in scoring such scales based on videos. However, whether education through e-learning is an effective strategy, need further investigation since outcome evaluation on the level of nurses' behaviour was not part of this PhD.

Furthermore, the development of systems in which the scores on a screening scale are linked with clinical action might be of value. Communication of scoring outcomes to clinicians and an early and effective treatment of delirium is a prerequisite to avoid the negative outcomes of delirium in patients.[54] This was strengthened by a statement reported in our study on the intensive care unit (Chapter V), in which almost half of the bedside nurses described that the ICDSC adds no value to their nursing practice. One of the reasons for this statement could be

that screening without further action is useless. Indeed, screening should be part of a global delirium management protocol which was not implemented in that study. In this context, Rippon et al.[69] developed a Delirium Early Monitoring System (DEMS) which initiate clinical action in accordance to the delirium assessment scores derived. Moreover, DEMS aims to enable staff to routinely screen patients for delirium and communicate the outcomes to other staff members of a multidisciplinary team. Such systems are hypothesised to embed delirium assessment and treatment into routine daily practice in order to improve patient outcomes, and thus are an interesting topic for further research.

From E-learning to Blended-learning Education

Our PhD findings support delirium education through e-learning as an effective method to improve staffs delirium-related knowledge and their ability to recognize delirium based on case vignettes. However, it is insufficient to implement in its current form to influence patient outcomes including incidence, duration and severity of delirium on wards with staff having high levels of delirium knowledge. This finding is particularly important for both hospitals implementing e-learning as delirium education and the research community which wants to evaluate e-learning in future research. Moreover, we found that the effect of the e-learning tool on nursing outcomes (Chapter VII) was slightly related with its level of completion, yet, the effect of it on patient outcomes need to be determined. Since all of our 17 geriatric nurses were exposed to six modules (Chapter VIII) and only three of those nurse completed more modules, we could not evaluate whether the level of module completion affects patient outcomes. Nevertheless, monitoring the adherence rate might be important when e-learning is used in practice. Indeed, nurses have highlighted the importance of having sufficient self-discipline and a positive attitude towards delirium to complete all e-learning modules without supervision (Chapter VI). Hence, additional approaches aiming to improve uptake and effect of e-learning need to be developed and evaluated in practice.

In that context, the PRECEDE model (acronym for “Predisposing, Reinforcing and Enabling Constructs in Educational Diagnosis and Evaluation”) which defined factors relevant to influence practice,[70] might be an interesting course of action. Those factors, applied by Davis et al.[71] to evaluate educational interventions, includes predisposing (e.g. disseminating information, didactic teaching), enabling (e.g. use of protocols, guidelines, pocket cards) and reinforcing (e.g. reminders, feedback) strategies. Evidence based data have demonstrated that educational interventions embedding enabling and reinforcing strategies including restructuring of practice (e.g. interprofessional learning, involvement of an advanced practice nurse in the coordination of the learning in practice through coaching and discussion of delirium

cases) appear to be effective in improving patient-related outcomes.[10,11] Therefore, a switch from an e-learning educational approach to a larger approach of blended-learning education (i.e. e-learning combined with follow-up discussions) extended with enabling and reinforcing factors might be necessary to influence patient outcomes. Within this latter approach, a person with specific clinical expertise and collaboration skills, such as an advanced practice nurse, who will coordinate the educational intervention in practice plays a pivotal role. Indeed, evidence has identified educational approaches including trained experts in delirium to be effective, probably because of their reinforcement of didactic teaching in routine care, provision of feedback, monitoring of adherence level and reminders given to staff.[10,72-75]

AVENUES FOR FURTHER RESEARCH

Although this PhD dissertation has contributed to the body of knowledge regarding nursing aspects of delirium prevention and detection, several areas remain unexplored. Avenues for further research contains four topics including (1) further evaluation of the contribution of preoperative psychological factors in the onset of delirium, (2) further validation of observation-based screening tools, (3) e-learning versus blended-learning education and (4) evaluation of staff delirium education as a complex intervention.

Further Evaluation of the Contribution of Preoperative Psychological Factors in the Onset of Delirium

First, although there is evidence that preoperative psychological factors are associated with adverse patient outcomes in the postoperative period such as overall cognitive impairment and poor functional recovery,[41,64-66] this PhD did not identify those factors as risk factors for postoperative delirium in older cardiac surgery and hip fracture surgery patients. Yet, while the exact pathophysiological mechanisms that contribute to delirium are still not fully understood, physiological stressors and elevated cortisol levels are some of the leading mechanisms in the onset of delirium.[4] Since especially high levels of anxiety cause negative physiological reactions such as increased blood cortisol levels and blood pressure,[76] anxiety is hypothesized to be a harbinger for the development of delirium. To expand the generalizability of our PhD findings, additional studies are required. However, appropriate measurement of anxiety should be tackled first. Indeed, the fact that anxiety is difficult to capture has been indicated by the various types of anxiety and existing assessment scales.[45,46,77-82] Yet, it is the state anxiety – which reflex the stress during a particular moment – that is recommend to be evaluated in the surgical population. Nowadays, the most commonly used scale to assess this type of anxiety is the state subscale of the STAI.[46] Yet, its lengthy (i.e. 20 items), complexity (i.e. scoring based on Likert scale with four response options) and constitution of items that are not related to the situation with which the patient is dealing (i.e. hospitalisation because of oncoming surgery) are comments reported in the literature.[81,82] Moreover, when used to assess state anxiety in older patients in particular, the response options (i.e. not at all, somewhat, moderately, very much) might be confusing.[83] Other state anxiety scales such as the Visual Analogue Scale (VAS)[79] and the Amsterdam Preoperative Anxiety and Information Scale (APAIS)[81] have been developed to overcome the reported shortcomings. The VAS is easy to score which correlates moderate to high (0.50 to 0.84) with the state scale of the STAI.[80] Nevertheless, the APAIS - also been found easy to score and to correlate moderate to high (0.63 to 0.74) with the STAI-state scale[81-82] - seems to be a more valuable tool to measure state anxiety for the oncoming

surgery and anesthesia in the preoperative period. Indeed, this six-item scale includes four questions representing anxiety for surgery and anesthesia. The two other questions represents the need for information. Further research should therefore focus on the relationship between this type of preoperative anxiety and the development of postoperative delirium. To get a first impression, we will perform a secondary data-analysis comprising data from a prospective randomized controlled trial evaluating general anesthesia with either xenon or sevoflurane on the incidence of postoperative delirium in elective cardiac surgery patients.[84] Yet, special attention should be paid to the proportion of women and men in future samples. The women in our study (Chapter II) had a higher prevalence of anxiety symptoms than the men. It would be interesting to investigate whether there are differences for anxiety as risk factor for delirium between both genders. However, because of the small proportion of women in our sample (n=22) we could not perform this subgroup analysis.

Second, most of the patients included in our studies (Chapter II and III) had no pre-existing cognitive impairment, which is a well-known predisposing risk factor for delirium. Since vulnerable patients require fewer precipitating factors to become delirious,[85] our findings regarding the lack of relationship between preoperative psychological factors and postoperative delirium might not be representative for older cardiac surgery patients with pre-existing cognitive morbidity. Future studies should therefore focus on additional samples including patients with cognitive impairment. However, since this PhD identified difficulties measuring anxiety with the STAI in older patients with cognitive impairment (Chapter III), future research should first focus on the development and validation of anxiety scales in this subpopulation of older patients. Indeed, although the use of yes/no response options has been suggested as more valuable for measurement in geriatric patients with cognitive impairment,[83] to our knowledge, to date there exists no scale designed to assess state anxiety in this latter population.

Further Validation of Observation-Based Screening Tools

First, although the DOSS seems to be a promising scale to actively screen for delirium in verbally active palliative care unit patients by bedside nurses, this PhD identified difficulties with some DOSS items which may mimic typical symptoms of advanced illness. Future studies need to confirm these results in a larger group of palliative care unit nurses and should evaluate whether problematic items can be removed. Moreover, a previous study[69] indicated that the 13-item DOSS might be too long for use in the busy clinical practice. Indeed, the brevity of a scale is important for its incorporation into daily practice.[20,69] To get a first view on an abbreviated DOSS version, we performed a secondary data analysis comprising data from our

prospective observational study in the palliative care unit.[86] Three items were removed (i.e. pulls IV tubes, feeding tubes, catheters; is easily or suddenly emotional; sees persons/things as something/somebody else). Importantly, one of these three items (i.e. is easily or suddenly emotional) correspond with the items being identified by the nurses as more difficult to understand. The 10-item DOSS with cut-off 2 showed good sensitivity (90.9%) and specificity (90.2%) in the palliative care unit population. Yet, further research is needed in different hospital settings to confirm these findings. Our research group, therefore, is currently conducting a new study including an expert survey regarding the content validity of the 13 item DOSS, and another secondary data analysis using a large database of DOSS observations (n= +/- 5000 patients).

Second, despite our findings demonstrate that the ICDSC is a valuable tool for monitoring delirium in daily ICU practice, its use as a severity scale needs additional testing in samples of delirious and non-delirious ICU patients against different existing delirium severity instruments.

E-learning versus Blended-learning Education

Although this PhD dissertation demonstrated positive effects of delirium education through e-learning on nursing outcomes, several areas need further investigation. First, we know from previous research in nurses[32] that the level of knowledge after a learning session or module decreases in time. This supports the further exploration of ways to improve the retention of knowledge. However, this PhD did not evaluate the effect of delirium education through e-learning on the evolution of nurses' delirium-related knowledge over time, which should be addressed in further research. Second, it would be interesting to compare the effectiveness of a delirium e-learning approach with a delirium blended-learning approach extended with enabling and reinforcing strategies on Kirkpatricks' four-level model[35,36] including participants' reaction (e.g. satisfaction, usability), their learning skills (i.e. changes in knowledge/skills), their behavioural change, and the benefits to patients (i.e. incidence, duration and severity of delirium) in geriatric and non-geriatric settings. Hence, future research should first focus on the development of such delirium blended-learning educational programs by taking into account the key components (e.g. case-based discussion, feedback, audit, experts)[32] for a successful improvement in patient outcomes. Within the development phase, feedback (e.g. focus groups) from healthcare workers working in different healthcare settings might be important in order to improve the feasibility of the program for clinical practice and to support the sense of ownership. An evaluation of this type of educational intervention should be preferably performed in settings where healthcare workers experience lower levels of delirium-related knowledge, however, with high risk for delirium onset in patients (e.g. cardiac surgery, intensive

care, or hip fracture surgery). Since the implementation of a new intervention is mostly challenging, a person with specific clinical expertise and collaboration skills, such as an advanced practice nurse, who will coordinate the educational intervention in practice should be involved. Such person could identify barriers and facilitators and develop solutions for locally problems during an exploratory trial. Yet, to draw conclusions about the effectiveness of such a program, a (cluster) randomized controlled trial should be conducted. Nevertheless, when using the Delirium Knowledge Questionnaire to evaluate healthcare workers' delirium-related knowledge in future research, additional validity (e.g. content validity using a Delphi procedure) and reliability (e.g. test-retest reliability evaluating the stability) testing is needed.

Evaluation of Staff Delirium Education as a Complex Intervention

Complex interventions are commonly defined as interventions containing numerous interacting components crucial for an appropriate functioning of the intervention.[87] Yet, there are different dimensions of complexity: the number of interacting components within the intervention, the number and difficulty of behaviours required by those delivering or receiving the intervention, the number of groups or organisational levels targeted by the intervention, the number and variability of outcomes, and the degree of flexibility of the intervention permitted.[87] According to the British Medical Research Council (MRC),[87] complex interventions should therefore be evaluated using a framework that comprise different stages for developing, piloting, evaluating and implementing complex interventions. Since a staff delirium education program is an example of a complex intervention, this MRC framework can be used for developing and evaluating the adapted delirium education program which was suggested before (i.e. switch from delirium e-learning to blended-learning combined with enabling and reinforcing strategies). Within this framework, the use of mixed methods (i.e. incorporating a trial and a qualitative study) are recommended to explore the findings deeply in order to determine the effectiveness of the intervention.

OVERALL CONCLUSION

Despite the investments being made in delirium management over the past decades, delirium remains poorly prevented and frequently unrecognized or misdiagnosed in daily practice.[12-15] As such, it is the most common neurocognitive syndrome in the hospital which has a tremendous impact on patients, families and society.[1-4] Prevention through modification of identified risk factors and an early detection are the most effective strategies to avoid delirium and its associated complications.[5-7] Permanent investments in delirium prevention and

detection are thus crucial. Yet, the strategic position of nurses necessitates their involvement in strategies to optimize delirium management in daily practice. This PhD dissertation, therefore, focused on gaps in the body of knowledge regarding three nursing aspects of delirium prevention and detection including risk factors for delirium, screening for delirium and staff education.

First, although there is evidence that preoperative psychological factors - common in surgical patients - are associated with adverse patient outcomes in the postoperative period such as overall cognitive impairment and poor functional recovery,[41,64-66] our findings do not support them to be risk factors for postoperative delirium in older cardiac and hip fracture patients. Hence, tackling these factors in the preoperative period might enhance postoperative recovery, however, should not be included in delirium preventive and educational strategies.

Second, early detection of delirium can be enhanced through systematic monitoring of patients' cognition and behaviour. We found that routinely monitoring of patients' states in verbally active palliative care unit and intensive care unit patients can be validly and reliably done by bedside nurses using the DOSS and the ICDSC, respectively. Hence, those screening scales should be included in staff educational strategies in order to improve its use and consequently the recognition of delirious patients in daily practice.

Last, we developed an online self-directed delirium e-learning tool for hospital staff. Although the provision of delirium education through this e-learning tool is proven to be effective in improving staffs delirium-related knowledge and their ability to recognize delirium based on case vignettes, it is insufficient to implement in its current form to influence patient outcomes on wards with staff having high levels of delirium knowledge. We therefore suggest a switch from an e-learning educational approach to a larger approach of blended-learning education extended with enabling (e.g. use of protocols) and reinforcing (e.g. reminders, feedback) factors. Within this strategy, a person with delirium expertise and collaboration skills who will coordinate the educational intervention in practice might facilitate implementation in order to change practice and consequently patient outcomes.

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LAY SUMMARY

Lay Summary

Delirium is the most common neurocognitive complication in the hospital, affecting 11% to 68% of surgical, 29% to 64% of medical, and up to 88% of intensive care and palliative care unit patients. To date, prevention through modification of identified risk factors and an early detection are the most effective strategies to avoid the onset of delirium and its associated complications. Within these strategies, nurses play a pivotal role. Indeed, because of their continuous contacts with patients, they are key in identifying and targeting risk factors and observing early signs of delirium such as acute disturbances and fluctuations in consciousness, cognition and behaviour. However, delirium remains poorly prevented and frequently unrecognized in daily practice. Hence, permanent investments in delirium prevention and early detection are crucial to optimize delirium management in day-to-day care.

This PhD project aimed to investigate three important nursing aspects of delirium prevention and detection by 1) determining if preoperative psychological factors (i.e. anxiety, depression) are risk factors for postoperative delirium in older cardiac surgery and hip fracture patients, 2) evaluating the psychometrics and ease-of-use of two observation-based delirium screening tools for the detection of delirium when performed by bedside nurses in routine daily practice, and 3) by investigating the impact of delirium education through a newly developed e-learning tool on nursing and patient outcomes in delirium care. A total of seven studies were performed.

Risk Factors for Delirium

Although there is evidence that preoperative psychological factors are associated with adverse patient outcomes in the postoperative period such as overall cognitive impairment and poor functional recovery, the relation with delirium is underexplored. Yet, tackling these factors might be a new target for strategies to prevent postoperative delirium, as its onset correlates with the number of risk factors. Therefore, this PhD investigated the relationship between preoperative psychological factors including anxiety and depression, and postoperative delirium in older cardiac surgery patients. We found no significant differences in preoperative anxiety and depressive symptoms between patients with and without delirium. Generally, these factors did not increase the chance of having postoperative delirium, nor were associated with delirium severity. This lack of relationship was also observed in our study of older patients undergoing surgery for a traumatic hip fracture. The chance of having delirium did not increase with increasing preoperative anxiety or depressive symptoms, and the presence of state anxiety before surgery was not associated with delirium incidence, duration and severity. Hence, these data do not support the control of these psychological factors as a new target for preventive strategies to mitigate postoperative delirium.

Screening for Delirium

Since not all delirium cases are preventable, early detection is important for an adequate and early treatment of the syndrome and its negative consequences. This can be enhanced through systematic monitoring of patients' cognition and behaviour. Two of the most common scales used by nurses to screen for delirium are the Delirium Observation Screening Scale (DOSS) and the Intensive Care Delirium Screening Checklist (ICDSC). However, its use in daily routine care in specific risk populations is underexplored. Therefore, two studies were performed as part of this PhD evaluating the psychometric properties and user-friendliness of the DOSS (i.e. palliative care unit) and the ICDSC (i.e. intensive care unit) administered by bedside nurses in routine practice. We found that both the DOSS and the ICDSC can be validly, reliably and easily used for delirium screening in verbally active palliative care unit and intensive care unit patients, respectively. However, although the DOSS was useful for nursing practice, its use in the palliative care unit setting revealed that some DOSS items mimic typical symptoms of advanced illness in palliative care (e.g. suddenly emotional) which make scoring sometimes difficult. Moreover, only a small majority of the nurses under study rated the ICDSC as valuable to their nursing practice. One of the reasons could be that screening without further action is useless. Therefore, further research focusing on the development of systems in which the scores on a screening scale can be linked with clinical action might be of value. Furthermore, the DOSS and the ICDSC should be included in staff educational strategies in order to improve its use and consequently the recognition of delirious patients in daily practice. The optimum types of educational strategies, including e-learning, should be explored in further research.

Staff Education

Nurses (and other healthcare workers) are supposed to have the knowledge, skills and attitudes required to ensure the quality of delirium care in the hospital. Yet, evidence have demonstrated shortcomings in their knowledge and skills required to prevent, recognize and treat delirium effectively, leading to adverse patient outcomes. Staff education about delirium has been identified as an important initiative to improve delirium management in practice, however, seems difficult to implement beyond the research setting. Education through e-learning may be a valuable alternative, however, its effect on nursing and patient outcomes is sparse. As part of this PhD, an on-line self-directed delirium educational tool for staff was developed, which consists of 11 modules including information about delirium specifics, delirium prevention and treatment strategies, and information about the use of screening instruments for delirium detection. This PhD demonstrated that the provision of delirium

education through e-learning significantly improved general hospital nurses' delirium-related knowledge, and led to a significantly 20% to 21% higher proportion of correctly identified hypoactive and hyperactive delirium cases, respectively. No improvements in these nursing outcomes, however, were demonstrated in a sample of geriatric nurses. This can partially be explained by the high baseline delirium-related knowledge and recognition levels in this latter group of nurses. Furthermore, this PhD could not demonstrate a beneficial effect of delirium e-learning on patient outcomes including the occurrence, duration and severity of delirium. However, since nurses highlighted the importance of having sufficient self-discipline and a positive attitude towards delirium to complete all 11 e- modules without supervision, monitoring the adherence (compliance) rate is deemed mandatory. Hence, additional approaches (e.g. feedback, reminders, pocket cards) aiming to improve uptake and effect of e-learning need to be developed and evaluated in practice.

In conclusion, the results of this PhD dissertation enlarged the knowledge about delirium prevention and detection in several ways. First, preoperative psychological factors (i.e. anxiety and depression) are not identified as risk factors for postoperative delirium in older cardiac and hip fracture surgery patients. For this reason, tackling these factors should not be included in delirium preventive and educational strategies. Second, routinely monitoring of patients' states in verbally active palliative care unit and intensive care unit patients can be validly and reliably done by bedside nurses using the DOSS and the ICDSC, respectively. Hence, those screening scales should be included in staff educational strategies in order to improve its use and consequently the recognition of delirious patients in daily practice. Third, we developed a delirium e-learning tool for hospital staff. Although this tool is proven to be effective in improving staffs delirium-related knowledge and their ability to recognize delirium, it is insufficient to implement in its current form to influence patient outcomes on wards with staff having high levels of delirium knowledge. We therefore suggest a switch from an e-learning educational approach to a larger approach of blended-learning education (i.e. combination e-learning with more traditional learning approaches) extended with enabling (e.g. use of protocols) and reinforcing (e.g. reminders, feedback) factors. Within this strategy, a person with delirium expertise who will coordinate the educational intervention in practice might facilitate implementation in order to change practice and consequently patient outcomes.

Samenvatting

Delirium is de meest voorkomende complicatie in het ziekenhuis. Het treft 11% tot 68% van de chirurgische patiënten, 29% tot 64% van de medische patiënten, en tot meer dan 88% van de patienten op de afdelingen intensieve zorgen en palliatieve zorgen. Preventie en een vroegtijdige detectie zijn momenteel de meest effectieve strategieën om het optreden van delirium en zijn negatieve gevolgen te beperken. Binnen deze strategieën spelen verpleegkundigen een belangrijke rol. Door de continuiteit in hun contacten met patienten spelen zij een centrale rol in het detecteren en aanpakken van risicofactoren en in het observeren van vroegtijdige signalen die duiden op een delirium, zoals acute veranderingen en fluctuaties in het bewustzijn, cognitie en gedrag van patiënten. Toch worden preventieve maatregelen weinig toegepast en wordt delirium vaak niet herkend in de dagelijkse praktijk. Daarom zijn blijvende investeringen in de preventie en vroegtijdige detectie van het syndroom noodzakelijk om het management van delirium in de dagelijkse praktijk te optimaliseren.

Dit doctoraatsproject beoogt drie belangrijke verpleegkundige aspecten binnen de preventie en vroegtijdige detectie van delirium te bestuderen, door: 1) het bepalen of preoperatieve psychologische factoren (i.e. angst, depressie) risicofactoren zijn voor een postoperatief delirium bij oudere cardiochirurgische en heupfractuur patiënten, 2) het evalueren van de psychometrische aspecten en gebruiksvriendelijkheid van twee screeningsinstrumenten voor delirium wanneer deze gescoord worden door verpleegkundigen tijdens de dagelijkse routinezorg, en 3) het evalueren van de effectiviteit van delirium educatie via een nieuw ontwikkelde e-learning tool op uitkomsten bij verpleegkundigen en patiënten. In totaal werden zeven studies uitgevoerd.

Risicofactoren voor Delirium

Ondanks het feit dat preoperatieve psychologische factoren geassocieerd zijn met negatieve gevolgen voor de patiënt in de postoperatieve periode (bv. cognitieve achteruitgang, slecht functioneel herstel), is de relatie met delirium onvoldoende bestudeerd. Aangezien de kans op delirium toeneemt met het stijgen van het aantal risicofactoren, zou het aanpakken van deze psychologische factoren een nieuwe preventieve strategie kunnen zijn. Daarom bestudeerde dit doctoraat de relatie tussen preoperatieve psychologische factoren zijnde angst en depressie, en het optreden van postoperatief delirium bij oudere cardiochirurgische patiënten. De aanwezigheid van preoperatieve angst en depressie verschilde niet significant tussen patiënten met en zonder delirium. Verder deden de psychologische factoren de kans op delirium niet toenemen, en waren deze eveneens niet geassocieerd met de ernst van delirium. Het gebrek aan een relatie tussen preoperative psychologische factoren en een postoperatief

delirium werd ook geobserveerd in onze studie die uitgevoerd werd bij oudere patiënten die een operatie ondergingen omwille van een heupfractuur. De kans op delirium nam niet toe met een stijging van de preoperatieve angst of depressieve symptomen, en de aanwezigheid van toestandsangst in de periode voor de operatie was niet geassocieerd met het optreden van delirium noch met zijn duur en ernst. Deze resultaten ondersteunen de aanpak van psyhologische factoren als nieuwe strategie ter preventie van delirium niet.

Screenen voor Delirium

Aangezien niet elk delirium te voorkomen is, is een vroegtijdige detectie belangrijk voor een adequate en vroegtijdige behandeling van het syndroom en zijn negatieve gevolgen. Dit kan door het gedrag en cognitie van patiënten systematisch op te volgen. Twee van de meest voorkomende schalen die hiervoor door verpleegkundigen gebruikt worden zijn de Delirium Observatie en Screening Scale (DOSS) en de Intensive Care Delirium Screening Checklist (ICDSC). Hun gebruik in de dagelijkse praktijk binnen specifieke risicopopulaties is echter onvoldoende bestudeerd. Daarom werden binnen dit doctoraat twee onderzoeken uitgevoerd die de psychometrische aspecten en de gebruiksvriendelijkheid van de DOSS (i.e. palliatieve zorgen eenheid) en de ICDSC (i.e. intensieve zorgen eenheid) bestudeerden wanneer deze schalen door vepleegkundigen werden gescoord tijdens de routinezorg. We vonden dat zowel de DOSS als de ICDSC valide, betrouwbaar en gemakkelijk gebruikt kunnen worden bij patiënten op respectievelijk de afdelingen palliatieve zorgen en intensieve zorgen. De DOSS werd als waardevol beschouwd voor de verpleegkundige praktijk, maar zijn gebruik op de palliatieve zorgenafdeling bracht aan het licht dat sommige DOSS items typische symptomen van vergevorderde ziekte imiteren (vb. plotseling geëmotioneerd) waardoor het scoren van die items soms moeilijk kan zijn. Wat de ICDSC betreft, enkel een kleine meerderheid van de verpleegkundigen in onze studie beschouwde dit instrument als waardevol voor de praktijk. Een van de redenen kan zijn dat screenen zonder verdere actie zinloos is. Daarom is onderzoek dat zich richt op de onwikkeling van systemen waarbij de scores van een screeningsinstrument gelinkt worden aan mogelijk te ondernemen stappen waardevol. Verder moeten de DOSS en de ICDSC opgenomen worden binnen bijscholingen en andere educatie voor gezondheidswerkers om hun gebruik en dus ook de herkenning van delirium in de dagelijkse praktijk te verbeteren. De optimale educationele strategieën, met ingebrip van e-learning, moet in verder onderzoek bestudeerd worden.

Educatie voor Gezondheidswerkers

Van verpleegkundigen (en andere gezondheidswerkers) wordt verondersteld dat zij over de nodige kennis, vaardigheden en attitudes beschikken om de kwaliteit van de zorg rond delirium te garanderen. Toch hebben studies aangetoond dat deze mensen tekorten hebben in hun kennis en vaardigheden die nodig zijn om delirium te voorkomen, te herkennen en te behandelen. Dit leidt echter tot negatieve gevolgen voor de patiënt. Delirium educatie voor gezondheidswerkers is belangrijk om het management rond delirium in te praktijk te verbeteren, echter, deze strategieën lijken moeilijk te implementeren buiten de onderzoekssetting. Educatie via e-learning kan een waardevol alternatief zijn, maar zijn effecten op de resultaten bij verpleegkundigen en patiënten zijn schaars. Een online delirium e-learning tool voor gezondheidswerkers werd binnen dit doctoraat ontwikkeld. Deze tool bestaat uit 11 modules die informatie bevatten over delirium, zijn preventieve en behandelingsstrategieën, en over het gebruik van screeningsinstrumenten voor de detectie van delirium. Dit doctoraat toonde aan dat delirium educatie via e-learning leidde tot een significante verbetering van de delirium-gerelateerde kennis bij algemene ziekenhuisverpleegkundigen. Daarnaast werd hypoactief en hyperactief delirium in respectievelijk 20% en 21% van de gevallen meer herkend. Bij geriatrische verpleegkundigen daarentegen werden geen significante verbeteringen vastgesteld. Dit kan gedeeltelijk verklaard worden door het feit dat hun kennis en herkenningsvaardigheden bij aanvang van de studie reeds hoog was. Dit doctoraat kon echter geen effect aantonen van e-learning op de resultaten voor de patiënt, zoals op het voorkomen, de duur en de ernst van delirium. Verder, aangezien verpleegkundigen het belang benadrukten van het hebben van voldoende zelfdiscipline en een positieve attitude tegenover delirium om alle e-modules zelfstandig door te nemen, is opvolging tijdens e-learning belangrijk. Daarom moeten bijkomende strategieën (bv. feedback, herinneringen, richtlijnen in zakvorm) die tot doel hebben het doorlopen van de modules te stimuleren en de impact van e-learning te verbeteren ontwikkeld en uitgetest worden.

Als conclusie, de resultaten van deze doctoraatsthesis verruimden de kennis rond de preventie en detectie van delirium in verschillende opzichten. Ten eerste, preoperatieve psychologische factoren (i.e. angst, depressie) werden niet geïdentificeerd als risicofactoren voor een postoperatief delirium bij oudere cardiochirurgische patiënten en patiënten die een ingreep ondergingen naar aanleiding van een heupfractuur. De aanpak van deze factoren moet daarom niet opgenomen worden in strategieën ter preventie van delirium noch binnen deliriumeducatie. Ten tweede, het opvolgen van de mentale toestand van patiënten op

afdelingen palliatieve zorgen en intensieve zorgen kan valide en betrouwbaar uitgevoerd worden door verpleegkundigen aan de hand van respectievelijk de DOSS en de ICDSC. Daarom moeten deze schalen opgenomen worden binnen educationele strategieën voor gezondheidswerkers om hun gebruik en dus ook de herkenning van delirium in de dagelijkse praktijk te verbeteren. Ten derde, we ontwikkelden een delirium e-learning tool voor gezondheidswerkers. Deze tool is effectief in het verhogen van de verpleegkundigen hun delirium-gerelateerde kennis en hun mogelijkheid om delirium te herkennen. Doch, delirium educatie via e-learning is bij gezondheidswerkers met een hoge kennis van delirium onvoldoende om resultaten bij patiënten te beïnvloeden. Daarom stellen we voor om over te schakelen van e-learning naar blended-learning (i.e. combinatie van e-learning met meer traditionele leermethoden) uitgebreid met bijkomdende strategieën (vb. gebruik van protocols, herinneringen, feedback). Een persoon met delirium expertise die de educationele interventie in de praktijk coördineert kan de implementatie hiervan ondersteunen.

CURRICULUM VITAE

Elke Detroyer was born on October 20, 1982 in Halle, Belgium. She graduated as a Bachelor in Nursing at the EHSAL in 2003 (Magna cum Laude) and obtained a Master degree in Nursing Science at the KU Leuven (Cum Laude) in 2006. She holds a Master degree in Teaching Education since 2007 (KU Leuven) and received a certificate in infection prevention (KU Leuven) in the same year.

From August 2007 until December 2009, she worked as a research associate at LUCAS, Centrum voor Zorgonderzoek en Consultancy at the KU Leuven. She was involved in several research projects related to geriatric care including patient participation in nursing homes; and the care for people with dementia, a project in collaboration with the Koning Boudewijnstichting and the University of Liège. Elke was also co-investigator and trainer in the BelRAI project, evaluating the feasibility of the RAI in Belgium.

From January 2008 until December 2015, she worked as a research associate at the University College Leuven-Limburg (Hasselt). She was project coordinator of the research projects “Development and evaluation of delirium e-learning in the detection of delirium” (2008-2011) and “Development and evaluation of a mobility protocol to prevent immobility and functional decline in hospitalized older people” (2014-2015), and co-investigator of the project “Spiritual care competencies in the home care” (2012-2014). From 2012 to 2015 she worked as lecturer Evidence-Based Nursing in the Bachelor Nursing and Bachelor after Bachelor diabetes care, lecturer during delirium seminars (2013-2015) and guest lecturer in the postgraduate elderly care (2014-2015) (UCLL).

In January 2009, she started working as a research assistant at the Academic Centre for Nursing and Midwifery (AccentVV, KU Leuven). She was student counsel for the programs ‘Master in Nursing and Midwifery’ and ‘Master in Management and Policy of Healthcare’ (2009-2011) and is part of the delirium research group. Since 2016, she is part of the research group geriatric oncology that evaluate the implementation of geriatric screening and assessment within the older population with cancer. Within this group, she writes research proposals.

Elke started her PhD training at the doctoral school of Patient Related and Public Health Research at the Faculty of Medicine of the KU Leuven in March 2009. In 2010, she enrolled the three-year summer school of the European Academy of Nursing Science, which she finalized in 2012. Elke Detroyer received the ‘Best Poster Presentation Price’ at the 6th Scientific Congress of the European Delirium Association in Umea, Sweden, and received an award for the ‘Best Quality Project’ by the College Geriatrie. Since 2014, she is board member of the European Delirium Association.

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