TURUN
YLIOPISTO
UNIVERSITY
OF TURKU

PATIENT OBSERVATION SKILLS IN CRITICAL CARE NURSING

A Theoretical Construction and Evaluation

Mika Alastalo

TURUN YLIOPISTON JULKAISUJA – ANNALES UNIVERSITATIS TURKUENSIS
SARJA – SER. D OSA – TOM. 1552 | MEDICA – ODONTOLOGICA | TURKU 2021

TURUN YLIOPISTO
UNIVERSITY OF TURKU

PATIENT OBSERVATION SKILLS IN CRITICAL CARE NURSING

A Theoretical Construction and Evaluation

Mika Alastalo

TURUN YLIOPISTON JULKAISUJA – ANNALES UNIVERSITATIS TURKUENSIS
SARJA – SER. D OSA – TOM. 1552 | MEDICA – ODONTOLOGICA | TURKU 2021

University of Turku

Faculty of Medicine
Department of Nursing Science
Nursing Science
Doctoral programme in Nursing Science

Supervised by

Professor Helena Leino-Kilpi
Department of Nursing Science
University of Turku
and Turku University Hospital
Turku, Finland

Professor Leena Salminen
Department of Nursing Science
University of Turku
and Turku University Hospital
Turku, Finland

Reviewed by

Professor Marion Mitchell
School of Nursing and Midwifery
Griffith University
Brisbane, Queensland, Australia

Adjunct Professor Miia Jansson
Research Unit of Medical Imaging,
Physics and Technology
University of Oulu
Oulu, Finland

Opponent

Professor Hannele Turunen
Department of Nursing Science
University of Eastern Finland
Kuopio University Hospital
Kuopio, Finland

The originality of this publication has been checked in accordance with the University of Turku quality assurance system using the Turnitin OriginalityCheck service.

ISBN 978-951-29-8457-2 (PRINT)
ISBN 978-951-29-8458-9 (PDF)
ISSN 0355-9483 (Print)
ISSN 2343-3213 (Online)
Painosalama, Turku, Finland 2021

To all critical care nurses and critically ill patients

UNIVERSITY OF TURKU
Faculty of Medicine
Department of Nursing Science
Nursing Science
MIKA ALASTALO: Patient observation skills in critical care nursing – A Theoretical construction and evaluation
Doctoral Dissertation, 158 pp.
Doctoral Programme in Nursing Science
April 2021

ABSTRACT

This two-phase study focused on critical care nurses' skills. The purpose was first to describe and create a theoretical construction of patient observation skills in critical care nursing, and second, to evaluate the current level of Finnish critical care nurses' patient observation skills using subjective and objective assessment and investigate the factors associated with the skills. The aim was to deepen the understanding of critical care nurses' skills, and ultimately to develop their skills to enhance quality of care and patient safety in intensive care units.

In the first study phase, patient observation skills were described and a preliminary theoretical construction was created based on the semi-structured interviews among experienced critical care nurses (n=20). Thematic analysis was used to analyse the data. The second phase utilized cross-sectional correlational design to evaluate critical care nurses' patient observation skills and to investigate associated factors. An instrument, Patient Observation Skills in Critical Care Nursing (POS-CCN) consisting of self-assessment and knowledge test, was developed. Critical care nurses (n=372, response rate 49%) in Finnish intensive care units in university hospitals answered the questionnaire. The methods of data analysis included descriptive and inferential statistics and general linear model.

Patient observation skills in critical care nursing consist of information-gaining, information-processing, decision-making and co-operation skills. The evaluation of critical care nurses' skills was limited to information-gaining and information-processing skills. Critical care nurses assessed their information-gaining skills as excellent, whereas knowledge test assessment suggested that information-processing skills are suboptimal. Critical care nurses who were highly confident in their competence and educated for special tasks in intensive care units had higher level of patient observation skills.

There is a need for improving critical care nurses' patient observation skills especially in information processing. Systematic education and training in patient observation is needed in intensive care units, and skills evaluation practices need to be developed further.

KEYWORDS: Critical care nursing, intensive care unit, patient observation, POS-CCN, skills assessment

TURUN YLIOPISTO
Lääketieteellinen tiedekunta
Hoitotieteen laitos
Hoitotiede
MIKA ALASTALO: Potilaan kliinisen tilan tarkkailutaidot tehohoitotyössä – Teoreettinen rakenne ja arviointi
Väitöskirja, 158 s.
Hoitotieteen tohtoriohjelma
Huhtikuu 2021

TIIVISTELMÄ

Tämä kaksivaiheinen tutkimus kohdentui tehosairaanhoitajien taitoihin. Tarkoituksena oli ensin kuvailla ja muodostaa teoreettinen rakenne tarkkailutaidoille tehohoitotyössä ja sitten arvioida tehosairaanhoitajien tarkkailutaitojen tasoa subjektiivisesti ja objektiivisesti sekä tunnistaa taitoihin yhteydessä olevia tekijöitä. Tavoitteena oli syventää ymmärrystä tehosairaanhoitajien taidosta, ja lopulta kehittää taitoja hoidon laadun ja potilasturvallisuuden varmistamiseksi.

Ensimmäisessä vaiheessa tarkkailutaidot kuvailtiin ja alustava teoreettinen rakenne luotiin kokeneiden tehosairaanhoitajien (n=20) puolistrukturoitujen haastattelujen perusteella. Aineisto analysoitiin temaattisella analyysilla. Tutkimuksen toisessa vaiheessa korrelatiivisessa poikkileikkeusasetelmassa arvioitiin tehosairaanhoitajien tarkkailutaitoja ja tunnistettiin niihin yhteydessä olevia tekijöitä. Arviointia varten kehitettiin mittari Tarkkailutaidot Tehohoitotyössä (TarkkaTeho), joka koostui taitojen itsearvioinnista ja tietotestistä. Suomalaisten yliopistosairaaloiden teho-osastoilla työskentelevät sairaanhoitajat vastasivat kyselyyn (n=372, vastausprosentti 49%). Aineisto analysoitiin tilastollisin menetelmin hyödyntäen yleistä lineaarista mallia monimuuttujamenetelmänä.

Potilaan kliinisen tilan tarkkailutaidot koostuvat taidoista hankkia ja käsitellä tietoa, taidoista tehdä päätöksiä sekä yhteistyötaidoista. Arviointi rajoittui tiedonhankinta- ja -käsittelytaitoihin. Tehosairaanhoitajat arvioivat tiedonhankintataitonsa eriomaiseksi, kun taas tietotestin perusteella tiedonkäsittelytaidot eivät olleet optimaalisella tasolla. Taidot olivat paremmat tehosairaanhoitajilla, jotka olivat luottavaisia omaan tehohoitotyön osaamiseensa, ja jotka olivat saaneet koulutuksen erityistehtäviin teho-osastolla.

Tehosairaanhoitajien tarkkailutaitoja tulisi parantaa erityisesti tiedonkäsittelyn osalta. Potilaan tilan tarkkailun koulutusta tulisi olla järjestelmällisesti tarjolla teho-osastoilla, ja taitojen arviointia on tarve kehittää edelleen.

AVAINSANAT: Tehohoitotyö, teho-osasto, potilaan kliinisen tilan tarkkailu, TarkkaTeho, taitojen arviointi

Table of Contents

Tables, figures and appendices

Tables

Figures

Appendices

Abbreviations

ANOVA	One-way analysis of variance
CCN	Critical care nurse
CCU	Coronary Care Unit
CFA	Confirmatory factor analysis
CI	Confidence interval
CINAHL	Cumulative Index to Nursing and Allied Health Literature
CVI	Content Validity Index
EFA	Exploratory factor analysis
HDU	High-dependency unit
ICU	Intensive care unit
POS-CCN	Patient Observation Skills in Critical Care Nursing –instrument
RN	Registered nurse
UAS	University of Applied Sciences
VAS	Visual analogue scale

List of Original Publications

This dissertation is based on the following original publications, which are referred to in the text by their Roman numerals:

I Alastalo M, Salminen L, Lakanmaa R-L & Leino-Kilpi H. Seeing beyond monitors – Critical care nurses’ multiple skills in patient observation: Descriptive qualitative study. *Intensive and Critical Care Nursing*, 2017; 42: 80–87.

II Alastalo M, Salminen L, Jeon Y, Vahlberg T & Leino-Kilpi H. Critical care nurses' self-assessed patient observation skills: a cross-sectional survey study. *Nursing in Critical Care*, 2019; 24(5): 268–275.

III Alastalo M, Salminen L, Vahlberg T & Leino-Kilpi H. Knowledge of patient observation among critical care nurses. *Nursing in Critical Care*, 2020; DOI: 10.1111/nicc.12573

IV Alastalo M, Salminen L, Vahlberg T & Leino-Kilpi H. Subjective and objective assessment of critical care nurses’ patient observation skills: a cross-sectional study *Submitted*

1 Introduction

Critical care is focusing on the specialized medical and nursing care of the most severely ill or injured patients. These patients are being cared for in various hospital units such as coronary care units, emergency departments, paediatric and adult intensive care units (ICUs) (Aitken, et al. 2019). In this study, critical care nursing refers to the nursing care of patients in adult ICUs. The need for critical care is constantly increasing due to expanding possibilities of providing critical care (Rhodes et al., 2011), the development of new technologies to support patients' vital functions (Thompson et al., 2018) and the aging population (Guidet et al., 2017).

In Finland, there are around 20 000 admissions in ICUs yearly (The Finnish Society of Intensive Care, 2019), and approximately 260 ICU beds in total denoting 5 ICU beds per 100 000 head of population (Reinikainen & Varpula, 2018). Internationally, the average number of ICU beds in total and per 100 000 population is more than 140 000 and 3.6 in Asia (Phua, et al., 2020a) more than 70 000 and 11.5 in Europe (Rhodes, et al., 2012), and nearly 80 000 and 34.7 in the United States (Wallace et al., 2015). The ratio of ICU beds to hospital beds has been increasing, because the length of hospital stay in general has been decreasing and fewer beds are needed while the need for critical care has been increasing (Guidet et al., 2017). Recently, the demand for the critical care capacity has peaked due to the COVID-19 pandemic (Phua, et al., 2020b; Aziz, et al., 2020), which has emphasized the role of critical care as a key function of hospitals.

The expenditure in critical care is high as an average cost for an ICU day in Finland is more than 3000 € and the total cumulative costs per patient in three years' follow up after critical care are more than 40 000 € in average (Jukarainen, et al., 2020). Even though critical care is resource-intensive, it is very cost-effective when allocated appropriately saving lives and producing quality of life (The Finnish Society of Intensive Care, 2019).

The most valuable critical care resource is the skilled staff. Critical care nurses (CCNs) are the largest group of professionals in interprofessional teams, who are providing constant observation and care for the critically ill patients. Thus, CCNs play vital roles in the teams in ensuring desirable patient outcomes (West, et al., 2014). Therefore, developing CCNs' skills is highly relevant in order to ensure good quality of care (Egerod, et al., 2020; Hopia & Heikkilä, 2020).

Observation of a patient's clinical condition has always been of the essence of critical care (Berthelsen & Cronqvist, 2003). Observations guide clinical decisions making (Poncette et al., 2020) and are crucial in detecting changes in a patient's condition (Kelly et al., 2014a; Lavoie et al., 2014). In fact, patient observation was a starting point for the development of ICUs and critical care as a medical and nursing specialty during the Crimean War (1850s). At that time, Florence Nightingale realized, that the most seriously ill patients should be grouped together enabling nurses to observe them better (Crocker, 2007; Vincent, 2013). Patient observation provided by CCNs has remained as a key element of modern critical care (Thompson et al., 2018), even though technological development in patient observation has been tremendous and new sophisticated technologies, such as artificial intelligence, machine learning and clinical decision support systems have been introduced into ICUs (De Georgia et al., 2015; Kindle et al., 2019; Medic, et al., 2019).

Patient observation is a fundamental element of CCNs' duties and responsibilities and is linked with the quality of care and patient safety as careful observation enables detecting changes in a patient's condition and prevents complications (Ääri et al., 2008; Gill et al., 2014; Jones & Johnstone, 2017). CCNs' role in patient observation does not limit to detecting changes and reporting the findings to a physician, but they also make independent decisions based on observation (Grenvik & Pinsky, 2009; Trinier et al., 2016). Thus, CCNs have to possess an extensive set of skills in patient observation.

Patient observation has been identified as a content area of critical care nursing education (World Federation of Critical Care Nurses, 2005). However, there are variations in availability of critical care nursing education internationally. Contrary to what is found in many countries, there is no specialised postgraduate education in critical care (Endacott, et al., 2015) or anaesthesia nursing (Jeon et al., 2015) in Finland. Finnish nursing education takes place in universities of applied sciences (UAS), and is regulated by EU directives (The European Parliament and the Council, 2005; The European Parliament and the Council, 2013), and bases its curriculum on nationally defined core competence areas for generalist registered nurses (Eriksson et al., 2015; Kajander-Unkuri, et al., 2020). Those competence areas do not include critical care nursing. However, UAS may provide complementary studies in critical care nursing to varying extent and nursing students may have some clinical placements in critical care settings (Opintopolku, 2020), hence developing their critical care nursing skills during their basic professional education. Master level university studies in critical care nursing are not available in Finland. Nevertheless, due to the lack of specialized education, professional development relies on orientation programs, working experience and continuing education with varying scope and content in ICUs (The Finnish Society of Intensive Care, 2011; Lakanmaa, et al., 2015).

Sudden demand for critical care services due to COVID-19 pandemic required ICUs to train nurses from other specialties to care for the critically ill patients (Brickman, et al., 2020). Patient observation skills can be seen as a prerequisite for working as a CCN, and therefore the training should equip new nurses entering ICUs with adequate skills. However, patient observation skills have not been comprehensively defined, or described in earlier literature. Neither have CCNs' patient observation skills been comprehensively evaluated by previous studies. In order to understand and develop CCNs' patient observation skills, frameworks for skill development and evaluation methods are needed. Furthermore, the evidence about the level of CCNs' skills in patient observation are needed for planning and focusing continuing education and on-the-job training in ICUs.

The purpose of this study was two-folded: theoretical and evaluative. First patient observation skills in critical care nursing were described as currently there is deficit in knowledge around this, and a theoretical construction was created. Second the current level of Finnish CCNs' patient observation skills was evaluated using subjective and objective assessment and the factors associated with the skills were investigated. The aim was to deepen the understanding of CCNs' skills, and ultimately to develop their skills to enhance quality of care and patient safety in ICUs.

The following summary of the two-phased study begins with the definition of the main concepts of the study, and continues with the review of the existing literature describing and evaluating CCNs' patient observation skills. The empirical part of the summary describes the research methods, presents the results, discusses the results, validity and reliability and finally gives recommendations for clinical practice, management, education and future research.

2 Definition of the concepts

The main concepts of the study are *critically ill patient*, *critical care nursing* and *patient observation in critical care nursing*. Conceptual literature, dictionaries, subject headings (U.S. National Library of Medicine and CINAHL), reports by professional associations and relevant research literature were reviewed to define the concepts. What is previously known about CCNs' patient observation skills and the level of those skills are reported in the literature review based on the literature search (chapter 3).

2.1 Critically ill patient

A critically ill patient either suffers or potentially suffers from life threatening conditions (European federation of Critical Care Nursing associations, 2004). Whereas, critical illness is "a disease or state in which death is possible or imminent" (U.S. National Library of Medicine, 2020a). Patients who are suffering from, or who are in the potential risk of developing severe defects in their vital functions are, where able, taken care of in intensive care units (ICU). The most common reasons for patients to receive critical care are dysfunctions in respiratory, circulatory or central nervous systems. Most patients enter the ICU through emergency admission, but considerable proportion of the patients are receiving elective postoperative care in ICU after major surgery like cardiothoracic procedures (Reinikainen & Varpula, 2018). Severe infections resulting in sepsis and septic shock are the most common diagnoses of critically ill patients through emergency admissions globally (Vincent, et al., 2014).

Critical illness may cause a great variety of manifestations such as changes and alterations in hemodynamic status (Cecconi, et al., 2014; Maclay & Rephann, 2017), breathing (Cioffi et al., 2009; Choi, et al., 2017), neurological status (Cioffi, et al., 2009) and gastrointestinal functions (Gray et al., 2018), as well as symptoms like delirium, weakness and fatigue (Choi, et al., 2017). Most patients in ICUs suffer from pain that is caused by the critical condition itself or by various procedures such as endotracheal suctioning and wound care (Puntillo, et al., 2018). Furthermore, high dependency on others (Yang, 2016), and impaired privacy characterize critically ill patients, and their intimate space may be violated several times per day due to nursing and medical interventions (Meriläinen et al., 2010).

Mortality among the Finnish patients in ICUs was 6% in 2015, and hospital mortality 10% (Reinikainen & Varpula, 2018). Internationally there are some variations in the mortality rates in ICUs: 16.2% in a global study (Vincent, et al., 2014), and 19.1% in a European study (Capuzzo, et al., 2014). The mortality is highest among the patients with sepsis (25.8%) (Vincent, et al., 2014) and major non-cardiac surgical patients (22.3%) (Ekeloef et al., 2019), whereas lowest among elective cardiac surgical patients (hospital mortality 1.4%) (Reinikainen & Varpula, 2018). The comparability of the mortality rates is limited as there are deviations in the inclusion criteria for certain patient groups (e.g. medical vs. surgical) in different studies. Even though most critically ill patients survive if taken care of in an ICU, their health related quality of life may remain significantly worse in the long term compared to the population in general (Kaarlola et al., 2003; Seppänen, et al., 2018; Gerth et al., 2019). Moreover, they may suffer from long-term delusional memories and psychological distress following ICU discharge (Kiekkas et al., 2010; Meriläinen et al., 2013).

The severity of a patient’s condition and their needs make certain demands for critical care. The more complex the needs are, the more advanced and intense care the patient requires. Critical care services can be classified in three levels: level one ICUs care for patients with mild organ dysfunctions, while level three ICUs can provide support and management of multiple and complex organ dysfunctions over a prolonged period of time. (Marshall, et al., 2017) The severity of patients’ condition (Kiekkas, et al., 2007) and their care needs determine the nursing workload and nursing intensity in the ICUs (Pyykkö, et al., 2004a; Lundgrén-Laine & Suominen, 2007). Nursing workload is usually higher when caring for emergency-operated and medical patients, than electively operated surgical patients (Pyykkö, et al., 2004b). Adequate nurse staffing in ICUs is very important as evidence suggests that the increased workload and nurse understaffing are for example associated with higher incidence of multiple organ failure (Jansson, et al., 2020) and ventilator-associated pneumonia as well as increased mortality among critically ill patients (Jansson, et al., 2019). In general, a critically ill patient requires one critical care nurse’s workload constantly (Ala-Kokko & Pettilä, 2018; Word Federation of Critical Care Nurses, 2019).

2.2 Critical care nursing

2.2.1 Critical care as a nursing specialty

Critical care nursing is a nursing specialty focusing on the care of the acutely and critically ill patients (U.S. National Library of Medicine, 2020b) having complex health problems, and conditions requiring constant and comprehensive care and monitoring (CINAHL Subject Headings, 2020a). Critical care nurses are usually taking care of their critically ill patients in ICUs. However, there may be other units in the hospitals taking care of critically ill patient as well, such as high-dependency units (HDU) (World Health Organization, 2003; Kelly et al., 2014b; Marshall, et al., 2017). In this study, critical care nurse (CCN) refers to a registered nurse (RN) working in an adult ICU.

CCNs develop special skills required in the care of critically ill patient either through specialized education (World Health Organization, 2003; European federation of Critical Care Nursing associations, 2004; Endacott, et al., 2015; Gullick, et al., 2019) or by working experience and on-the-job training (The Finnish Society of Intensive Care, 2011; Lakanmaa et al., 2015). Post-graduation education aiming at nationally recognized qualification for critical care nursing is provided in most European countries ranging from diploma level to master level (Endacott, et al., 2015). As there is no specialized education in critical care nursing (Endacott, et al., 2015) or anaesthesia nursing (Jeon et al., 2015) in Finland, professional development takes place mainly in orientation programs, working experience and continuing education within ICUs (Lakanmaa et al., 2015).

CCNs are working in a close collaboration with their colleagues (Lakanmaa et al., 2015) and physicians, but also with many other professionals like physiotherapists, pharmacists and social workers (Marshall, et al., 2017; Hutri, 2019; Zhang et al., 2020). Inter-professional teamwork in ICUs is based on the shared patient responsibility (Kvande, et al., 2017) and ethical standards (The Finnish Society of Intensive Care, 2019).

CCNs implement various activities and interventions in their daily practice including for example monitoring and assessment, respiratory care, support of various physiological functions, basic nursing care, infusion and transfusion therapies, medication care, drainage tube care, psychological support as well as support and care of relatives (Miranda et al., 2003; Yamase, 2003; Padilha et al., 2008; Stafseth et al.,2011; Stafseth et al., 2018). Some of the nursing interventions are autonomous in nature, such as basic nursing care whereas others are directed by a physician which is the case for example in medication administration (Pyykkö et al., 2001).

CCNs use most of their working time on direct patient care, clerical nursing duties and patient assessment (Kaya, et al., 2011). However, there are some differences in critical care nursing practices (Benbenishty et al., 2005; Stafseth, et al., 2018) and level of professional autonomy (Papathanassoglou, et al., 2012) between different countries, and therefore the role and duties of the CCNs have some variations internationally.

2.2.2 Skills in critical care nursing

Several skills in critical care nursing can be identified (World Health Organization, 2003; European federation of Critical Care Nursing associations, 2013). CCNs' apply various skills in their clinical practice such as decision making, care planning, communication, leadership skills (The Critical Care National Network Nurse Leads Forum (CC3N), 2015), as well as patient observation skills (Solberg et al., 2012; Hardenberg et al., 2019).

There is an on-going epistemological debate concerning the essence of the skill as a concept, and especially its relation to knowledge – whether skill is prior to knowledge or vice versa (Fridland, 2015; Pavese, 2016a; Bäckström & Gustafsson, 2017). Independent from the epistemological view, a skill and its associated knowledge base are closely intertwined (Humburg & van der Velden, 2015) as can be seen in the following definitions of skill: "the knowledge and ability that enables you to do something well" (Collins English Dictionary, 2020) and "the ability to use one's knowledge effectively and readily in execution or performance" (Merriam-Webster Dictionary, 2020). Skill can be seen as a disposition to know (Stanley & Williamson, 2017), thus skills can be defined as knowing how to (Pavese, 2016b), and furthermore, knowing when to, where to and whether to (Stanley & Williamson, 2017). Knowledge (Pavese, 2016a; Stanley & Williamson, 2017) and cognitive processes (Christensen et al., 2016) guide most skilled actions. Well-known Dreyfus model of skill acquisition (Dreyfus & Dreyfus, 1980; Dreyfus, 2004), that is widely adapted also in nursing (Benner, 1984; Benner, 2004), suggests that skilled expert performance is largely automatic and bases on intuitive decision-making. This standpoint has been challenged by proposing that cognitive control is always present in skilled actions, even in the apparently automatic ones (Christensen et al., 2016). Skilled actions always require applied and situation-specific knowledge (Stanley & Williamson, 2017).

Many skills in critical care nursing, as in nursing and health care in general, are cognitive in their nature, hence they combine skills and knowledge (Paakkonen, 2008; Pires, et al., 2017). Examples of these are decision-making (Scott et al.,2008; Lake & McInnes, 2012; Pires, et al., 2017; Knol & Keller, 2019), professional judgement (Lake & McInnes, 2012), clinical reasoning (Lake & McInnes, 2012), situation-awareness (Pires, et al., 2017; Knol & Keller, 2019), risk assessment (Knol & Keller, 2019), anticipation (Knol & Keller, 2019) and emergency care (Dankbaar, et al., 2016) skills, and also patient observation skills (Dankbaar, et al., 2016; Brannan et al., 2008), which are on the focus of this study. According to Benner (2004), observing and evaluating a patient's condition skilfully require CCNs to incorporate both techné and phronesis. Techné refers to the practice itself, like performing vital sign measurements, whereas phronesis refers to the practical reasoning, for example evaluating the significance of the measured parameters.

Distinguishing cognitive skills from the well-established concept of competence is not straightforward at the conceptual level. CCNs' skills constitute an essential domain of critical care nursing competence (Lakanmaa et al., 2012), and furthermore CCNs' skills represent their clinical competence (DeGrande et al., 2018). In addition to skills, competence comprehends the domains of knowledge, attitudes and values (c.f. Meretoja et al., 2004a; Cowan et al., 2008; Scott Tilley, 2008; Kajander-Unkuri, et al., 2014). However, in practice, competence is often difficult to evaluate (Pijl-Zieber et al., 2014; Franklin & Melville, 2015). Therefore, from the perspective of clinical relevance, there is an acknowledged need for evaluating context-specific skills instead of competence as a broad concept (Windsor et al., 2012; Garside & Nhemachena, 2013). Thus, this study focuses on CCNs' cognitive skills instead of competence. Cognitive skills in this study refers to the skills that require constant application of knowledge.

2.3 Patient observation in critical care nursing

In this study, the concept of patient observation comprises both patient assessment (The Australian College of Critical Care Nurses, 2002; West, 2006; European federation of Critical Care Nursing associations, 2013; Kvande et al., 2016) and continuous monitoring of the patient (Padilha et al., 2008; Ääri et al., 2008; Gill et al., 2014; Trinier et al., 2016; Poncette, et al., 2019). Patient assessment is defined as "the assessment of a person to determine health services and care needs" (CINAHL Subject Headings, 2020b). In the care of a critically ill patient, assessment focuses on "the systematic physical assessment of the patient for signs of disease or abnormality" i.e. physical examination (U.S. National Library of Medicine, 2020c). Whereas monitoring is, "the continuous measurement of a patient's physiological processes" (U.S. National Library of Medicine, 2020d). Hence, by including patient assessment and monitoring, patient observation in critical care nursing involves all activities that a CCN undertakes to collect and use the data about the clinical condition of a critically ill patient.

Constant and comprehensive patient observation is a fundamental element in critical care nursing (Gill et al., 2014; Marshall, et al., 2017), and one of the most important duties (Harrison & Nixon, 2002; Kaya, et al., 2011), responsibilities (Williams et al., 2006; European federation of Critical Care Nursing associations, 2007) and skills (Solberg et al., 2012; Hardenberg et al., 2019) of a CCN. A critically ill patient's condition may change and deteriorate rapidly (Yang, 2016; Word Federation of Critical Care Nurses, 2019) and therefore a CCN's role in detecting changes is paramount (Kelly et al., 2014a; Lavoie et al., 2014; Jones & Johnstone, 2017). Hence, patient observation is an essential nursing activity in ensuring patient safety (Eltaybani et al., 2018; Milhomme et al., 2018) as well as promoting patients' perception of feeling safe (Wassenaar et al., 2014). Furthermore, CCNs' vigilant observation prevents complications (Milhomme et al., 2018; Jones & Johnstone, 2017), thus it is connected with the quality of care. Adequate patient observation is connected with favourable patient outcome (West, et al., 2014), and careful observation may contribute to lowering mortality of critically ill patients (Kelly et al., 2014a).

Clinical decisions in critical care nursing are influenced by many factors such as availability of resources and patient preferences, but also very much by the observed findings regarding a patient's clinical condition (Lauri, et al., 1998; Papathanassoglou, et al., 2005; Ramezani-Badr et al., 2009; Karra et al., 2014; Tingsvik et al., 2014). CCNs' observations also serve the inter-professional decision-making as CCNs bring forth their perceptions about a patient's condition (Manias & Street, 2001; Lundgrén-Laine, et al., 2011; Kvande et al., 2017). Observed information is also used as a basis for decisions in daily management in ICUs (Lundgrén-Laine, et al., 2011).

CCNs observe several physiologic areas regarding their patient's clinical condition such as cardiovascular and respiratory functions (Table 1). Furthermore, observation extends to pain assessment (Hoffman et al., 2009; Elliot & Coventry, 2012; American association of Critical Care Nurses, 2018), assessing sedation level (Aitken et al., 2009), observing psychological status (Frazier, et al., 2002; Moser, et al., 2003), delirium assessment (Gélinas, et al., 2018), evaluating the quality of a patient's sleep (Ritmala-Castrén, et al., 2016) and socio-emotional assessment (Gill et al., 2014). In this study, CCNs' patient observation is focused to the assessment and monitoring of the physiologic areas of the clinical condition due to its fundamental role in the care of a critically ill patient.

Table 1. Physiologic areas of critical care nurses' patient observation.

Physiologic areas of observation	References
Cardiovascular functions	Kleinpell, 2003; Yamase, 2003; West, 2006; Papathanassoglou, et al., 2005; Hoffman et al., 2009; Doig et al., 2011; European federation of Critical Care Nursing associations, 2013
Respiratory functions	Kleinpell, 2003; West, 2006; Hoffman et al., 2009; European federation of Critical Care Nursing associations, 2013; Kydonaki et al., 2016; Wax & Christian, 2020
Neurological functions	Kleinpell, 2003; Yamase, 2003; Elliot & Coventry, 2012; European federation of Critical Care Nursing associations, 2013; Hutri, 2019
Renal functions	Kleinpell, 2003; Elliot & Coventry, 2012; European federation of Critical Care Nursing associations, 2013
Gastrointestinal functions	Kleinpell, 2003; Hoffman et al., 2009; European federation of Critical Care Nursing associations, 2013
Metabolic functions	European federation of Critical Care Nursing associations, 2013; The Critical Care National Network Nurse Leads Forum (CC3N), 2015
Coagulation functions	Kleinpell, 2003; European federation of Critical Care Nursing associations, 2013; The Critical Care National Network Nurse Leads Forum (CC3N), 2015

2.4 Summary of the definition of the concepts

The main concepts used in the study were defined from the various perspectives in this section. The definitions of the concepts are summarized in the table (Table 2).

Table 2. Summary of the definitions of the concepts.

Concept	Definition
Critically ill patient	A critically ill patient suffers from life threatening condition, and is in the risk of developing severe defects in vital functions (European federation of Critical Care Nursing associations, 2004; U.S. National Library of Medicine, 2020a). Critically ill patients are taken care of in the intensive care units. Critically ill patients are highly dependent on others, and usually require one nurses' workload constantly (Ala-Kokko & Pettilä, 2018; Word Federation of Critical Care Nurses., 2019).
Critical care nursing	Critical care nursing is a nursing specialty focusing on the care of critically ill patients (CINAHL Subject Headings, 2020a). Critical care nurses provide constant monitoring, assessment and care for their patients in intensive care units working in a close collaboration with their colleagues and other professionals (Lakanmaa et al., 2015; Stafseth et al., 2018). Critical care nurses use their cognitive skills in their daily practice (Benner, 2004; Lakanmaa et al., 2012).
Patient observation in critical care nursing	Patient observation in critical care nursing involves constant monitoring and assessment, thus all activities that a critical care nurse takes to collect and use the data about the clinical condition of a critically ill patient (European federation of Critical Care Nursing associations, 2013). In this study, patient observation is limited to physiological functions.

3 Review of the literature

The literature review presented in this section updates and extends earlier reviews, which were conducted to provide background for both study phases and all four original publications. The purpose of the literature review is to describe patient observation skills in critical care nursing and to examine evaluation of CCNs' patient observation skills in previous studies. The literature review aims at answering the following questions:

1. What are the patient observation skills in critical care nursing?
2. How CCNs' patient observation skills have been evaluated?
   a. What is the focus of evaluation?
   b. What is the level of CCNs' patient observation skills?
   c. Which factors are associated with CCNs' patient observation skills?

3.1 Literature search

Literature search using CINAHL, Cochrane Library, Embase, Pubmed/Medline and Scopus databases was conducted in August 2020. The same literature search was used to provide answers to both research questions. However, in the inclusion phase of the search process, the articles were grouped and reviewed according to the research questions (Figure 1). The search was not limited to any time period in order to gain as inclusive insight as possible into previous studies. Searches were limited to the English and Finnish languages. Relevant subject headings/keywords were used in the databases where applicable (CINAHL, Embase and Pubmed/Medline). Searches were supplemented by screening reference lists of the selected articles and critical care nursing journals. The search terms were applied to titles and abstracts, and Boolean operators AND and OR were used (Table 3).

Table 3. Databases and search terms used in the literature search.

Database	Search terms
CINAHL	((MH "Critical Care Nursing+") OR (MH "Intensive Care Units+") OR (MH "Critical Illness")) OR AB "critical care nurs*" OR AB "intensive care nurs*") AND ((MH "Patient Assessment+") OR (MH "Nursing Assessment") OR (MH "Physical Examination+") OR (MH "Monitoring, Physiologic+")) OR AB ((observ* OR assess* OR evaluat* OR examin* OR monitor* OR surveil*)) AND ((MH "Clinical Competence+") OR (MH "Nursing Skills")) OR AB ((skill* OR competenc*))
Cochrane Library	"critical care nursing" OR "intensive care nursing" in Title Abstract Keyword AND observ* OR monitor* OR assess* OR evaluat* OR examin* OR surveil* in Title Abstract Keyword AND skill* OR competenc* in Title Abstract Keyword
Embase	('critical care nurs*' OR 'intensive care nurs*' OR 'intensive care nursing'/exp) AND (observ* OR monitor* OR assess* OR evaluat* OR examin* OR surveil* OR 'monitoring'/exp OR 'assessment'/exp OR 'surveillance and monitoring'/exp) AND (skill* OR competenc* OR 'skill'/exp OR 'competence'/exp)
PubMed (Medline)	(critical care* OR intensive care* OR "Critical Care"[Mesh] OR "Critical Care Nursing"[Mesh] OR "Intensive Care Units"[Mesh] OR "Critical Illness"[Mesh]) AND (nurs*) AND (observ* OR assess* OR evaluat* OR examin* OR monitor* OR surveil* OR "Nursing Assessment"[Mesh]OR "Physical Examination"[Mesh] OR "Monitoring, Physiologic"[Mesh]) AND (skill* OR "Clinical Competence"[Mesh])
Scopus	TITLE-ABS-KEY ("intensive care nurs*" OR "critical care nurs*") AND (observ* OR assess* OR evaluat* OR examin* OR monitor* OR surveil*) AND (skill* OR competenc*)

Altogether 27 articles were included for the review (Figure 1). All articles (n=27) provided answers to the first research question by describing some areas of CCNs' patient observation skills. Whereas, 14 of the included articles also answered to the second research question by reporting skills evaluation. The included articles (n=27) describing and/or evaluating CCNs' patient observation skills are presented in the table (Appendix 1). Majority of the included studies (n=15) originate from either Australia or United States. There are also studies from Nordic countries (n=6) and single studies from other European and Middle Eastern countries (Figure 2).

Additionally, manual search was conducted to identify articles, which evaluate patient observation skills as part of general competence. This search yielded 10 articles to supplement the review.

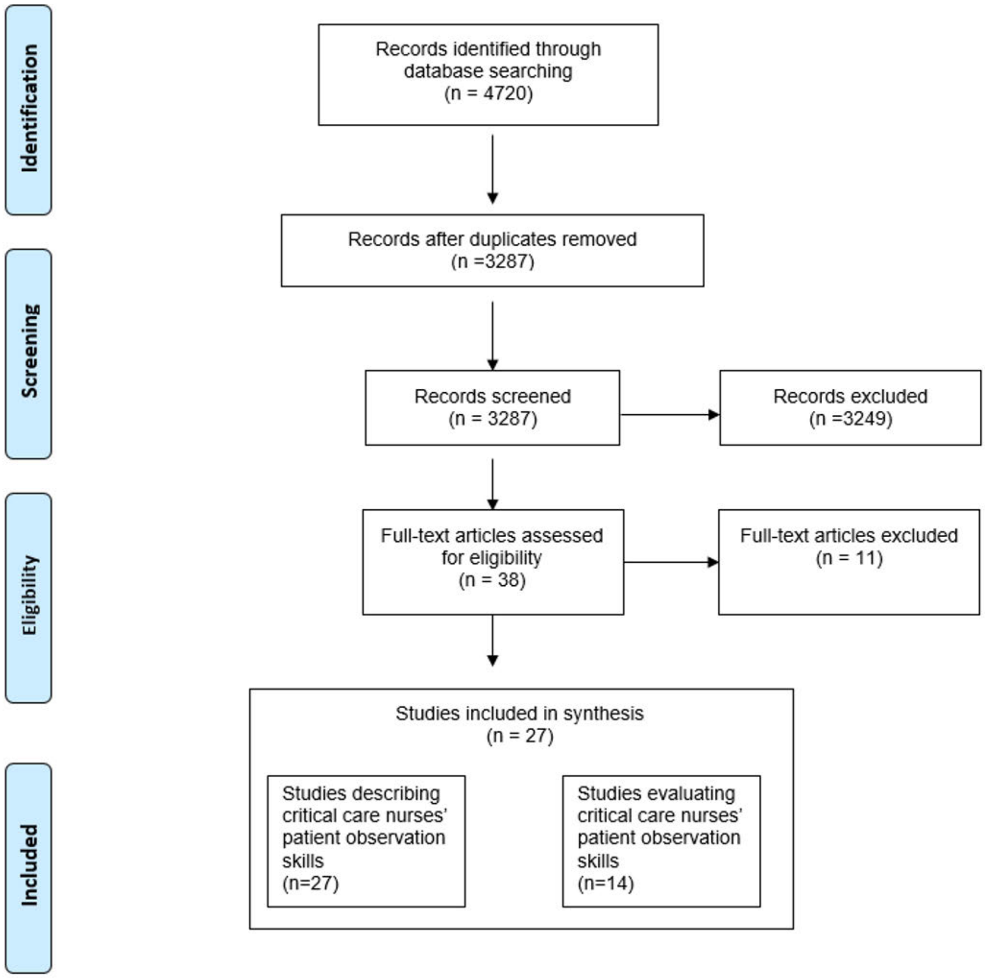

Figure 1. Literature search process. Modified from http://www.prisma-statement.org/. All included articles (n=27) described patient observation skills, and 14 of them reported also the results of skills evaluation.

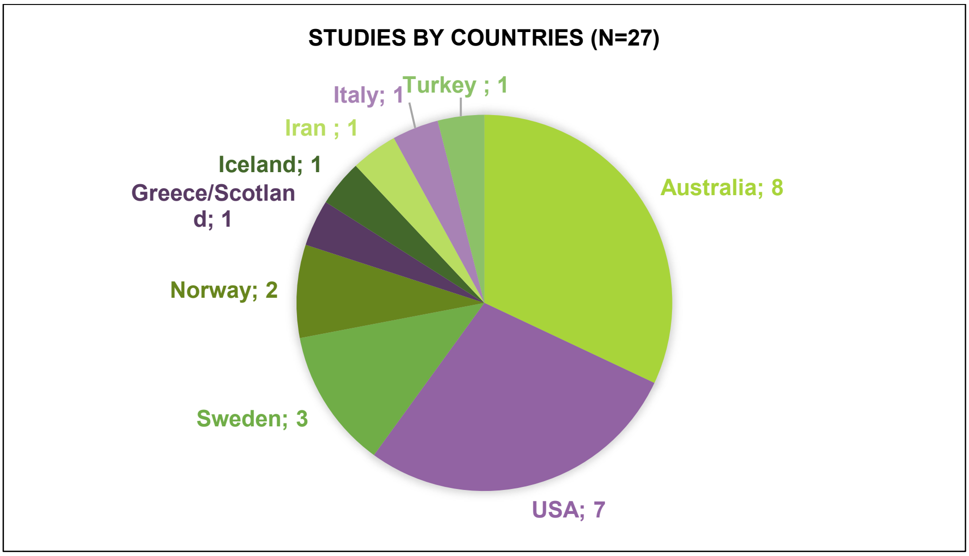

Figure 2. Previous studies by countries.

3.2 Critical care nurses' patient observation skills

Based on the literature search, there are studies (n=27) describing some aspects of patient observation skills, but no studies explicitly and comprehensively defining or describing CCNs' skills in observing a patient's clinical condition. The following skills domains can be identified in the previous literature: skills in using observation methods, skills in processing observed information, and decision-making skills in observation (Figure 3).

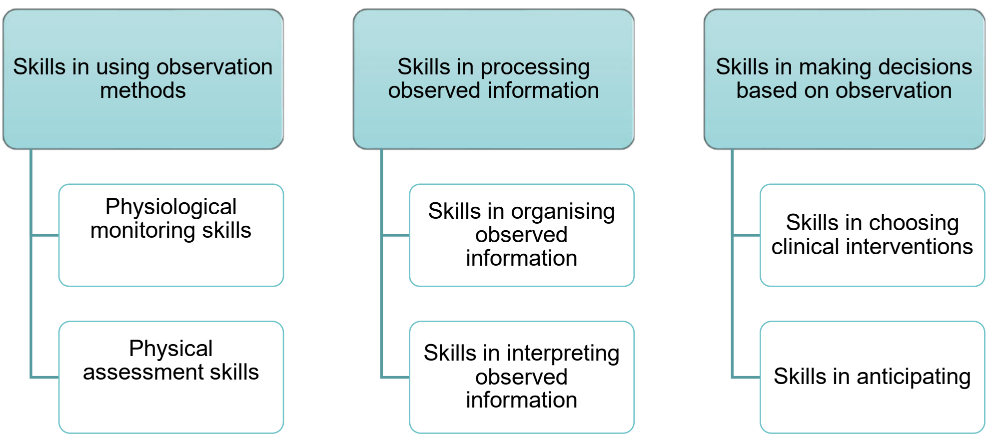

Figure 3. Domains of patient observation skills in previous literature.

3.2.1 Skills in using observation methods

When observing the clinical condition of a critically ill patient, CCNs apply their skills in both physiological monitoring and physical assessment. Skills in physiological monitoring involves identifying relevant parameters to monitor (Aitken, 2000), and monitoring vital signs (Coombs & Moorse, 2002; Sharafi et al., 2020) and more advanced parameters related to haemodynamic (Aitken, 2000; Currey & Botti, 2006) and respiratory functions (Attin, et al., 2002; Giuliano & Liu, 2006; Tingsvik et al., 2014; Kydonaki et al., 2016). Furthermore, physiological monitoring requires skills for measuring, for example intra-abdominal pressure ((Christensen & Barnes, 2012; Hunt et al., 2017) and temperature (Coombs & Moorse, 2002) as well as carrying out laboratory test such as blood gas analysis (Tingsvik et al., 2014; Kydonaki, et al., 2016). In order to monitor a patient's clinical condition, CCNs use their skills in monitoring technology (McGhee & Woods, 2001; Sowan, et al., 2017) for example to solve technical problems (Freysdóttir et al., 2019) and to customise monitor alarms appropriately (Ruppel, et al., 2019),

Physical assessment skills involve use of one's own senses in observation (Tunlind et al., 2015; Cicolini, et al., 2015) and identifying the physiological areas to assess such as work of breathing (Cicolini, et al., 2015; Kydonaki et al., 2016), abdominal status (Cicolini, et al., 2015; Hunt et al., 2017), pupil diameter (Kerr, et al., 2016) and level of consciousness (Kydonaki et al., 2016). CCNs should not rely only on monitoring technology in patient observation, but they should also be able to apply physical assessment such as inspection, palpation, auscultation and percussion (Coombs & Moorse, 2002) to collect information about a patient's clinical condition (Tunlind et al., 2015). Physical assessment skills entails also the use of scoring systems like the Glasgow Coma Scale for assessment of impairment of conscious level (Kebapçı et al., 2020).

3.2.2 Skills in processing information

CCNs use their skills for processing all the information they have collected in observation. Skills in processing information consist of skills in organising observed information and skills in interpreting observed information. Regarding organising information, CCNs compare information from different parameters (Aitken, 2000; Currey & Botti, 2006) and for example from the results of X-ray images in terms of atelectasis and pleural fluid (Haugdahl & Storli, 2012). Furthermore, they organise information by grouping various findings (Aitken, 2000; Hoffman et al., 2009; Kvande et al., 2015; Kydonaki et al., 2016), which enables them to get an overall view of a patient's condition (Kvande et al., 2015; Tunlind et al., 2015).

Skills of interpreting observed findings are an integral element of processing information. CCNs interpret monitored parameters overall (Freysdóttir et al., 2019) and more specifically for example electrocardiograms (Preston et al., 2015; Currey et al., 2018), pulmonary artery catheter parameters (Aitken, 2000; Currey & Botti, 2006) and arterial blood-pressure waveforms (McGhee & Woods, 2001; Christensen & Barnes, 2012). Skills of interpreting observed findings extend to looking for causes of manifestations or symptoms such as dyspnoea (Haugdahl & Storli, 2012) and relating observed findings to therapeutic interventions such as haemodynamic observations to vasoactive drug effects (Häggström et al., 2017). Furthermore, CCNs apply their skills in forming hypotheses (Aitken, 2003) and diagnoses (Aitken, 2000; Reischman & Yarandi, 2002; Buchanan Keller & Raines, 2005) based on the observed information. They evaluate these hypotheses constantly, and use them as a basis for their decision-making (Aitken, 2003).

3.2.3 Skills in making decisions

Decision-making skills constitute a dimension of patient observation skills. Decision-making skills in patient observation consist of skills in choosing clinical interventions and skills in anticipating changes in clinical condition. As for choosing clinical interventions, CCNs make several decision in their daily practice while observing their patients' haemodynamic status and choosing appropriate treatment options for example in case of hypovolemia, hypotension or hypertension (Aitken, 2000; Aitken, 2003). Managing vasoactive drugs is a very typical CCNs' duty requiring them to evaluate drug effects and haemodynamic response constantly, and furthermore making rapid decisions on adjusting drug administration (Häggström et al., 2017). Weaning a patient from mechanical ventilation is another typical situation where CCNs make decisions on correct interventions and determine whether the patient can be weaned or not (Tingsvik et al., 2014; Kydonaki et al., 2016).

CCNs anticipate changes in clinical condition based on observation (Currey & Botti, 2006). They form a schema of a patient's condition (Kvande et al., 2015) and create possible clinical trajectories (Currey et al., 2018). This enables CCNs to prepare in advance for deteriorating clinical condition (Currey et al., 2018) and they can proactively consider different action plans (Hoffman et al., 2009).

3.3 Evaluation of critical care nurses' patient observation skills

The previous evidence concerning the evaluation of CCNs' patient observation skills is presented in this section according to the three sub-questions (see p. 23): *1.What is the focus of evaluation? 2. What is the level of CCNs' patient observation skills? 3. Which factors are associated with CCNs' patient observation skills?*

3.3.1 The focus of skills evaluation

CCNs' patient observation skills have been evaluated previously using objective tests, self-assessment and direct observation. The studies have been focusing on different areas of observation: use of physiological monitors (Sowan, et al., 2017; Freysdóttir et al., 2019) such as pulse oximetry (Attin, et al., 2002; Giuliano & Liu, 2006), intra-arterial blood pressure monitoring (McGhee & Woods, 2001; Christensen & Barnes, 2012), atrial electrogram (Preston et al., 2015) and intra-abdominal pressure measurement (Hunt et al., 2017), physical assessment techniques (Cicolini, et al., 2015) including the use of the Glasgow Coma Scale (Kebapçı et al., 2020) and pupil assessment (Kerr, et al., 2016), and furthermore, diagnostic cue utilization (Reischman & Yarandi, 2002) and observation related to decision-making (Currey & Botti, 2006; Hoffman et al., 2009).

Studies evaluating CCNs' patient observation skills could not be grouped according to skill domains presented in the previous section (3.2), because the studies focused mainly on some physiological or technical areas of observation, and therefore, skills in using observation methods, skills in processing observed information, and decision-making skills in observation could not be extracted.

Furthermore, patient observation skills have been evaluated in previous studies focusing on CCNs competence or knowledge in general. Nurse Competence Scale (NCS) (Meretoja et al., 2004a), The Intensive and Critical Care Nursing Competence Scale (ICCN-CS-1) (Lakanmaa, et al., 2013a), The Critical Care Nursing Competence Questionnaire for Patient Safety (C3Q-safety) (Okumura et al., 2019) and a questionnaire measuring ICU nurses' core competencies (Wei et al., 2018) are self-assessment instruments used in the studies evaluating CCNs' competence (Meretoja et al., 2004b; O'Leary, 2012; Lakanmaa et al., 2015; Wei et al., 2018; Okumura et al., 2019). Whereas, The Basic Knowledge Assessment Tool (BKAT) (Toth, 2003) and The Intensive Care Hundred Item Test (I-HIT) (Boyle et al., 1995) are knowledge tests used in studies measuring CCNs' basic knowledge (Toth, 2003; Fulbrook et al., 2012; Lakanmaa et al., 2015). All the aforementioned instruments include some items related to patient observation. However, patient observation skills do not form an independent dimension in these instruments and are not comprehensively evaluated, and furthermore, are not explicitly reported in the studies.

3.3.2 The level of patient observation skills

Previous studies have shown variation in the level of CCNs' patient observation skills. CCNs' results in objective tests in terms of the mean percentage of correct answers have ranged from less than 20% up to 87% (Table 4). CCNs' self-assessments have also shown some variation as CCNs have assessed their skills adequate in monitoring intra-arterial blood pressure (McGhee & Woods, 2001) and suboptimal in physical assessment techniques (Cicolini, et al., 2015) and use of physiological monitors (Sowan, et al., 2017). A study combining objective test and self-assessment revealed that there was no correlation between the objective test results (Mean percentage of correct answers 36.7%) and self-assessed skills (adequate) in intra-arterial blood pressure monitoring (McGhee & Woods, 2001). Studies using direct observation suggest that, in general CCNs' patient observation skills were adequate in terms of collecting information about a patient's condition, but expert nurses could collect and utilise information more effectively (Currey & Botti, 2006; Hoffman et al., 2009). CCNs' skills in the reliable use of physiological monitors (Freysdóttir et al., 2019) and Glasgow Coma Scale (Kebapçı et al., 2020) may be inadequate according to direct observations.

Many studies revealed CCNs lack skills in patient observation. Patient observation skills may be inadequate due to limited understanding of either physiological (McGhee & Woods, 2001) or technical (Christensen & Barnes, 2012) principles of observation. Inadequate skills may compromise the reliability of observation and lead to the incorrect clinical decisions and eventually to the unfavourable outcomes of care (Attin, et al., 2002; Currey & Botti, 2006).

Table 4. Critical care nurses' observation skills in objective tests.

Authors, year, country	Observation area	Measurement Sample size (n)	The level of CCNs' patient observation skills: % of correct	Factors associated with critical care nurses' patient observation skills
McGhee & Woods, 2001, USA	Intra-arterial blood pressure monitoring	A knowledge test (n=68)	Mean 36.7% (SD, 11.8%)	Not investigated
Attin, et al., 2002, USA	Use of pulse oximetry	A knowledge test before and after an educational intervention (n=331)	Mean 64% before intervention and 82% after intervention (p=< 0.01)	Not investigated
Reischman & Yarandi, 2002, USA	Diagnostic cue utilisation	Written simulated scenarios test (n=46)	Mean 47% (SD, not reported)	Experience in critical care nursing promotes skills
Giuliano & Liu, 2006, Usa	Use of pulse oximetry	A knowledge test (n=551)	Ranging from 63% to 87% (mean not reported)	Not investigated
Christensen & Barnes, 2012, Australia	Intra-arterial blood pressure monitoring	A knowledge test (n=20)	Mean 35.5% (SD, not reported)	No differences in skills between the different levels of CCNs (Band 6 & Band 7).
Preston, Currey, & Considine, 2015, Australia	Atrial electrogram interpretation	A case study test before and after an educational intervention (n=29)	Mean 64% before intervention and 88% after intervention (p= < 0.01)	CCNs with university level critical care qualification and who worked in a larger hospital had better skills
Kerr, et al., 2016, USA	Pupil assessment (detecting unequal pupils)	Skills tests (n=27/30 + 489 assessments)	Mean 33% of the picture and 58% of the patients (SD not reported).	Not investigated
Hunt, Frost, Newton, Salamonson, & Davidson, 2017, Australia	Intra-abdominal pressure measurement	A knowledge test (n=86)	Most CCNs identified obvious causes of intra-abdominal hypertension whereas less than 20% identified less obvious causes	No correlation between the skills and the years of experience or level of professional qualification

3.3.3 The factors associated with patient observation skills

The factors associated with CCNs' patient observation skills were investigated in nine out of fourteen studies evaluating skills (Appendix 1). Expertise in critical care nursing acquired by clinical working experience was most commonly identified as a factor promoting patient observation skills (Reischman & Yarandi, 2002; Currey & Botti, 2006; Hoffman et al., 2009; Freysdóttir et al., 2019). In comparison to their less experienced colleagues, experienced CCNs had better skills in detecting instability in a patient's condition (Currey & Botti, 2006) diagnosing accurately (Reischman & Yarandi, 2002), utilising observed information as a basis for nursing decisions (Freysdóttir et al., 2019) and making proactive decision based on observation (Hoffman et al., 2009). However, some studies did not identify association between skills and working experience (Christensen & Barnes, 2012; Hunt et al., 2017; Sowan, et al., 2017).

A higher educational level was identified as a factor promoting CCNs' patient observation skills by Cicolini et al. (2015) and Preston et al. (2015), while Hunt et al. (2017) did not identify this association. Moreover, according to Preston et al. (2015) CCNs who worked in larger hospitals had better skills compared to their colleagues in smaller hospitals.

3.4 Summary of the literature review

The evidence concerning CCNs' patient observation skills is rather scattered as studies are mainly focusing on observation of an individual physiological area (cf. Tingsvik et al., 2014; Hunt et al., 2017) or even some more specific areas of observation (cf. Sowan, et al., 2017; Ruppel, et al., 2019). Therefore, they do not provide a cohesive and comprehensive description or definition of the patient observation skills.

Patient observation skills are considered as cognitive skills in the context of this study, which can be verified by the previous evidence. Cognitive dimension involving application, analysing and evaluating knowledge, is evidently an integral element of patient observation skills (Cicolini, et al., 2015; Currey et al., 2018; Freysdóttir et al., 2019).

Overall, the level of CCNs' patient observation skills seems to be suboptimal. Previous studies revealed especially low scores in objective tests. The time range of the studies covers two decades (from 2001 to 2020), but the level of CCNs' skills has not increased. However, it is important to acknowledge that the evidence is scattered as studies have focused on different areas of observation. The role of different factors in promoting CCNs' patient observation skills remains somewhat unclear as the previous studies provide contradictory evidence.

This literature review did not include quality appraisal due to its descriptive nature (Whittemore & Knafl, 2005; Hopia et al., 2016). However, some limitations in the previous studies describing and evaluating CCNs' patient observation skills can be detected. First, most of the studies (n=15, 60%) originate from either Australia or United States (Figure 2). There are only two European studies evaluating CCNs' patient observation skills – one from Iceland and another one from Italy. All studies using objective tests in skills evaluation are from Australia or United States. Therefore, the findings may not represent the Finnish or European context very well even though critical care, especially in terms of patient observation, builds on the same principles globally (Lakanmaa et al., 2012; Thompson et al., 2018). Second, sample sizes are relatively small in most studies evaluating patient observation skills, which limits the generalizability of the results. Third, only one study used both objective test and subjective self-assessment in evaluating CCNs' patient observation skills, thus the results may be affected by the bias related to use of objective tests (Tanner, 2011) and self-assessment (Ballangrud et al., 2014; Lakanmaa et al., 2015; Kajander-Unkuri, et al., 2016; Williams & Parry, 2018).

To summarize, there is a need to comprehensively describe CCNs' patient observation skills, and their patient observation skills requires further evaluation using both objective and subjective assessment. Furthermore, evidence concerning the factors associated with CCNs' patient observation skills is needed (Figure 4).

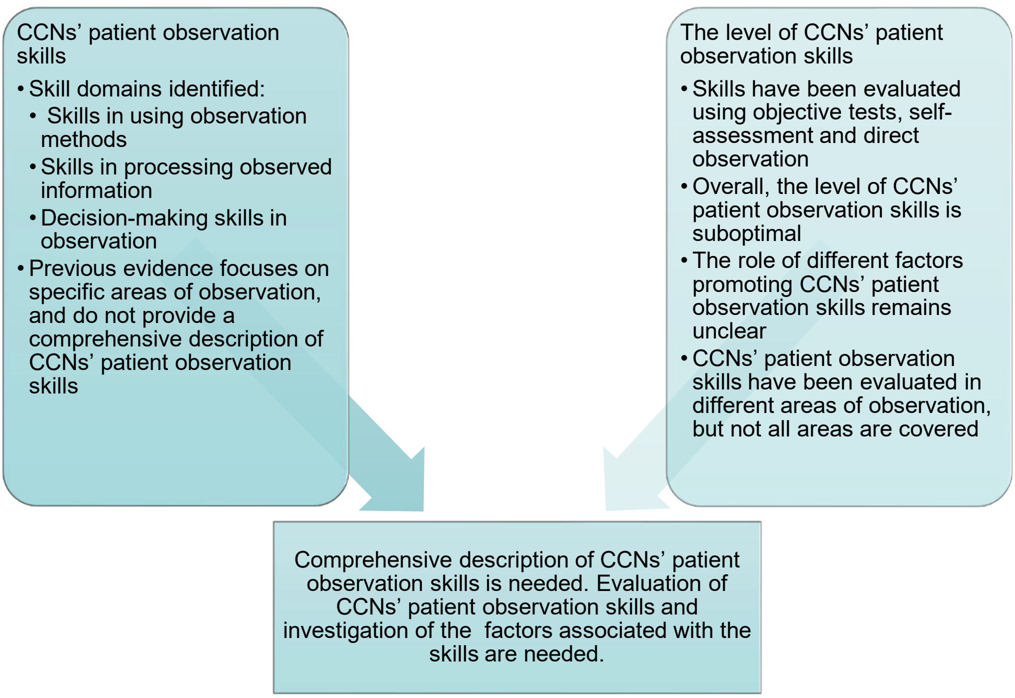

Figure 4. Summary of the previous literature.

4 Purpose, aim and research questions

Previous literature did not provide a comprehensive description of patient observation skills in critical care nursing, and evidence concerning the skill level is scattered. Therefore, the purpose of this two-phase study (Figure 5) was first, to describe and create a theoretical construction of patient observation skills in critical care nursing and second, to evaluate Finnish CCNs' level of patient observation skills using subjective and objective assessment and investigate the factors associated with the skills. The aim was to deepen the understanding of CCNs' skills, and ultimately to develop their skills to enhance quality of care and patient safety in ICU. As defined in the chapter 2.2.2, patient observation skills are considered as cognitive skills thus including knowledge.

The research questions were:

Phase I: Description of patient observation skills in critical care nursing

1. What are the patient observation skills in critical care nursing? (Paper I)

Phase II: Evaluation of CCNs' patient observation skills

2. What is the self-assessed level of CCNs' patient observation skills? (Paper II)
3. What level of knowledge do CCNs have of patient observation? (Paper III)
4. What are the factors associated with the level of CCNs' patient observation skills? (Papers II & III)
5. What is the association between subjective and objective assessment of CCNs' patient observation skills? (Paper IV)

Furthermore, as a summary of the findings, the theoretical construction of patient observation skills in critical care nursing will be presented.

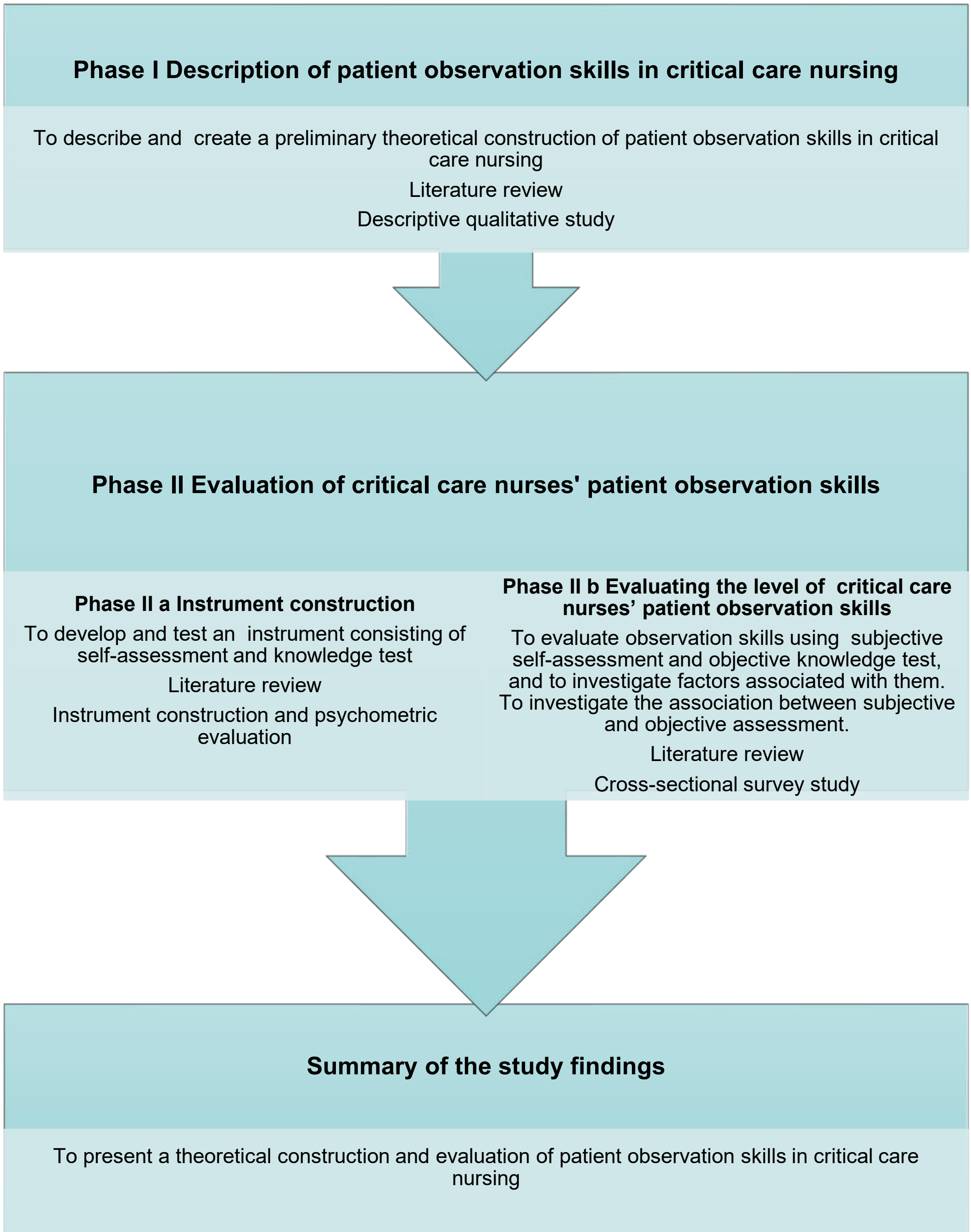

Figure 5. Phases and purposes of the study

5 Materials and Methods

Study designs, samples, data collection and analysis methods used to describe and evaluate CCNs' patient observation skills are described in this section (Table 5). In addition, ethical consideration are discussed.

Table 5. Overview of the designs, materials and methods used across the study

Phase	Paper	Design	Sample	Instruments (data collection)	Data analysis
I Description 2014–2015	I	Descriptive qualitative study	Experienced CCNs n=20 (a purposive sample of CCNs in three ICUs)	Semi-structured interview guide	Thematic analysis
II Evaluation					
IIa 2015–2019	II & III	Instrument construction and psychometric testing	Critical care nursing experts n=11 (expert panel) CCNs n= 46 (pre-test, a convenience sample of CCNs in two ICUs) CCNs n=372 (a total sample of CCNs in general ICUs in Finnish university hospitals)	The Patient Observation Skills in Critical Care Nursing (POS-CCN): self-assessment and knowledge test	Content validity, Descriptive statistics, Cronbach's alpha statistics, Item analysis, Exploratory factor analysis
IIb 2017–2019	II,III, IV	Cross-sectional correlational study	CCNs n=372 (a total sample of CCNs working in general ICUs in Finnish university hospitals)	The Patient Observation Skills in Critical Care Nursing (POS-CCN): self-assessment and knowledge test	Descriptive statistics, Independent samples T-test, Mann-Whitney U-test, One-way analysis of variance, Kruskall-Wallis test, Pearson's and Spearman's correlations, General linear model
Summary of the study findings 2020–2021	Summary		Findings of the previous study phases		

5.1 Methodological approach and design

This study was conducted in two phases between 2014 and 2019 (Table 5). During conceptualizing and planning of the study, previous literature was investigated, and no studies explicitly and comprehensively defined or evaluated CCNs' patient observation skills. Therefore, the first study phase was carried out to describe patient observation skills in critical care nursing, and to serve as a foundation for the second study phase.

The **first study phase** (Paper I) utilised descriptive qualitative method and used experienced CCNs as informants. Patient observation skills in critical care nursing were poorly described in the previous studies, and there were no pre-defined theoretical framework guiding this study phase. Therefore, a descriptive qualitative method was suitable for the study's purposes. Furthermore, qualitative descriptive method allowed staying close to CCNs' descriptions of patient observation skills and provided relevant information for instrument construction. (Sandelowski, 2010; Doyle et al., 2020.)

The **second study phase** (Papers II, III & IV) began with instrument construction (Phase IIa) including item construction, evaluating content validity, pre-test and psychometric testing (DeVellis, 2017). The instrument was used to evaluate CCNs' patient observation skills (Phase IIb) in cross-sectional correlational design (Hasson et al., 2015).

5.2 Settings and participants

In the **first study phase** (Paper I), the data were collected in three level III (Marshall, et al., 2017) adult mixed ICUs in two university hospitals in Finland between May and October 2014. Purposive sampling was used (Doyle et al., 2020) to recruit experienced CCNs (n=20) in the study. Experienced CCN was defined as a RN who has at least five years' working experience in critical care nursing and works daily in clinical patient care in an ICU (Benner, 1984). Experienced CCNs were presumed to have comprehensive understanding about the patient observation, and therefore were considered as key informants in describing skills in patient observation (Holloway & Galvin, 2017).

In the **second study phase** (Papers II, III & IV), the instrument for evaluating CCNs' patient observation skills was constructed and tested (phase IIa). The instrument's content validity was evaluated using an expert panel (DeVon, et al., 2007) between September and November 2015. Purposive sampling was used to recruit experts (n=11), who represented clinical practice (n=5), research (n=5) and nurse education (n=1) in critical care nursing. Instrument's pre-test used convenience sampling (Polit & Beck, 2017) among CCNs (N=100) in two ICUs in a university hospital in February and March 2016. The ICUs were specialized units, and CCNs from these units were not included in the sample of the following evaluation phase (phase IIb). Altogether, 46 CCNs participated in the pre-test (response activity 46%). The instrument was used to evaluate patient observation skills (IIb) among Finnish CCNs, and its psychometric properties were evaluated in a cross-sectional survey between September 2017 and January 2018). Total sampling was used and all CCNs (N=767) working in adult mixed ICUs (n=7) in all five Finnish university hospitals were invited to participate. The total amount of CCNs was estimated based on the feedback from the ward managers. Furthermore, the rule of thumb of having at least five respondents per item in order to conduct an exploratory factor analysis (EFA) was taken into consideration in the sampling (at least 280 respondents) (Rattray & Jones, 2007). Altogether, 372 CCNs participated (response activity 49%).

5.3 Instruments

In the **first study phase**, an interview guideline was designed, and it contained three questions asking CCNs: 1. To describe patient observation in their clinical practice, 2. To describe the skills required in patient observation, and 3. To give examples of patient observation and required skills in their daily practice. Although, the guideline provided a structure for the interviews, the interviews were flexible and allowed CCNs to express their individual thoughts and perceptions (Kallio et al., 2016).

In the **second study phase**, a new instrument, Patient Observation Skills in Critical Care Nursing (POS-CCN) was developed for the study to evaluate CCNs' patient observation skills. Evaluation of CCNs' patient observation skills included both subjective and objective assessment (Moore Jr, 2018), thus the instrument consisted of self-assessment and a knowledge test (Tanner, 2011; Humburg & van der Velden, 2015). The use of subjective and objective assessment enabled comprehensive evaluation of CCNs' skills levels. The decision to use knowledge test in skills evaluation is justified by defining patient observation skills as cognitive skills (section 2.2.2).

The instrument construction began with item construction, which included creating a theoretical structure for the instrument and writing preliminary items. The theoretical structure was based on the findings of the descriptive qualitative study conducted in the first study phase (section 6.1, Paper I). According to the findings, patient observation skills consist of four skill domains: *information gaining skills, information processing skills*, *decision-making skills* and *co-operation skills* (described further in the results section 6.1 and Paper I). However, the instrument focused only on the information gaining and processing skills. These two skill domains deal directly with the information about a patient's clinical condition, and build up the foundation for clinical decision-making. Information gaining and processing skills are tightly intertwined, and therefore limiting the evaluation within this study in these two skill domains was considered meaningful theoretically and clinically. Furthermore, this limitation enabled developing an instrument concise enough both from the theoretical and practical perspectives.

Thus, the instrument consisted of two main domains: A. Information gaining skills and B. Information processing skills. Furthermore, information gaining skills consisted of three sum-variables: A.1 Bio-physiological foundation of observation, A.2 Skills in using observation methods and A.3 Skills in recognizing the changing clinical condition. Information processing skills consisted of two sum-variables: B.1 Skills in evaluating the reliability of observation and B.2 Analytic thinking skills. Each sum-variable included items under seven physiological areas of observation: cardiovascular, respiratory, neurological, renal, gastrointestinal, metabolic and coagulation. The content of the items was based on the findings of the first phase supplemented with previous literature (Currey & Botti, 2006; Hoffman et al., 2009; Doig et al., 2011; Haugdahl & Storli, 2012; Solberg et al., 2012; European federation of Critical Care Nursing associations, 2013; Karra et al., 2014; Li, et al., 2014). Self-assessment was used to assess information gaining skills and knowledge test to assess information-processing skills (Table 6).

Table 6. The structure of the instrument.

Patient Observation Skills in Critical Care Nursing (POS-CCN)

	Information gaining skills: self-assessment, VAS 0-100, 56 items			**Information processing skills: knowledge test, maximum score and number of items is 20**	
Physiological areas of observation	Bio-physiological foundation of observation	Skills in using observation methods	Skills in recognising the changing clinical condition	Skills in evaluating the reliability of observation	Analytic thinking skills
	14 items:	28 items:	14 items:	11 items:	9 items:
Cardiovascular	2	4	2	3	2
Respiratory	2	4	2	2	1
Neurological	2	4	2	2	2
Renal	2	4	2	1	1
Gastrointestinal	2	4	2	1	1
Metabolic	2	4	2	1	1
Coagulation	2	4	2	1	1

Self-assessment items were written to elicit CCNs' perception of their skills in different dimensions of patient observation, and visual analogue scale (VAS) from zero to 100 was used in measurement (Waltz et al., 2016). VAS scores were classified into five even categories: poor (0–20), fair (>20–40), average (>40–60), good (>60–80) and excellent (>80–100). Examples of the self-assessment items are provided in the table (Table 7).

Knowledge test items (n=20) contained true/false-statements (n=14), multiple-choice questions (n=5) and one constructed response question (writing a single word as an answer, correct/incorrect). The items were formulated as either brief patient case descriptions or clinical statements. CCNs' had to apply their knowledge and critical thinking when answering the items, thus the knowledge test aimed at assessing cognitive skills (information processing skills) instead of only remembering the facts (Haladyna, 2004; McDonald, 2018). The items were dichotomous, thus correct answer produced one point and incorrect answer zero points. Examples of the knowledge test items are provided in table (Table 8).

The item writing provided a vast item pool that was critically scrutinized, and the number of the items was diminished from 92 to 63 in the self-assessment and from 49 to 20 in the knowledge test. This version's content validity was evaluated by the expert panel. Experts evaluated and rated items' relevance. Content Validity Index (CVI) was calculated for each item (I-CVI) and for the whole instrument (S-CVI). Seven items in the self-assessment part had lower I-CVI than the recommended 0.78, thus they were removed from the instrument. One of the knowledge test items had low I-CVI (0.64). However, the item was considered as theoretically relevant as it addressed the reliability of invasive pressure monitoring and was therefore retained in the instrument. According to experts' suggestions, some items were reworded for the clarity. As a result, POS-CCN contained 56 self-assessment items and 20 knowledge test items. S-CVI for the remaining self-assessment items was 0.96 and 0.93 for the knowledge test items, which represented good content validity (Polit et al., 2007).

POS-CCN instrument's clarity, applicability, item distribution and internal consistency (only for self-assessment) were evaluated in the pre-test. CCNs' (n=46) responded to the paper-and-pencil questionnaire and they had an opportunity to comment on the items and suggest improvements. The item distribution for the sum-variables were adequate and self-assessment sum-variables internal consistency was high (0.86-0.96). Some minor modification were made in the wording of the items based on the respondents' comments. One knowledge test item turned out to be very challenging to the respondents as very few of them (6%) answered correctly, which may have indicated ambiguity. Therefore, the item was modified to improve the clarity.

Demographic factors (age and gender) and background factors, which may potentially be related to the skills development were added to the questionnaire: working experience (length, experience in other ICUs and in other fields of nursing), continuing education, special duties, and independent information search (Meretoja, et al., 2004b; Lakanmaa, et al., 2015). An item measuring critical care nursing as a preferred field of nursing (VAS 0-100) and an item measuring CCNs' confidence in one's competence (VAS 0-100) were also added into background.

Table 7. Examples of the self-assessment items.

	Cardiovascular observation	
	A1. Bio-physiological foundation of observation	
	I am able to understand normal functions of the cardiovascular system	0 100
	I am able to understand the most common disorders of the cardiovascular system	0 100
	A2. Skills in using observation methods	
	I am able to monitor a patient's ECG	0 100
	I am able to observe a patient's hemodynamic status using invasive pressure measurements	0 100
	I am able to observe a patient's hemodynamic status using a pulmonary artery catheter	0 100
	I am able to observe a patient's peripheral circulation using my senses	0 100
	A3. Skills in recognizing the changing clinical condition	
	I am able to observe changes in a patient's cardiovascular system	0 100
	I am able to observe the effects of clinical interventions on a patient's cardiovascular status	0 100

The VAS line in the instrument was 10 cm. 0 = does not represent my skills at all, 100 = does represent my skills very well.

Table 8. Examples of the knowledge test items.

	Neurological observation	
	B1. Skills in evaluating the reliability of observation	
	Nursing activities have no effects on EEG recording if the EEG electrodes are appropriately fixed	a.True b.False
	Administration of atropine or opioids may affect the assessment of pupil diameter	a.True b.False
	B2. Analytic thinking skills	
	You are taking care of a patient who is in the ICU due to intracranial bleeding. Her intracranial pressure (ICP) is raised and therefore an intraparenchymal ICP monitoring system has been implanted. ICP is 20 mmHg, and according to an aim set by a physician, cerebral perfusion pressure (CPP) should be at least 60 mmHg. The aim can be reached if:	a. Mean arterial pressure is 60 mmHg b. Mean arterial pressure is 80 mmHg c. Mean arterial pressure is 60 mmHg and central venous pressure is 10 mmHg d. Mean arterial pressure is 40 mmHg
	You are taking care of a patient who is in the ICU due to subarachnoid haemorrhage (SAH). You test his motor response to supraorbital pressure every hour. Last time you tested the response, he bent his arms as a response. Now you can see extension in his arms. You may conclude that his condition in terms of motor response has improved.	a.True b.False

5.4 Data collection

In the **first study phase** (Paper I), data were collected among experienced CCNs (n=20) using semi-structured individual interviews (Holloway & Galvin, 2017). Ward managers informed experienced CCNs about the possibility to participate in the interviews. The interviews were audio-recorded and each interview was transcribed before the next interview session. This allowed constant evaluation of data saturation and adequacy, which was reached after 20 interviews (Vasileiou et al., 2018).

In the **second study phase** (Papers II, III & IV), data were collected using a survey questionnaire in the cross-sectional study. The questionnaire contained POS-CCN and background items, and it was delivered in paper-and-pencil format. Information sessions were organized in the ICUs and written information about the study was delivered to CCNs prior data collection. All CCNs working in the ICUs were eligible to participate, and the questionnaire was available for all of them (N=767).

5.5 Data analysis

The data of the **first study phase** (Paper I) were thematically analysed in six stages (Braun & Clarke, 2006 & 2014). First, the researcher familiarized himself with the data during the transcription and afterwards reading the interviews thoroughly. In the second analysis stage, CCNs expressions that were considered as meaningful related to the research question were coded. Third stage involved comparing codes and combining them to form potential themes. In the fourth stage, eight potential themes were compared with each other's and evaluated in relation to the codes they included and the whole data set. Based on the evaluation, potential themes were revised and combined to form four final themes and tentative thematic map was drawn. The themes were defined and named in the fifth stage, and finally, in the sixth stage the findings were reported and illustrated as a figure (Figure 1: Paper I).

The data of the **second study phase** (Papers II, III & IV) were analysed using IBM SPSS Statistics for Windows version 24 (IBM Corp., Armonk, NY). Descriptive and inferential statistical methods were used to analyse the data (Table 9). The sum variables were calculated from the cases that had at least 85% of items answered, and the data of the participants who answered only to background questions were excluded for the data set. The level of statistical significance was set at 0.05.

Table 9. Statistical methods used in the study phase II.

Purpose	Statistical test
To describe variables	Descriptive statistics: frequencies, percentages, means, medians, standard deviations, interquartile ranges
To evaluate internal consistency of POS-CCN (self- assessment) sum-variables	Cronbach's alpha and item analysis
To evaluate POS-CCN's (self-assessment) construct validity	Exploratory factor analysis (EFA) with the maximum likelihood extraction and oblique Promax rotation.
To analyse associations between the sum variables and categorical background factors	Independent samples t-test/Mann-Whitney U-test for comparing two groups One-way analysis of variance (ANOVA) with Tukey's method in post-hoc comparisons/the Kruskall–Wallis test for comparing multiple groups
To analyse association between continuous variables	Pearson's/Spearman's correlations
To identify the factors that are independently associated with the level of CCNs' patient observation skills	General linear model (factors significantly associated with patient observation skills in the univariate analysis were included)

5.6 Ethical considerations

Good scientific practices and research ethics were followed in all phases of the study (Finnish Advisory Board of Research Integrity, 2012; ALLEA - All European Academies, 2017; Finnish National Board on Research Integrity, 2019).

The aim was to deepen the understanding of CCNs' patient observation skills, and ultimately to develop their skills to enhance quality of care and patient safety in ICUs. From the ethical perspective, the topic and goal of the study are acceptable and justified, because there is a gap in knowledge that could potentially be used in improving clinical practice and patient care. Ensuring the high level of CCNs' patient observation skills may contribute to improved patient outcomes and safety (Kelly et al., 2014a; West, et al., 2014; Eltaybani et al., 2018; Milhomme et al., 2018).

In the **first study phase**, ethical approval was provided by the Ethics Committee for Human Sciences at the University of Turku (approval number 14/2014) and the research permissions were granted by the hospital districts. The CCNs who volunteered to participate were informed about the data collection and management, confidentiality and voluntariness, and they signed the informed consent form. The interviews took place in the ICUs in the separate rooms during the working shift of a CCN.

In the **second study phase**, ethical approval was provided by the Ethics Committee for Human Sciences at the University of Turku (approval number 37/2016) and the research permissions were granted by the hospital districts for the pre-test and survey study. The CCNs were informed about the study in brief information sessions and in information letters prior data collection. The cover letter of the questionnaire also contained information about data collection and management. Participation was voluntary for the CCNs. The questionnaires were returned in a closed envelope and placed in a covered box. No identifiable information (name or ID-number) was collected and it was not possible to match an individual CCN and a questionnaire. Returning the questionnaire was considered as consent to participate.

6 Results

The main results regarding the description and evaluation of CCNs' patient observation skills are summarized in this section according to research questions 1-4. The more detailed descriptions of the results are presented in the original publications I–IV.

6.1 Patient observation skills in critical care nursing

The CCNs (n=20) who participated in the first study phase (Paper I) had an average of 16 years' working experience in critical care nursing. Based on their descriptions, the preliminary theoretical construction of patient observation skills in critical care nursing was created and it consist of *information gaining skills*, *information-processing skills*, *decision-making skills* and *co-operation skills* (Figure 6). Patient observation was described as a process starting from gaining information followed by processing information and leading to making decisions based on the observation. Each phase of the process involves co-operation with colleagues, other professionals, patients and their loved ones.

While gaining information about a patient's clinical condition, CCNs base their observation in bio-physiological skills by applying their knowledge about normal and pathophysiological functions of a human body. They apply their skills in using both technical and non-technical observation methods, and recognise changes in a patient's condition. Furthermore, in information processing CCNs evaluate the reliability of the observed information and through analytic thinking create an overall view of a patient's condition. Even though information gaining precedes information processing, these two skills domains intersect, because CCNs start processing information that they gained immediately, which may guide CCNs to gain some additional information. Hence, CCNs may move back and forth between the phases to some extent.

CCNs apply their skills in decision-making as they react to the changes in a patient's condition and decide whether and how they should intervene. CCNs make proactive decisions as they anticipate based on the observation and create scenarios about the progression of a patient's condition. CCNs apply their co-operation skills throughout the observation process. Co-operation skills focuses on communication, teamwork and interprofessional working skills. The description of the patient observation skills domains are elaborated further in the Paper I (Tables 1-4).

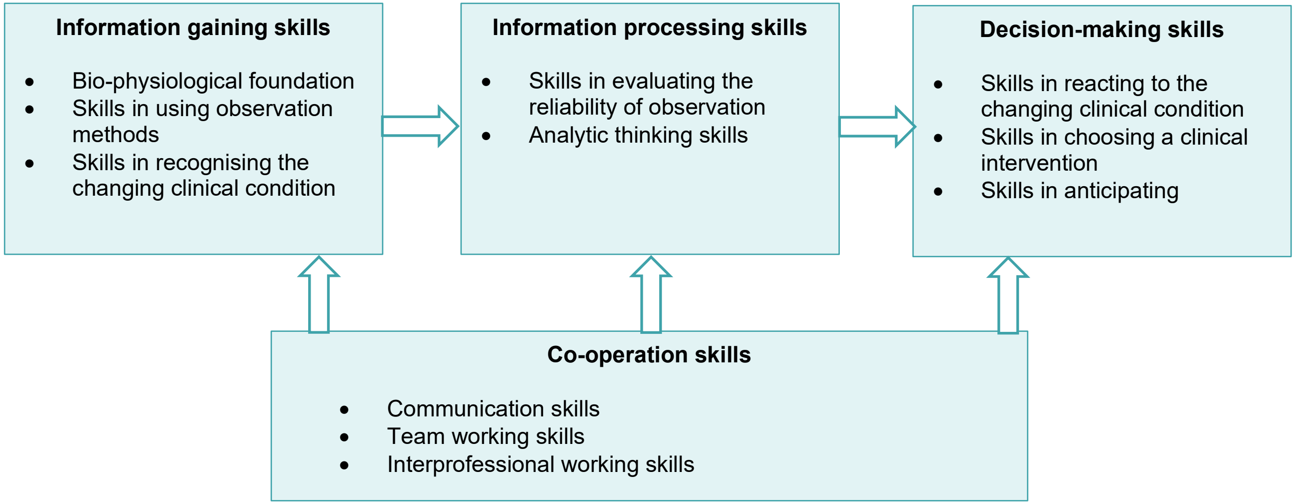

Figure 6. A preliminary theoretical construction of patient observation skills in critical care nursing. Modified from the Paper I (Figure 1).

6.2 Evaluation of critical care nurses' patient observation skills

Participants' characteristics

The data for the cross-sectional study were collected among CCNs in seven ICUs in five university hospitals. Almost half of the CCNs responded to the questionnaire (n=372, response activity 49%). The majority of CCNs were female (n=316, 87%) and their age ranged from 23 to 63 years (mean 39.8, SD 10.3). Most CCNs had a bachelor-level nursing degree (n=252, 69%) and they had an average of 12 years' working experience (SD 9.3) in critical care nursing and 15 years' working experience (SD 9.8) in nursing overall. In the background questions, CCNs were asked to assess how confident they were with their general critical care nursing competence using VAS from 0 to 100, and the mean score was 74.8 (SD 16.5). (Table 2: Paper III).

6.2.1 The level of patient observation skills

The evaluation of the patient observation skills focused on information-gaining and information-processing skills (Figure 6) because these skill domains focuses directly on the information about a patient's clinical condition and are tightly intertwined from theoretical and clinical perspectives. CCNs assessed their information gaining skills overall as excellent (Mean 81.9, SD 11.5) (Figure 7; Table 1: Paper II).

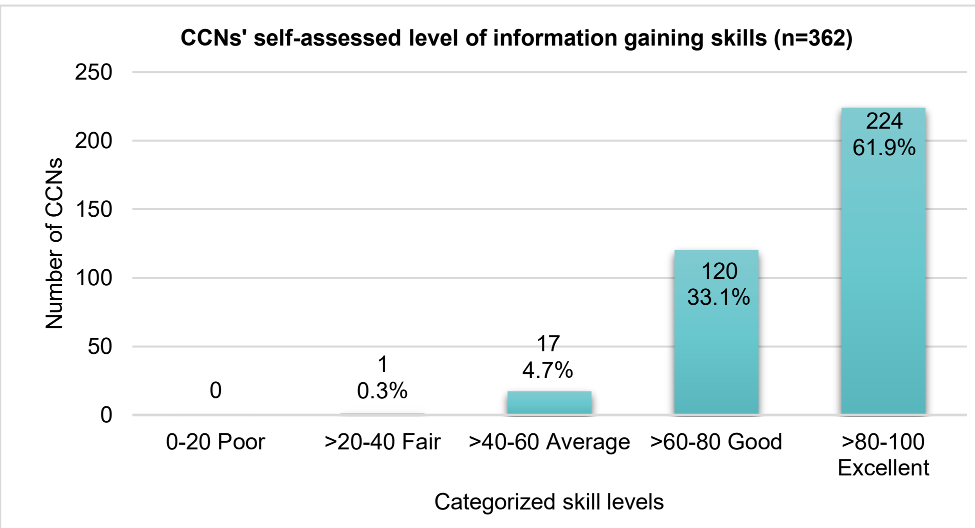

Figure 7. Critical care nurses' self-assessed level of information-gaining skills overall.

Regarding the sum-variables of information gaining skills, CCNs assessed their skills as excellent in *using observation methods* (Mean 83.4, SD 10.9) and *recognizing the changing clinical condition* (Mean 82.4, SD 12.2), and good in *bio-physiological foundation* (Mean 78.6, SD 13.4). (Figure 8; Figure 9; Figure 10; Table 1: Paper II).

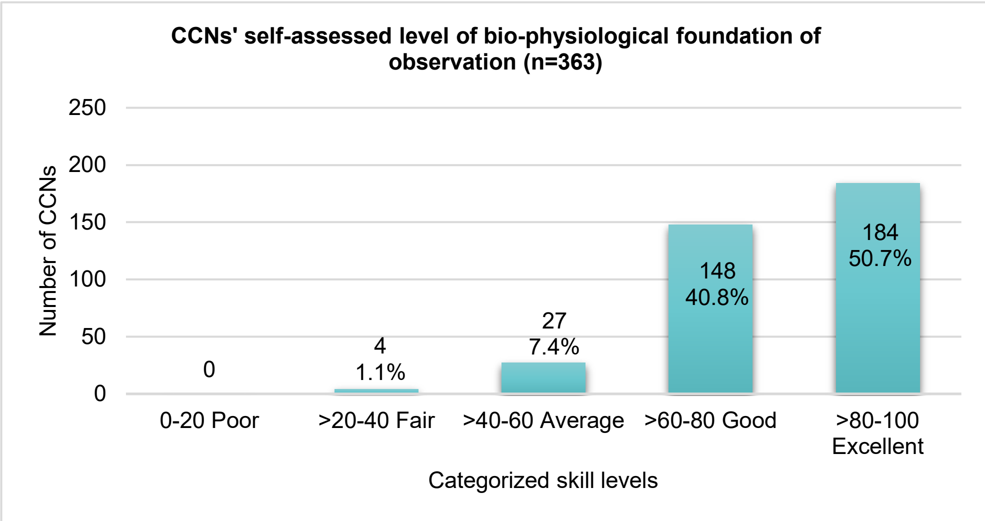

Figure 8. Critical care nurses' self-assessed level of bio-physiological foundation of observation.

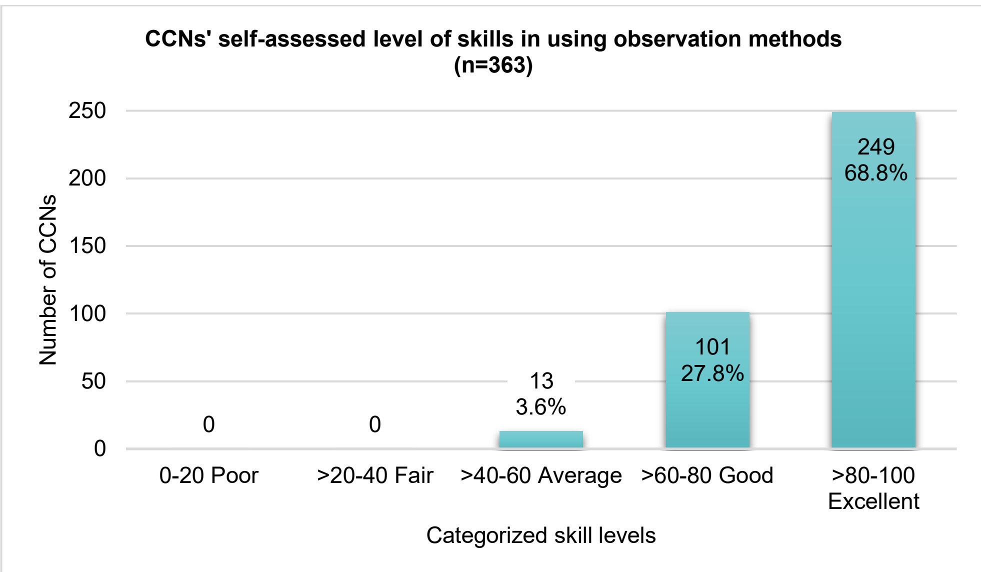

Figure 9. Critical care nurses' self-assessed level of skills in using observation methods.

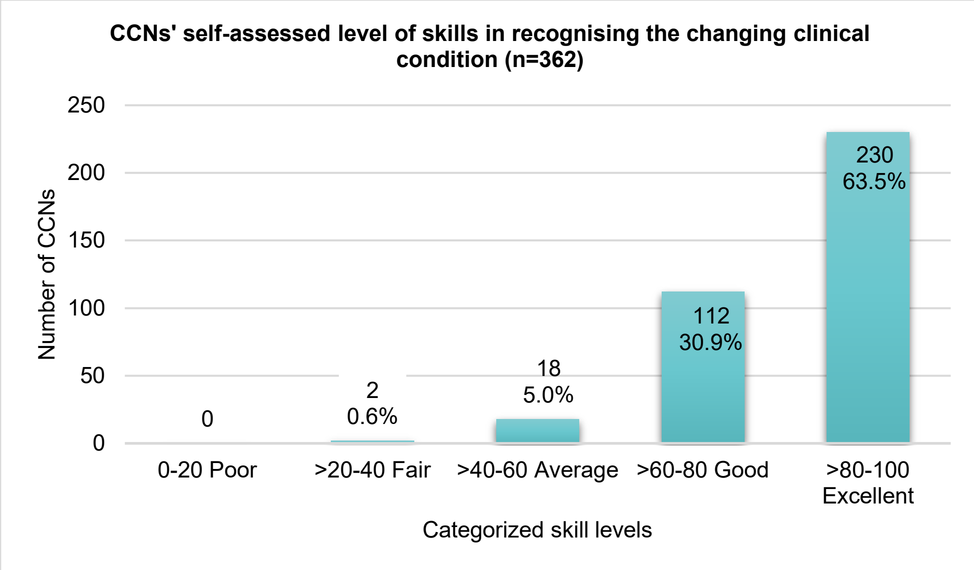

Figure 10. Critical care nurses' self-assessed level of skills in recognizing the changing clinical condition.

Regarding CCNs' information-processing skills, the average proportion of correct answers in the knowledge test was 77%. Whereas, in the sum-variable *evaluating the reliability of observation* proportion of correct answers was 75% and 79% in *analytic thinking* (Table 10, Figure 11; Table 1: Paper III)

Table 10. Knowledge test scores of critical care nurses' information processing skills (n=368).

	% of correct answers	Mean	SD	Min	Max
Information processing skills overall (maximum score 20)	77	15.3	2.4	7	20
Evaluating the reliability of observation (max 11)	75	8.2	1.5	5	11
Analytic thinking (max 9)	79	7.1	1.5	0	9

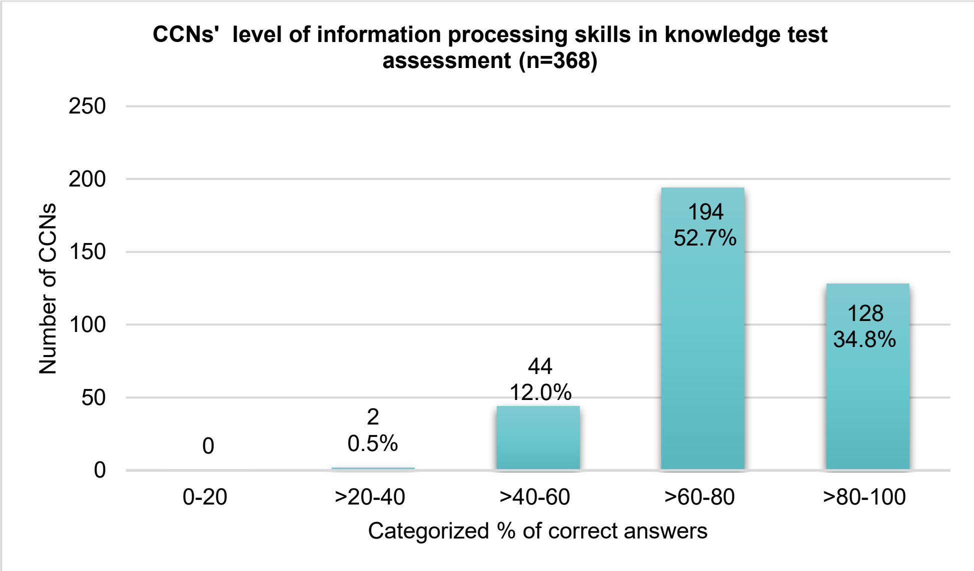

Figure 11. Critical care nurses' level of information processing skills in the knowledge test assessment

6.2.2 The factors associated with patient observation skills

General linear model was used to identify factors that were independently associated with information gaining and information processing skills. The variables that were significantly associated ($p < 0.05$) with CCNs' skills in univariate analysis were included in the general linear model. Exception was made with background factor *confidence in one's competence in critical care nursing* as it was excluded from the model to avoid the multicollinearity problem, because it had a strong positive correlation ($r=0.63$, $p \leq 0.001$) with information gaining skills. Furthermore, only the factors statistically significantly associated with CCNs' skills were retained in the model.

The level of patient observation skills (both information gaining and processing skills) were higher among CCNs who had been educated for special tasks in an ICU and who were highly confident in their critical care nursing competence. Furthermore, the length of working experience, critical care as a preferred field of nursing and independent information search from national scientific journals were positively associated with higher level of information gaining skills. Whereas, clinical placement in an ICU during nursing education and working experience in a high-dependency unit (HDU) were positively associated with higher level of information processing skills. The independent factors positively associated with the skill levels are presented in the table (Table 11) and in terms of sum-variables (sub-scales) in Papers II and III (Table 2: Paper II; Table 3: Paper III).

Table 11. Independent factors associated with critical care nurses' patient observation skills.

Information gaining skills (self-assessment) (r^2=0.36, adjusted r^2=0.34)	**n**	**Adjusted mean (95% CI)**	**Adjusted mean difference (95% CI) or adjusted β [95% CI]**	**Adjusted p**
Education for special tasks in an ICU				
Yes	239	87.04 (84.28-89.80)	3.39 (1.03–5.74)	0.005
No	105	83.65 (80.40–86.90)		
Information search from national scientific journals				
Yes	64	86.94 (83.68–90.20)	3.19 (0.18–6.20)	0.038
No	280	83.75 (80.70–86.80)		
The length of working experience in critical care nursing (years)	344		0.41 [0.29–0.53]	<0.001
Critical care as preferred field of nursing	344		0.19 [0.11–0.27]	<0.001
Information processing skills (knowledge test assessment) (r^2=0.21, adjusted r^2=0.18)				
Education for special tasks in an ICU				
Yes	245	15.59 (14.85–16.24)	0.74 (0.20–1.27)	0.007
No	107	14.81 (14.05–15.57)		
Working experience in a high-dependency unit				
Yes	69	15.52 (14.72–16.31)	0.67 (0.08–1.27)	0.026
No	283	14.84 (14.17–15.52)		
Clinical placement in an ICU during nursing education				
Yes	250	15.49 (14.81–16.17)	0.62 (0.11–1.12)	0.018
No	102	14.87 (14.11–15.64)		
Confidence in own critical care nursing competence (0–100)	352		0.13 [0.00–0.02]	0.046

General linear model, adjusted for other factors included in the model, β, Regression Coefficient. Modified from the Papers II (Table 2) and III (Table 3).

6.2.3 Association between subjective and objective assessment of patient observation skills

Association between CCNs' subjective self-assessment of information gaining skills and objective knowledge test assessment of information processing skills were investigated analysing correlations between the scores. Only weak positive correlations were detected between two domains of patient observation skills and consequently between self-assessment and knowledge test assessment. (r=0.11–0.13, Table 1: Paper IV). However, the CCNs' who reached at least the average score in the knowledge test (≥ 15) assessed their skills slightly higher (mean 82.9) than did their colleagues (mean 80.1, p=0.04).

6.3 Summary of the results

This study described patient observation skills in critical care nursing as *information gaining, information processing, decision-making* and *co-operation skills*. Information gaining skills and information processing skills are located in core of CCNs' patient observation, and they were evaluated and associated factors were investigated as presented in the theoretical construction (Figure 12). The level of information gaining skills was excellent according to CCNs' self-assessment, whereas knowledge test assessment revealed suboptimal information processing skills. Education in special tasks in ICU and high confidence in own critical care nursing competence were positively associated with CCNs' patient observation skills. Only a weak correlation was detected between self-assessment and knowledge test assessment.

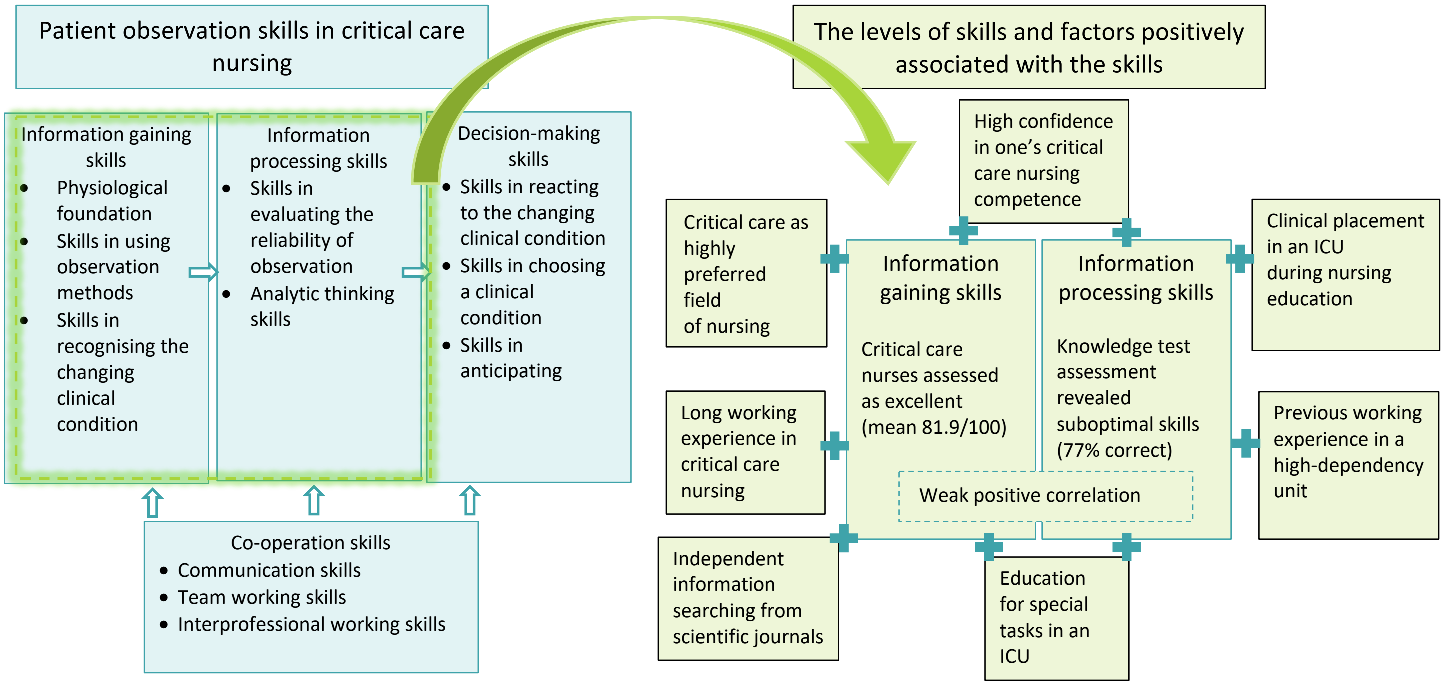

Figure 12. Theoretical construction and evaluation of patient observation skills in critical care nursing. Based on the first study phase, patient observation skills in critical care nursing consist of four skills domains, of which two – information gaining skills and information processing skill were evaluated in the second phase of the study. Small arrows represent the process-like structure of patient observation skills. The plus signs indicate the positive association between the factors and skill levels.

7 Discussion

In this section, the main results of the study, and validity and reliability of the study phases are discussed. Furthermore, implications for clinical nursing, nursing management and nursing education as well as suggestions for future research are presented. The papers I-IV include more detailed discussions.

7.1 Discussion of the results

The purpose of this study was first, to describe and create a theoretical construction of patient observation skills in critical care nursing and second, to evaluate Finnish CCNs' level of patient observation skills using subjective and objective assessment and investigate the factors associated with the skills. The study was conducted because CCNs' patient observation skills were neither described nor evaluated by the previous studies. The aim was to deepen the understanding of CCNs' skills, and ultimately to develop their skills to enhance quality of care and patient safety in ICUs.

7.1.1 Patient observation skills in critical care nursing

This first study phase provided a preliminary theoretical construction describing the skills CCNs use while observing their patients' clinical condition. Based on the description, patient observation is a process requiring CCNs to apply their skills in information gaining, information processing, decision-making and co-operation (Figure 6). During the study process, it became clear that information gaining skills and information processing skills can be considered as direct patient observation skills due to their intertwined nature and focus on information concerning a patient's clinical condition. Thus, they form the core of patient observation skills. Whereas, decision-making skills and co-operation skills can be considered indirect patient observation skills.

The findings of the first study phase provided deeper insight into information gaining skills compared to previous evidence. Previous studies focused mainly on the use of observation methods (cf. Tunlind et al., 2015; Freysdóttir et al., 2019), whereas current study elaborated information gaining skills further by introducing bio-physiological foundation of observation and skills in recognising the changing clinical condition as part of them.

Information processing skills were elaborated as well by introducing CCNs' skills in evaluating the reliability of observation. CCNs use their skills in distinguishing reliable information from artefacts and insignificant findings (Drew, et al., 2014; Milhomme et al., 2018). Thus, CCNs skills in evaluating the reliability of observation play important role in ensuring patient safety and good quality care as correct clinical conclusions and interventions rely on observed findings (Kvande et al., 2017; Currey et al., 2018). Various clinical decision support systems have been introduced to ICUs recently to improve the reliability of the conclusions made based on the observation (Medic, et al., 2019). However, these systems do not diminish the importance of a CCN providing reliable, accurate and relevant information to support decision-making.

Observations concerning a patient's clinical condition have always been an integral element of decision-making (Lauri, et al., 1998), clinical reasoning (Levett-Jones, et al., 2010) and clinical judgment (Tanner, 2006) in nursing. Clinical decisions rely on observed information (Lauri, et al., 1998; Aitken, 2003), thus information gaining and processing serve as prerequisites for decision-making. CCNs especially, make often decisions in acute and rapidly changing situations (Lauri, et al., 1998; Stinson, 2017), which highlights the importance of adequate information gaining and processing skills.

Co-operation skills were first time introduced in this study as a part of patient observation skills reflecting the highly collaborative and interprofessional nature of critical care (Lakanmaa et al., 2012; Marshall, et al., 2017). An individual CCN must have certain level of patient observation skills to fulfil their individual responsibilities in observing their patients' condition (European federation of Critical Care Nursing associations, 2007; Kaya, et al., 2011). However, also the critical care team taking care of a critically ill patient possesses shared observation skills as a result of negotiating and consulting each other's. Good co-operation within critical care team presumably improves the quality of the observation, and moreover promotes patient safety and quality of care overall.

Overall, CCNs' patient observation skills are closely related to patient safety as have been introduced earlier (Jones & Johnstone, 2017; Milhomme et al., 2018). Reliable observation, CCNs' skills in recognising and reacting to the changing clinical condition, anticipating, choosing right interventions and communicating appropriately are all connected with safety of a critically ill patient. From this perspective, the role of patient observation skills in critical care nursing is fundamental, and being skilled in patient observation can be seen as a prerequisite for developing towards competent CCN (Benner, 1984). Therefore, CCNs' patient observation skills should be at the high level.

The preliminary theoretical construction presented in this study provided a comprehensive description of CCNs' patient observation skills focusing on physiological observation. Physiological aspect of the clinical condition was focused due to its fundamental role in the care of a critically ill patient. However, patient observation extends far beyond physiological functions to pain (American association of Critical Care Nurses, 2018), and sedation assessment (Aitken et al., 2009), observing psychological status (Moser, et al., 2003), evaluating the quality of a patient's sleep (Ritmala-Castrén, et al., 2016) and socio-emotional assessment (Gill et al., 2014). Skills in observing physiological functions is of crucial importance due to critical and life-threatening condition of a patient. However, from the perspective of holistic and good quality care, other areas of observation are essential as well, and deserve attention when developing education and clinical practice as well as in future studies.

To sum up, the preliminary theoretical construction imposes the skill domains information gaining and processing skills into the core of patient observation (Figure 6, Figure 12). Whereas, decision-making skills relate patient observation to decision-making process in nursing, and co-operation skills reflects the highly collaborative nature of critical care. This preliminary theoretical construction can be used as a framework for developing educational activities promoting patient observation skills for example in orientation and continuing education programs.

7.1.2 The level of patient observation skills and associated factors

In the second study phase, the level of CCNs' patient observation skills was evaluated using subjective self-assessment for information gaining skills and objective knowledge test assessment for information processing skills. The factors associated with the skill levels were identified, and the association between subjective and objective assessments were investigated. The preliminary theoretical construction consisted also decision-making and co-operation skills but they were excluded from the evaluation phase. Focusing on information gaining and processing skills in this study was considered theoretically and clinically meaningful, as they focus directly on the information about a patient's clinical condition and are tightly intertwined. However, decision-making skills and co-operation skills are important skills domains of patient observation, thus evaluating them in the future studies would provide more comprehensive insight into CCNs' patient observation skills.

The results showed variation in CCNs' skill levels. According to self-assessment, information gaining skills were at higher level (mean 81.9/100) compared to information processing skills assessed by the knowledge test (average proportion of correct answers 77%). Due to their fundamental role in clinical nursing practice, information gaining skills should be at the excellent level (>80), which was achieved by most CCNs (61.9%). However, in the sum variable "bio-physiological foundation" skill level was lower. Regarding information processing skills, CCNs knowledge test scores were suboptimal with almost one fourth of answers incorrect.

Previous studies do not provide direct baseline for comparison, as their focus have been somewhat different. However, some reflections to previous studies can be presented. Congruent with the current results, previous studies showed variation in CCNs' patient observation skills, and they seemed to be especially low in objective assessments (McGhee & Woods, 2001; Christensen & Barnes, 2012; Hunt et al., 2017), which was the case also in the current study.

Some reflections to general competence or knowledge studies among Finnish CCN's can be presented as well. However, although patient observation skills are an essential element of critical care nursing competence, they do not constitute an independent domain in these studies. Thus, comparison with the current results is very suggestive in nature. In a study by Lakanmaa et al. (2015) most Finnish CCNs (67.5%) assessed their basic competence in critical care nursing as excellent (mean 4.19/5) as did CCNs in the self-assessment of patient observation skills. Whereas, in a study by Meretoja et al. (2004b) using Nurse Competence Scale, Finnish CCNs assessed their nursing competence as good (mean 63.5/100). CCNs were most confident in their competence in NCS's sum-variable, "diagnostic functions" (mean 68.5/100), which also included items related to patient observation. CCNs were more confident in their skills in the current study, but the POS-CCN assessments are not directly comparable with this sum-variable.

In the studies using general critical care nursing knowledge tests, Finnish CCNs' scores have been suboptimal being 68/100 in BKAT (Lakanmaa et al., 2015) and 64/100 in I-HIT (Fulbrook et al., 2012). Finnish CCNs' scores have been suboptimal also in more specific knowledge tests focusing on prevention of ventilator-associated pneumonia (Labeau, et al., 2008; Jansson et al., 2013). Even though, the previous findings did not focus directly on patient observation, they share similar remarks about the lacking knowledge with the current study.

Finnish CCNs' bio-physiological knowledge may be inadequate as bio-physiological foundation was assessed as lowest in information gaining skills and knowledge test scores were suboptimal in information processing skills, which also require comprehensive bio-physiological understanding. For example, a CCN has to understand the physiology of cardiovascular system in order to evaluate whether the measured parameters are reliable and to make conclusion based on the measured haemodynamic parameters. A sound bio-physiological knowledge base in essential in general when caring for critically ill patients (Ääri, et al., 2004; Ääri, et al., 2008; European federation of Critical Care Nursing associations, 2013). Thus, strengthening CCNs' bio-physiological knowledge should be in the focus of continuing education and on-the-job training. Adequate bio-physiological knowledge base should be built already during the basic nursing education, especially as the basic bio-physiological knowledge related to critical care has been identified as poor in an earlier study among Finnish graduating nursing students (Lakanmaa, et al., 2013b).

Previous evidence suggests that quality of CCNs' patient observation is connected with patient outcome (Kelly et al., 2014a; West, et al., 2014). The outcome of Finnish critical care as well as hospital care in general is at the good level in international comparison in terms of relatively low ICU and hospital mortality (Aiken, et al., 2014; Reinikainen et al., 2017). However, the mortality alone as a patient outcome may not reflect well the quality of critical care nursing (Yang, et al., 2019). Analysis of adverse events and complications related to nurse sensitive indicators such as hypoglycaemic episodes, unplanned extubations and hospital-acquired infections (Myers, et al., 2018) during the ICU care would provide more valuable information in this sense (Eltaybani, et al., 2018). Thus, more information about the quality of nursing care in relation to CCNs' skill levels in Finnish ICUs are needed to make further conclusions.

The second study phase investigated factors associated with patient observation skills. Education for special tasks in an ICU and high confidence in one's critical care nursing competence were positively associated with higher level of both information gaining and information processing skills. Albeit statistically significant, the differences in scores were not very big between the groups. CCNs may be educated in various tasks in ICUs such as performing renal replacement therapies, taking care for patients receiving extracorporeal membrane oxygenation (ECMO) therapy and working as a member of a medical emergency team (MET). These tasks require advanced patient observation that may be covered in education, thus developing CCNs skills in observation. Some of the previous studies did identify higher educational level as a factor associated with higher level of patient observation skills (Cicolini, et al., 2015; Preston et al., 2015), but they did not address education for special tasks. However, the education for special tasks may be included in specialized critical care nursing education in many countries contrary to Finland (Endacott, et al., 2015; Jeon et al., 2015).

CCNs were asked to evaluate their general critical care nursing competence as a background information, and those who were highly confident with their critical care nursing competence also assessed their skills higher and scored better in the knowledge test compared to their less confident colleagues. Patient observation skills can be seen as fundamental in critical care nursing, thus constituting an essential element of CCNs' competence. Therefore, it would be unlikely that CCNs with low confidence in their competence would assess their level of patient observation skills as high. Furthermore, it seems that CCNs have had a realistic assessment of their critical care nursing competence as it was congruent with the objective assessment in the knowledge test. It is worth noticing that CCNs assessed their critical care nursing competence overall as rather low (mean 74.8/100) compared to self-assessed information gaining skills (mean 81.9/100). This highlights the fundamental role of patient observation in CCNs' clinical practice (Gill et al., 2014; Marshall, et al., 2017) – CCNs have to be skilled in patient observation prior developing some other areas of their competence.

The role of working experience in promoting observation skills is ambivalent. Some previous studies suggest that experienced CCNs had higher level of patient observation skills compared to their less experienced colleagues (Reischman & Yarandi, 2002; Currey & Botti, 2006; Hoffman et al., 2009; Freysdóttir et al., 2019). The current study shares the similar findings in terms of self-assessment of information gaining skills, but not in knowledge test assessment of information processing skills. Experienced CCNs did not score better in the knowledge test than less experienced CCNs, which has been detected also in two earlier studies using knowledge test assessment (Christensen & Barnes, 2012; Hunt et al., 2017). This may indicate that working experience itself does not develop patient observation skills, but instead, highlights the previously acknowledged importance of lifelong learning and continuous professional development (Gill, et al., 2019). Thus, more systematic training including specialized education in critical care nursing and continuous education throughout CCNs' career is needed (Björn et al., 2017; Gomarverdi et al., 2019).

There was only a weak positive correlation between information gaining and processing skills, and respectively between subjective and objective assessments. Thus, even though a CCN may have excellent skills in gaining information her/his skills in processing information may be suboptimal. Some previous studies have made similar remarks suggesting that although being able to make observations CCNs may lack the thorough understanding of the complexity of the observed physiological functions (Currey & Botti, 2006; Christensen & Barnes, 2012). Information gaining is the first phase of the patient observation process; hence, information gaining skills are crucial in observation. However, the phases of the patient observation process are intertwined and being skilled in patient observation requires mastering both domains. CCNs have to be able to evaluate constantly the reliability of the information they gain as well as make interpretations and conclusions, which guide them to gain additional information. Therefore, the level of CCNs' patient observation skills can be considered at least partly inadequate.

The skill evaluation in the second study phase used both subjective and objective approach in assessment in order to reach comprehensive evaluation (Sears, et al., 2014; O'Shaughnessy & Joyce, 2015). Self-assessment as a subjective method and knowledge test assessment as objective method yielded slightly different results. The similar remarks about missing association between self-assessment and knowledge test have been made previously among CCNs (McGhee & Woods, 2001; Lakanmaa et al., 2015). Furthermore, incongruence between self-assessment and objective assessment has been detected in previous studies among CCNs (Ballangrud et al., 2014; Williams & Parry, 2018). Thus, self-assessment may have some limitations regarding the reliability of assessment, which may affect the results of the evaluation. Self-assessment may not always be realistic due to either limited understanding of the required skills (Kajander-Unkuri, et al., 2016; Forsman, et al., 2020) or lack of self-assessment skills (Baxter & Norman, 2011; Kajander-Unkuri, et al., 2016). However, the CCNs in the current study were relatively experienced, thus they can be assumed to have realistic idea about the required skill level. Whereas, lack of adequate self-assessment skills may have affected to results to some extent. There is no evidence available concerning the self-assessment skills among Finnish CCNs. Investigating CCNs' self-assessment skills can be recommended, because self-assessment has a crucial role in self-regulated learning (Panadero & Alonso-Tapia, 2013) and continuous professional development (Sambell et al., 2012; Kajander-Unkuri, et al., 2016), and also in assuring safe patient care (Epstein, et al., 2008). Furthermore, it is possible that some CCNs' have assessed their skills in a socially desirable way, thus potentially overestimating their skills.

To sum up, evaluation phase showed variation in the levels of CCNs' patient observation skills. Information gaining skills were at the excellent level based on the self-assessment, whereas information processing skills were suboptimal in the knowledge tets assessment. Based on the identification of associated factors, education covering special tasks and responsibilities in ICUs can be seen as beneficial for improving CCNs' patient observation skills, and they should be systematically available fo all CCNs throughout their career. This study phase also introduced the complexity of skills evaluation, thus indicating the need for developing methods and practices of CCNs' skills evaluation. Furthermore, this study provided POS-CCN instrument, that can possible be used in skills evaluation in ICUs. However, it requires some further development and validation. POS-CCN could also be used as a framework for assessment by others (peer, mentor, manager) and in direct skills observation, and it could also provide content for objective structured clinical examinations in clinical nursing practice in ICUs (Mitchell, et al., 2013).

7.2 Validity and reliability of the study

The validity and reliability of this study were considered in both study phases. The following chapters discuss the validity and reliability of data collection, the instruments and results. Limitations of the study are addressed.

7.2.1 Validity and reliability of data collection

Phase I

The data for the descriptive qualitative study were collected among experienced CCNs using semi-structured interview (Paper I). Experienced CCNs were selected as informants because they were assumed to be able to provide in-depth information about the skills that are needed in patient observation and provide examples from their own experience (Milne & Oberle, 2005). They had an average of 16 years' working experience in critical care nursing and 40% of them (n=8) had gained experience in other ICUs. Thus, they were very experienced in critical care nursing and were able to provide rich description. However, possibly, the depth of the data could have been increased by using focus group interviews instead of individual interviews as CCNs' could have provided different and even contradictory perspectives to patient observation and elaborated them further (Doody et al., 2013; Holloway & Galvin, 2017).

The use of an interview guide in semi-structured interviews (Kallio et al., 2016) ensured consistency in data collection, thus fostered the dependability of the study (Colorafi & Evans, 2016). The interview guide was flexible enough for CCNs to bring out their perceptions broadly. The interview guide was pilot tested with one CCN, and as it turned out to be appropriate the data from the pilot interview was included in the analysis, and no changes in the guide were required. The interviews were conducted in separate rooms in ICUs during the shift of a CCN. The time reserved for the interviews was adequate and none of the interviews was interrupted. The researcher had a relatively long working experience in critical care nursing, which required paying constantly attention to not steer the interviewees according to own assumptions and experiences (Colorafi & Evans, 2016). However, it still is possible that the researcher's background and own perceptions of critical care nursing affected the interview for example by leading the conversation to certain direction when asking interviewees to specify their answers.

Each recorded interview was transcribed prior the next interview by the researcher himself. This allowed evaluating the adequacy and saturation of the data throughout the data collection, which were gained after 20 interviews (Vasileiou et al., 2018).

Phase II

The data for the cross-sectional study (Paper II, III & IV) was collected using paper-and-pencil questionnaire. The decision of using traditional questionnaire instead of electronic questionnaire was made as response activity tends to be low in electronic questionnaires (Jones et al., 2008; McPeake et al., 2014; Kulju et al., 2020). Moreover, CCNs may have limited access to computers during their shifts, and therefore, the traditional paper-and-pencil questionnaire was considered most suitable method for collecting data, and eventually yielded to 49% response activity. CCNs were reminded about participation and deadlines for answering were prolonged to increase response activity. However, more than half of the CCNs did not respond, thus response activity can be considered moderate. The questionnaire was rather lengthy (20 background items, 20 knowledge test items and 56 self-assessment items), which may have diminished the response activity

Total sampling among CCNs in Finnish university hospitals' adult mixed ICUs was used in order to gain heterogeneous sample, which is desirable in a correlational survey study (Grove et al., 2013). CCNs answered questionnaire without any supervision, hence the possibility of them discussing or using various materials while completing the knowledge test could not be ruled out.

7.2.2 Validity and reliability of the instruments

A new instrument, POS-CCN, was developed for the study due to lack of existing instruments evaluating CCNs patient observation skills. The instrument development was based on the findings of the first study phase, which provided a meaningful structure for the instrument, which was complemented by the previous literature.

The content validity of POS-CCN was evaluated by the expert panel as described in the section 5.3. S-CVI for the instruments self-assessment part was 0.96 and 0.93 for the knowledge test part, which represented good content validity (Polit et al., 2007). However, the knowledge test contained only 20 items, and may therefore be limited to some extent for example by excluding some physiological parameters essential for observation.

The construct validity of POS-CCN's self-assessment part was evaluated using exploratory factor analysis (EFA). Confirmatory factor analysis (CFA) provides a possibility to test how well the theoretical construct fits the data (Waltz et al., 2016). However, EFA was used instead of CFA, because POS-CCN was still in early stage of development (DeVellis, 2017). The evaluation was based on the sample of the cross-sectional survey (CCNs, n=372). According to a rule of thumb of having at least five respondents per item, the sample was large enough (6.5/item) for conducting EFA (Rattray & Jones, 2007). EFA was conducted using the maximum likelihood extraction method and oblique Promax rotation, which allowed factors to correlate, because correlations between the items were detected in item analysis (DeVellis, 2017).

EFA did not support the theoretical structure of POS-CCN self-assessment but provided an alternative structure containing six factors, of which Eigenvalues ranged from 1.0 to 34.7, and the first factor explained 61.9% of POS-CCN self-assessment. Exploration of the six factors revealed that this alternative structure was not theoretically meaningful. Factors did not constitute logical entities in terms of loaded items. The correlations between the self-assessment items were relatively strong, which has been identified also in previous studies focusing on skills or competencies and may explain the result of EFA (Meretoja et al., 2004a; Fisher et al., 2005). However, the structure of the instrument was based on the evidence provided by the first study phase and previous literature. Furthermore, the instrument provided meaning information about the CCNs' skills.

The reliability of POS-CCN self-assessment in terms of internal consistency was evaluated using item analysis and Cronbach's alpha coefficient (DeVon, et al., 2007). Item analysis revealed item-to-total correlations ranging from 0.36 to 0.86, thus all items surpassed the general cut-off point (> 0.3) for adding explanatory power (Rattray & Jones, 2007). Inter-item correlations ranged from 0.10 to 0.95, and Cronbach's alpha coefficients were high for all sum variables (Table 12).

Table 12. Internal consistency of POS-CCN self-assessment.

Instrument/sum variables	Number of items	Cronbach's α
POS-CCN	56	0.99
Bio-physiological foundation	14	0.97
Skills in using observation methods	28	0.96
Skills in recognising the changing clinical condition	14	0.96

High alpha coefficients may be resulted from the relatively high number of self-assessment items (Waltz et al., 2016), and furthermore, high inter-item correlations (>0.80) indicate similarity between some items (Rattray & Jones, 2007). High inter-item correlations (0.89-0.95) were detected especially in the sum variable bio-physiological foundation. This sum variable included two items under each physiological areas of observation (Table 6, Table 7); one focusing on normal function, and another focusing on disorders. These items had a high degree of similarity based on item analysis, and therefore, they could be combined as one item, which would reduce the total number of self-assessment items to 49. Thus, POS-CCN could be developed further by reducing items, and it should be tested again.

POS-CCN knowledge test's psychometric evaluation was limited to content validity evaluation. Evaluating internal consistency of the items was not considered meaningful as the degree of difficulty of the knowledge test items was expected to be varying (proportion of correct answers 45-99%).

To summarize, POS-CCN's content validity was acceptable for both self-assessment and knowledge test assessment. Self-assessment part had high alpha coefficients and inter-item correlations, which indicates that the amount of items could be reduced for the second version of POS-CCN. A new version of POS-CCN requires psychometric evaluation especially in terms of construct validity.

7.2.3 Validity of the results

Phase I

Objectivity of the study findings was enhanced by identifying researcher's own assumptions and experiences of the study topic and not letting them to interfere the analysis process (Colorafi & Evans, 2016). Furthermore, objectivity was maintained by staying close to the data, thus making in-depth interpretations of the data was avoided (Milne & Oberle, 2005). However, both qualitative descriptive study (Doyle et al., 2020) and thematic analysis (Braun & Clarke, 2020) always require interpretation to some extent, and therefore the possibility of the researcher's own assumptions affecting the findings cannot be completely ruled out (Vaismoradi, et al., 2013). On the other hand, interpreting the data without critical care nursing expertise would have been very difficult and potentially could have increased the risk of bias by misunderstanding terminology and clinical examples provided by the interviewees. The methods used and study process are presented and explained carefully (Paper I), which enhanced objectivity as well (Colorafi & Evans, 2016).

Internal validity (credibility) represents the truth-value of the data. Thematic analysis provided a clear structure for the data analysis and checklist of criteria for good thematic analysis was used (Braun & Clarke, 2006), which enhanced credibility of the findings. Credibility was enhanced also by comprehensive description of patient observation skills and observation process that was discussed and evaluated in the research team. The critical care nursing expertise of the research team allowed them to evaluate the truth-value of the findings. The findings of the first study phase shared some similarities in terms of identified skills domains (i.a. information processing skills and decision-making skills) with previous studies enhancing internal validity. (Colorafi & Evans, 2016.)

External validity (transferability) of the findings was promoted by presenting background information about the interviewees and study context. This allows researchers, managers, educators and CCNs to evaluate the transferability of the findings. The CCNs who participated in the first study phase worked in level III (Marshall, et al., 2017) mixed ICUs, which may limit the transferability of the findings for example in central hospitals and in specialized ICUs (i.e. cardiothoracic and trauma ICUs).

Phase II

Generalizability (external validity) of the cross-sectional survey study may be limited due to moderate response rate (49%). More than half of the CCNs did not answer, and dropout analysis was not performed. Therefore, the generalizability of the sample among Finnish CCNs cannot be clearly evaluated. However, the amount of CCNs in the study (n=372) was relatively large, which allowed investigating skill levels and associated factors using multivariate analysis. The required sample size was not estimated based on the power analysis, because total sampling was used. However, the minimum number of respondents required for EFA was calculated as 280 (Rattray & Jones, 2007), which was clearly surpassed in the study.

The CCNs who participated in the study were relatively experienced with an average of 12 years' working experience in critical care nursing and their mean age was 40 years. There are no data available concerning Finnish CCNs' demographics or work history, and therefore the representativeness of the sample cannot be reliably evaluated. When compared to the demographics of the Finnish RNs' in general, the proportions of CCNs was higher than RNs' in general in age groups of under 35 years (RNs 29.8%, CCNs 35.7%) and 35-55 years (RNs 51.8%, CCNs 56.9%) whereas lower in the age group of 55 years and older (RNs 18.4%, CCNs 7.4%) (Finnish Nurses Association, 2020). Hence, the CCNs in the current study were younger than Finnish RNs in general. Even though the amount of working experience was relatively high, less experienced CCNs (i.e. < five years, n=68, 18.8%) were represented as well.

The strength of the results was enhanced by evaluating content and construct validity of the POS-CCN instrument. Content validity was at the acceptable level. Whereas, construct validity of the POS-CCN was limited by EFA not supporting the theoretical construct. However, the theoretical structure of POS-CCN was based on the thorough descriptive work and previous evidence. Another limiting factor is the unavailability of criterion instrument or measurement, thus criterion validity of POS-CCN was not possible to evaluate (DeVon, et al., 2007). The lack of criterion instrument also hinders the interpretation of CCNs' skill levels and determining the acceptable skill level. Therefore, the knowledge test's degree of difficulty may not be established with respect to other measurements, and the possibility of knowledge test being too demanding cannot be ruled out.

Self-assessment as a method may cause some limitations in the results. Previous studies among nurses and nursing students suggest that self-assessment may not always be reliable in skill evaluation as overestimation of one's skills is rather common (Baxter & Norman, 2011; Ballangrud et al., 2014; Lakanmaa et al., 2015; Kajander-Unkuri, et al., 2016; Williams & Parry, 2018). However, self-assessment is not always upward biased as some nurses may be very self-critical and underestimate their skills (Ballangrud et al., 2014; Takase et al., 2018) as well. Furthermore, self-assessment allows assessing the elements of skills that are unobservable by other methods and by other persons (Humburg & van der Velden, 2015).

7.3 Implications for clinical nursing practice, management and education

Based on the results of the study, following implications for clinical nursing practice and nursing education can be presented.

Clinical nursing practice and management

- Patient observation is an essential skill in critical care nursing, and therefore learning and developing them should be incorporated in ICUs' orientation programs and professional development plans. The theoretical construction presented in this study may be used as a framework for that.
- Development and implementation of systematic skills evaluation practices in ICUs can be recommended. Skills evaluation could incorporate self-assessment and objective assessment such as knowledge tests. Furthermore, CCNs' actual performance in patient observation could be evaluated in authentic, simulated or virtual clinical situations.
- CCNs' POS-CCN instrument could be used as a structure for skills evaluation, and self-assessment could be complemented by peer, mentor or manager assessment using the same instrument.
- Self-assessment is a key to self-directed learning and continuous professional development, which are very much needed in the rapidly developing field of critical care nursing. Therefore, assuring CCNs' adequate self-assessment skills, developing self-assessment practices and promoting the culture supporting honest self-assessment in ICUs can be recommended.

Nursing education

- There is a need for developing and providing systematic education strengthening Finnish CCNs' bio-physiological knowledge base, which is essential not only in patient observation but also in the care of a critically ill patient in general. Education focusing on information processing is needed as well.

- Simulations, virtual simulations and gamification could be used in education to develop patient observation skills. These methods would provide repeatedly opportunities to train in the complex scenarios how to collect, compare, connect and interpret information, and furthermore, how to make conclusions based on the observations.
- Critical care nursing education should be available for nursing students as a part of their complementary studies and also as specialized post-graduation education for registered nurses. Current high demand for CCNs highlights the need for developing critical care nursing programs and curricula nationally.
- Ensuring and supporting the development of accurate and critical self-assessment skills can be recommended during the basic nursing education. This would promote future nurses' abilities in lifelong learning and constant professional development

7.4 Suggestions for further research

Some suggestions for future research from content and methodological perspective can be presented.

Content of the research

- The content and required level of bio-physiological knowledge in critical care nursing can be recommended to be defined and the actual knowledge level among CCNs evaluated.
- This study focused on physiological observation, but CCNs observe also for example their patients' psychological condition, pain, level of sedation, quality of sleep and general comfort. These areas of observation can be recommended to be investigated and evaluated.
- From the perspective of promoting patient-centeredness in ICUs, patients' involvement in observation should be investigated. Evidence regarding their abilities and possibilities to contribute to patient observation as well as nursing interventions promoting patients' involvement in observation is needed

- International studies comparing CCNs' patient observation skills between countries are recommended. International comparison could reveal factors promoting patient observation skills and provide opportunity for international benchmarking.
- Patient observation skills can be seen as fundamental skills not only in critical care but in clinical nursing practice in general as clinical decisions are based on observations. Therefore, knowledge about nurses' observation skills in various fields of nursing is needed. Moreover, the knowledge about nurses' observation skills in paediatric and neonatal critical care is needed as well.
- This study provided an example of evaluating nurses' cognitive skills in clinical practice instead of competence. Evaluation of concrete and specific clinical skills can be recommended in the future studies as well.
- Nurses' and nursing students' self-assessment skills are recommended to be investigated and evaluated.

Research methodology

- POS-CCN instrument should be developed further by critically evaluating the number of items and validated in more diverse settings; ICUs outside university hospitals, specialized ICU and in international context.
- Patient observation and development of patient observation skills could be investigated using multidisciplinary approach including for example educational sciences and psychology to reach deeper understanding in the underlying cognitive processes.
- This study introduced the complexity of skills evaluation. Therefore, reliable, accurate and feasible evidence-based skills assessment methods are needed. These methods should aim at objectivity and they could utilize modern technologies such as extended reality.
- Longitudinal studies investigating the development of CCNs' skills during their career can be recommended to be conducted. The evidence concerning the factors promoting skills development and lifelong learning during CCNs' careers is needed. Register data among Finnish CCNs are needed for the future longitudinal studies.

8 Conclusions

This study provided new knowledge about i) patient observation skills in critical care nursing, ii) the level of CCNs' patient observation skills, iii) factors associated with the level of patient observation skill, and iv) methods of assessing CCNs' patient observation skills.

i) Patient observation skills in critical care nursing can be divided into direct observation skills that focus on information about a patient's clinical condition, namely information gaining and information processing skills. Indirect skills are needed in patient observation as well, and they focus on decisions made based on observation and co-operation during the observation.

ii) CCNs' patient observation skills seem to be at the adequate level in terms of information gaining whereas suboptimal in terms of information processing.

iii) Education for special tasks in ICUs seems to promote CCNs' patient observation skills. Thus, education should be available for nursing students and nurses to specialize in critical care nursing, and also as continuing education throughout CCNs' careers.

iv) There were incongruence between CCNs' subjective self-assessment and objective knowledge test assessment. This indicates the complexity of skills evaluation, thus there is a need for developing methods and practices of CCNs' skills evaluation in future. Ensuring the adequate level of self-assessment skills among CCNs is important in terms of lifelong learning and continuous professional development.

This study deepened the understanding of essential skills in critical care nursing. The new knowledge provided can be used to develop CCNs' skills in ICUs and furthermore to ensure quality of care and patient safety. Furthermore, this study contributed to the body of knowledge in nursing science with special focus on critical care and acute care nursing. Current undesirable development in the field due to COVID-19 pandemic has highlighted the importance of skilled nursing staff. By expanding the conception of CCNs' essential skills, this study provided potentially valuable and actual information to support decision-making in ICUs, healthcare organizations and society in terms of adequate critical care nursing skills development.

Acknowledgements

This study was conducted at the Department of Nursing Science, University of Turku. I received help, support and encouragement from several people during the dissertation process. I would like to express my sincere gratitude to all of them, even though I cannot name each of them individually.

First of all, I wish to express my deepest gratitude to my supervisors Professor Helena Leino-Kilpi and Professor Leena Salminen. Without your continuous support and guidance, completion of this dissertation would not have been possible. Professor Helena Leino-Kilpi as my principal supervisor, with your visionary insight and experience you have helped me to scrutinize my work critically and encouraged me to develop my scientific thinking. I have been empowered by your genuine interest in critical care nursing and my research topic all these years. Professor Leena Salminen, I wish to thank you for your encouraging guidance and support during the dissertation process. In addition to your pedagogical expertise, you have provided fresh ideas outside critical care and in many occasions helped me to clarify my thoughts and ideas by asking the right questions.

I would like to thank my follow-up committee member PhD Riitta-Liisa Lakanmaa. Your studies on critical care nursing competence have served as a background and inspiration for my dissertation. You have encouraged and supported me in many ways, and co-authored one of the original publications. I also wish to thank MSc, biostatistician Tero Vahlberg for your statistical guidance throughout the process and your contribution to the publications.

I am deeply grateful for the official reviewers of my dissertation, Professor Marion Mitchell from the Griffith University and Adjunct Professor Miia Jansson from the University of Oulu. Your feedback was encouraging while constructive and helped me to improve the summary of the dissertation. Thank you Professor Hannele Turunen from the University of Eastern Finland for accepting the invitation to act as my opponent.

I would like to thank all teachers and professors at the Department of Nursing Science who have taught me and supported me during my studies. I wish to thank Professor Elina Haavisto and Professor Riitta Suhonen for your feedback in our seminar groups over the years. I also wish to thank Professor Sanna Salanterä; you had an important role in guiding my first steps in the field of research during the researcher path studies. You helped me to elaborate my original idea of a research topic further and provided essential support and guidance in the early stage of planning my own research. I would also like to thank Training Expert Anna Mäkinen at the Department of Nursing Science for your invaluable help with finalizing the summary. Furthermore, thank you MSc Helena Ollila for your help in recording the research data and MD Waltteri Siirala for your medical expertise in the instrument construction process.

I owe my sincere gratitude to all critical care nurses who participated in the different phases of the study, and critical care nursing experts for contributing to the evaluation of the instrument. I want to express my special thanks to all the nurse managers and contact persons in intensive care units for enabling data collection.

There are many colleagues and co-workers in the field of critical care nursing whom I would like to thank for inspiring me over the years, although I cannot thank you all by names. I wish to thank PhD Marita Ritmala-Castrén for encouraging me to develop my abilities in clinical practice and in critical care nursing research. I also wish to thank ward manager Laura Lehtonen for inspiring and supporting me to develop my competences during my career as a critical care nurse. I wish to thank MNSc Annika Björn for sharing thoughts and ideas about critical care nursing research already during our master studies.

Warm thanks go to my fellow students in the Doctoral Programme in Nursing Science between 2014 and 2020. Our discussions in the seminars and your feedback helped me to develop my research and thinking further. Special thanks to PhD Camilla Strandell-Laine, PhD Anu-Marja Kaihlanen, MNSc Hanna Repo-Jamal and MNSc Yunsuk Jeon. I owe my sincere gratitude especially to my fellow PhD-student, colleague and dear friend MNSc Jonna Vierula. I have had a privilege to share this journey with you – our reflective discussions have been invaluable support for me. I would also like to thank Research in Nursing Education (RENE) group, which has provided possibilities to share ideas and update latest information about research in nursing education. Moreover, I wish to thank the European Academy of Nursing Science (EANS) Summer School, in which I had a privilege to participate in 2015 – 2017.

I want to thank all my co-workers and managers in Laurea University of Applied Sciences. You have helped my dissertation process with your genuine interest and supportive discussions. I am grateful to development manager, MHS Heli Karjalainen, former director, PhD Kati Komulainen and the whole Laurea community for your flexibility and enabling study leaves, which allowed me to focus on my research in its most intense phases. Thank you Kati for your support and discussions in our unofficial doctoral students' meetings.

I would like to express my gratitude to my friends. You have encouraged me to proceed further and believed in me. You have also helped me to keep my feet on the ground and put my studies aside every now and then. My special thanks go to Laura, Marko, Johanna & Pekka, Jaakko, Hummelin family, Mikkola family, Timo & Walt, Ilkka & Jani, Elina, Kristiina and Tiina. I am deeply grateful to my parents Maija and Olavi for always supporting my choices and me in different stages of life.

Last, but not least, I owe my deepest gratitude to my soul mate and partner in life, my husband Antti. You have supported and encouraged me through thick and thin by listening my sorrows and celebrating successful moments. Thank you for taking this journey with me and always believing in me.

The study was supported financially by the Doctoral Programme in Nursing Science, the Turku University Foundation, the Finnish Foundation for Nursing Education and Finnish Nurses Association.

25.4.2021
Mika Alastalo

References

Aiken, L., Sloane, D., Bruyneel, L., Van den Heede, K., Griffiths, P., Busse, R., . . . Sermeus, W. (2014). Nurse staffi ng and education and hospital mortality in nine European countries: a retrospective observational study. *Lancet, 383*, 1824-1830.

Aitken, L. (2000). Expert critical care nurses' use of pulmonary artery pressure monitoring. Intensive and Critical Care Nursing, 16(4), 209-220.

Aitken, L. (2003). Critical care nurses’ use of decision-making strategies. Journal of Clinical Nursing, 12(4), 476–483.

Aitken, L., Chaboyer, W., & Marshall, A. (2019). Section 1 - Scope of critical care. In L. Aitken, A. Marshall, & W. Chaboyer, Critical Care Nursing (4 ed.). Chatswood, Australia: Elsevier.

Aitken, L., Marshall, A., Elliot, R., & McKinley, S. (2009). Critical care nurses’ decision-making: sedation assessment and management in intensive care. Journal of Clinical Nursing, 18(1), 36–45.

Ala-Kokko, T., & Pettilä, V. (2018). Kenelle tehohoitoa annetaan? Duodecim, 134, 165-166.

ALLEA - All European Academies. (2017). The European Code of Conduct for Research Integrity. Revised edition. Retrieved September 3, 2020, from https://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf

American association of Critical Care Nurses. (2018). AACN Practice Alert. Assessing Pain in Critically Ill Adults. Critical Care Nurse, 38(6), e13–e16.

Attin, M., Cardin, S., Dee, V., Doering, L., Dunn, D., Ellstrom, K., . . . Olson, L. (2002). An Educational Project to Improve Knowledge Related to Pulse Oximetry. American Journal of Critical Care, 11(6), 529-534.

Aziz, S., Arabi, Y., Alhazzani, W., Evans, L., Citerio, G., Fischkoff, K., . . . Chu, L. e. (2020). Managing ICU surge during the COVID-19 crisis: rapid guidelines. Intensive Care Medicine. doi:10.1007/s00134-020-06092-5

Ballangrud, R., Persenius, M., Hedelin, B., & Hall-Lord, M. (2014). Exploring intensive care nurses’ team performance in a simulation-based emergency situation, − expert raters’ assessments versus self-assessments: an explorative study . BMC Nursing, 13(47).

Baxter, P., & Norman, G. (2011). Self-assessment or self deception? A lack of association between nursing students’ self-assessment and performance. Journal of Advanced Nursing, 67, 2406–2413.

Benbenishty, J., DeKeyser Ganz, F., & Adam, S. (2005). Differences in European critical care nursing practice: a pilot study. Intensive and Critical Care Nursing, 21(3), 172–178.

Benner, P. (1984). From Novice to Expert. Excellence and Power in Clinical Nursing Practice. Menlo Park: Addison-Wesley Publishing Company.

Benner, P. (2004). Using the Dreyfus Model of Skill Acquisition to Describe and Interpret Skill Acquisition and Clinical Judgment in Nursing Practice and Education. Bulletin of Science, Technology & Society, 24(3), 188–199.

Berthelsen, P., & Cronqvist, M. (2003). The first intensive care unit in the world: Copenhagen 1953. Acta Anaesthesiologica Scandinavica, 47, 1190-1195.

Björn, A., Pudas-Tähkä, S., Salanterä, S., & Axelin, A. (2017). Video education for critical care nurses to assess pain with a behavioral pain assessment tool: A descriptive comparative study. Intensive and Critical Care Nursing, 42, 68-74.

Boyle, M., Kenney, C., & Butcher, R. (1995). The development of the Australian basic intensive care knowledge test. Australian Critical Care, 8(2), 10-17.

Brannan, J., White, A., & Bezanson, J. (2008). Simulator Effects on Cognitive Skills and Confidence Levels. Journal of Nursing Education, 47, 495–500.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3, 77-101.

Braun, V., & Clarke, V. (2014). What can "thematic analysis" offer health and wellbeing research? International Journal of Qualitative Studies on Health and Well-being, 9(1).

Braun, V., & Clarke, V. (2020). One size fits all? What counts as quality practice in (reflexive) thematic analysis? Qualitative Research in Psychology. doi:10.1080/14780887.2020.1769238

Brickman, D., Greenway, A., Sobocinski, K., Thai, H., Turick, A., Xuereb, K., . . . Liu, S. (2020). Rapid Critical Care Training of Nurses in the Surge Response to the Coronavirus Pandemic. American Journal of Critical Care, 29(4), 104-107.

Buchanan Keller, K., & Raines, D. (2005). Arrhythmia knowledge: A qualitative study. Heart & Lung, 34, 309–316.

Bäckström, S., & Gustafsson, M. (2017). Skill, Drill, and Intelligent Performance: Ryle and Intellectualism. Journal for the History of Analytical Philosophy, 5(5), 40–55.

Capuzzo, M., Volta, C., Tassinati, T., Moreno, R., Valentin, A., Guidet, B., . . . Rhodes, A. (2014). Hospital mortality of adults admitted to Intensive Care Units in hospitals with and without Intermediate Care Units: a multicentre European cohort study. Critical Care, 18(5), 551.

Cecconi, M., De Backer, D., Antonelli, M., Beale, R., Bakker, J., Hofer, C., . . . Rhodes, A. (2014). Consensus on circulatory shock and hemodynamic monitoring. Task force of the European Society of Intensive Care Medicine. Intensive Care Medicine, 40, 1795-1815.

Choi, J., Campbell, M., Gélinas, C., Happ, M., Tate, J., & Chlan, L. (2017). Symptom assessment in non-vocal or cognitively impaired ICU patients: Implications for practice and future research. Heart & Lung, 46, 239–245.

Christensen, M., & Barnes, A. (2012). Intra-arterial waveform analysis: a study of senior nurse knowledge in a general intensive care unit. Journal of Clinical Nursing, 22, 1783–1785.

Christensen, W., Sutton, J., & McIlwain, D. (2016). Cognition in Skilled Action: Meshed Control and the Varieties of Skills Experience. Mind & Language, 31(1), 37– 66.

Cicolini, G., Tomietto, M., Simonetti, V., Comparcini, D., Flacco, M., Carvello, M., & Manzoli, L. (2015). Physical assessment techniques performed by Italian registered nurses: a quantitative survey. . Journal of Clinical Nursing, 24, 3700–3706.

CINAHL Subject Headings. (2020a). Critical Care Nursing. Retrieved August 31, 2020, from http://web.a.ebscohost.com.ezproxy.utu.fi/ehost/mesh?vid=3&sid=8c5e365c-37d5-4c9e-abdd-0a9e5d0bd52e%40sessionmgr4007

CINAHL Subject Headings. (2020b). Patient assessment. Retrieved August 31, 2020, from http://web.a.ebscohost.com.ezproxy.utu.fi/ehost/mesh?vid=6&sid=8c5e365c-37d5-4c9e-abdd-0a9e5d0bd52e%40sessionmgr4007

Cioffi, J., Scott, J., & Senior, J. (2009). 'Patients of concern' to nurses in acute care settings: A descriptive study. Australian Critical Care. Australian Critical Care, 22, 178–186.

Collins English Dictionary. (2020). Skill. Retrieved August 31, 2020, from https://www.collinsdictionary.com/dictionary/english/skill

Colorafi, K., & Evans, B. (2016). Qualitative Descriptive Methods in Health Science Research. Health Environments Research & Design Journal, 9(4), 16-25.

Coombs, M., & Moorse, S. (2002). Physical assessment skills: a developing dimension of clinical nursing practice. *Intensive and Critical Care Nursing, 18*(4), 200–210.

Cowan, D., Wilson-Barnett, J., Norman, I., & Murrells, T. (2008). Measuring nursing competence: development of a self-assessment tool for general nurses across Europe. *International Journal of Nursing Studies, 45*, 902–913.

Crocker, C. (2007). The development of critical care in England. *Intensive and Critical Care Nursing, 23*, 323-330.

Currey, J., & Botti, M. (2006). The influence of patient complexity and nurses' experience on haemodynamic decision-making following cardiac surgery. *Intensive and Critical Care Nursing, 22*, 194–205.

Currey, J., Massey, D., Allen, J., & Jones, D. (2018). What nurses involved in a Medical Emergency Teams consider the most vital areas of knowledge and skill when delivering care to the deteriorating ward patient. A nurse-oriented curriculum development project. *Nurse Education Today, 67*, 77-82.

Dankbaar, M., Alsma, J., Jansen, E., van Merrienboer, J., van Saase, J., & Schuit, S. (2016). An experimental study on the effects of a simulation game on students' clinical cognitive skills and motivation. *Advances in Health Sciences Education, 21*, 505–521.

De Georgia, M., Kaffashi, F., Jacono, F., & Loparo, K. (2015). Information Technology in Critical Care: Review of Monitoring and Data Acquisition Systems for Patient Care and Research. *The Scientific World Journal*, Article ID 727694,. doi:10.1155/2015/727694

DeGrande, H., Liu, F., Greene, P., & Stankus, J. (2018). Developing professional competence among critical care nurses: An integrative review of literature. *Intensive and Critical Care Nursing, 49*, 65–71.

DeVellis, R. (2017). *Scale development : theory and applications* (4 ed.). Los Angeles: Sage.

DeVon, H., Block, M. M.-W., DM, E., Hayden, S., Lazzara, D., Savoy, S., & Kostas-Polston, E. (2007). A Psychometric Toolbox for Testing Validity and Reliability. *Journal of Nursing Scholarship, 39*(2), 155-164.

Doig, A., Drews, F., & Keefe, M. (2011). Informing the Design of Hemodynamic Monitoring Displays. *CIN: Computer, Informatics, Nursing, 29*(12), 706–713.

Doody, O., Slevin, E., & Taggart, L. (2013). Focus group interviews in nursing research: part 1. *British Journal of Nursing, 22*(1), 16-19.

Doyle, L., McCabe, C., Keogh, B., Brady, A., & McCann, M. (2020). An overview of the qualitative descriptive design within nursing research. *Journal of Research in Nursing, 25*(5), 443–455.

Drew, B., Harris, P., Zègre-Hemsey, J., Mammone, T., Schindler, D., Salas-Boni, R., . . . Hu, X. (2014). Insights into the problem of alarm fatigue with physiologic monitor devices: a comprehensive observational study of consecutive intensive care unit patients. *PLoS One, 9*(10).

Dreyfus, S. (2004). The Five-Stage Model of Adult Skill Acquisition . *Bulletin of Science, Technology & Society, 24*(3), 177–181.

Dreyfus, S., & Dreyfus, H. (1980). *A five-stage model of the mental activities involved in direct skill acquisition.* Berkeley: University of California. Retrieved August 31, 2020, from https://apps.dtic.mil/dtic/tr/fulltext/u2/a084551.pdf

Egerod, I., Kaldan, G., Lindahl, B., Sætre Hansen, B., Froulund Jensen, J., Oxenbøll Collet, M., . . . Jensen, H. (2020). Trends and recommendations for critical care nursing research in the Nordic countries: Triangulation of review and survey data. *Intensive and Critical Care Nursing, 56*. doi:10.1016/j.iccn.2019.102765

Ekeloef, S., Thygesen, L., & Gögenur, I. (2019). Short- and long-term mortality in major non-cardiac surgical patients admitted to the intensive care unit. *Acta Anaesthesiologica Scandinavica, 63*, 639–646.

Elliot, M., & Coventry, A. (2012). Critical care: the eight vital signs of patient monitoring. *British Journal of Nursing, 21*(10), 621–625.

Eltaybani, S., Mohamed, N., & Abdelwareth, M. (2018). Nature of nursing errors and their contributing factors in intensive care units. *Nursing in Critical Care, 24*, 47–54.

Endacott, R., Jones, C., Bloomer, M., Boulanger, C., Ben Nun, M., Iliopoulou, K., . . . Blot, S. (2015). The state of critical care nursing education in Europe: an international survey. *Intensive Care Medicine, 41*, 2237–2240.

Epstein, R., Siegel, D., & Silberman, J. (2008). Self-monitoring in clinical practice: A challenge for medical educators. *Journal of Continuing Education in the Health Professions, 28*, 5-13.

Eriksson, E., Korhonen, T., Merasto, M., & Moisio, E. (2015). *Sairaanhoitajan ammatillinen osaaminen – Sairaanhoitajakoulutuksen tulevaisuus-hanke (The nurse competence – the future of the nursig education-project).* Retrieved August 31, 2020, from https://sairaanhoitajat.fi/wp-content/uploads/2015/09/Sairaanhoitajan-ammatillinen-osaaminen.pdf

European federation of Critical Care Nursing associations. (2004). *Position Statement on Post-registration Critical Care Nursing Education within Europe.* Retrieved August 31, 2020, from https://www.efccna.org/images/stories/publication/2004_position_statement_on_post_registration_cc.pdf

European federation of Critical Care Nursing associations. (2007). *Position Statement on Workforce Requirements in Critical Care Units.* Retrieved August 31, 2020, from https://www.efccna.org/images/stories/publication/2007_ps_workforce_requirements_neu.pdf

European federation of Critical Care Nursing associations. (2013). *EfCCNa Competencies for European Critical Care Nurses.* Retrieved August 31, 2020, from https://www.efccna.org/images/stories/publication/competencies_cc.pdf on

Finnish Advisory Board of Research Integrity. (2012). *Responsible conduct of research and procedures for handling allegations of misconduct in Finland.* Retrieved September 3, 2020, from https://tenk.fi/sites/tenk.fi/files/HTK_ohje_2012.pdf

Finnish National Board on Research Integrity. (2019). *The ethical principles of research with human participants and ethical review in the human sciences in Finland.* Retrieved September 3, 2020, from https://www.tenk.fi/sites/tenk.fi/files/Ihmistieteiden_eettisen_ennakkoarvioinnin_ohje_2019.pdf

Finnish Nurses Association. (2020). *Tilastoja sairaanhoitajista*. Retrieved October 9, 2020, from https://sairaanhoitajat.fi/ammatti-ja-osaaminen/tilastoja-sairaanhoitajista-2/

Fisher, M., Marshall, A., & Kendrick, T. (2005). Competency standards for critical care nurses: do they measure up? *Australian Journal of Advanced Nursing, 22*, 32-39.

Forsman, H., Jansson, I., Leksell, J., Lepp, M., Sundin Andersson, C., Engström, M., & Nilsson, J. (2020). Clusters of competence: Relationship between self-reported professional competence and achievement on a national examination among graduating nursing students. *Journal of Advanced Nursing, 76*, 199-208.

Franklin, N., & Melville, P. (2015). Competency assessment tools: An exploration of the pedagogical issues facing competency assessment for nurses in the clinical environment. *Collegian, 22*, 25–31.

Frazier, S., Moser, D., Riegel, B., McKinley, S., Blakely, W., Kim, K., & Garvin, B. (2002). Critical care nurses' assessment of patients' anxiety: Reliance of physiological and behavioral parameters. *American Journal of Critical Care, 11*(1), 57–64.

Freysdóttir, G., Björnsdóttir, K., & Svavarsdóttir, M. (2019). Nurses' use of monitors in patient surveillance: an ethnographic study on a coronary care unit. *European Journal of Cardiovascular Nursing, 18*, 272–279.

Fridland, E. (2015). Skill, Nonpropositional Thought, and the Cognitive Penetrability of Perception . *Journal for General Philosophy of Science, 46*, 105–120.

Fulbrook, P., Albarran, J., Baktoft, B., & Sidebottom, B. (2012). A survey of European intensive care nurses' knowledge levels. *International Journal of Nursing Studies, 49*, 191–200.

Garside, J., & Nhemachena, J. (2013). A concept analysis of competence and its transition in nursing. *Nurse Education Today, 33*, 541–545.

Gélinas, C., Bérubé, M., Chevrier, A., Pun, B., Ely, E., Skrobik, Y., & Barr, J. (2018). Delirium Assessment Tools for Use in Critically Ill Adults: A Psychometric Analysis and Systematic Review. *Critical Care Nurse, 38*, 38-49.

Gerth, A., Hatch, R., Young, J., & Watkinson, P. (2019). Changes in health-related quality of life after discharge from an intensive care unit: a systematic review. *Anaesthesia, 74*, 100–108.

Gill, F., Leslie, G., Grech, C., Boldy, D., & Latour, J. (2014). Development of Australian clinical practice outcome standards for graduates of critical care nurse education. *Journal of Clinical Nursing, 24*, 486–499.

Gill, F., Lin, F., Massey, D., Wilson, L., Greenwood, M., Skylas, K., . . . Gullick, J. (2019). Development of a position statement for Australian critical care nurse education. *Australian Critical Care, 32*, 346-350.

Giuliano, K., & Liu, L. (2006). Knowledge of Pulse Oximetry among Critical Care Nurses. *Dimensions of Critical Care Nursing, 25*(1), 44–49.

Gomarverdi, S., Khatiban, M., Bikmoradi, A., & Soltanian, A. (2019). Effects of a multi-component educational intervention on nurses' knowledge and adherence to standard precautions in intensive care units. *Journal of Infection Prevention, 20*, 83-90.

Gray, S., Christensen, M., & Craft, J. (2018). The gastro-renal effects of intra-abdominal hypertension: Implications for critical care nurses. *Intensive and Critical Care Nursing, 48*, 69–74.

Grenvik, A., & Pinsky, M. (2009). Evolution of the Intensive Care Unit as a Clinical Center and Critical Care Medicine as Discipline. *Critical Care Clinics, 25*, 239–250.

Grove, S., Burns, N., & Gray, J. (2013). *The Practice of Nursing Research: Appraisal, Synthesis, and Generation of Evidence* (7 ed.). St Louis: Elsevier.

Guidet, B., van der Hoort, P., & Csomos, A. (2017). Intensive care in 2050: healthcare expenditure. *Intensive Care Medicine, 43*, 1141-1143.

Gullick, J., Lin, F., Massey, D., Wilson, L., Greenwood, M., Skylas, K., . . . Gil, F. (2019). Structures, processes and outcomes of specialist critical care nurse education: An integrative review. *Australian Critical Care, 32*, 331–345.

Haladyna, T. (2004). *Developing and validating multiple-choice test items* (3 ed.). New York City: Routledge.

Hardenberg, J., Indrajeetsinh, R., & Tori, K. (2019). Simulation Exposure Improves Clinical Skills for Postgraduate Critical Care Nurses. *Clinical Simulation in Nursing, 28*, 39–45.

Harrison, L., & Nixon, G. (2002). Nursing activity in general intensive care. *Journal of Clinical Nursing, 11*(2), 158–167.

Hasson, F., McKenna, H., & Keeney, S. (2015). Surveys. In K. Gerrish, & J. Lathlean, *The Research Process in Nursing* (7 ed.). Chichester: John Wiley & Sons.

Haugdahl, H., & Storli, S. (2012). 'In a way, you have to pull the patient out of that state…': the competency of ventilator weaning. *Nursing Inquiry, 19*(3), 238–246.

Hoffman, K., Aitken, L., & Duffield, C. (2009). A comparison of novice and expert nurses' cue collection during clinical decision-making: Verbal protocol analysis. *International Journal of Nursing Studies, 46*(10), 1335–1344.

Holloway, I., & Galvin, K. (2017). *Qualitative Research in Nursing and Healthcare* (4 ed.). Chichester: John Wiley & Sons.

Hopia, H., & Heikkilä, J. (2020). Nursing research priorities based on CINAHL database: A scoping review. *Nursing Open, 7*, 483-494.

Hopia, H., Latvala, E., & Liimatainen, L. (2016). Reviewing the methodology of an integrative review. *Scandinavian Journal of Caring Sciences, 30*, 662–669.

Humburg, M., & van der Velden, R. (2015). Self-assessments or tests? Comparing cross-national differences in patterns and outcomes of graduates' skills based on international large-scale survey. *Studies in Higher Education, 40*, 482-504.

Hunt, L., Frost, S., Newton, P., Salamonson, Y., & Davidson, P. (2017). A survey of critical care nurses' knowledge of intra-abdominal hypertension and abdominal compartment syndrome. *Australian Critical Care, 30*, 21–27.

Hutri, I. (2019). *Sairaanhoitajien hoitotyön toimintojen osaaminen SAV-potilaan tehohoidossa.* University of Eastern Finland. Retrieved October 6, 2020, from https://epublications.uef.fi/pub/urn_nbn_fi_uef-20200022/urn_nbn_fi_uef-20200022.pdf

Häggström, M., Bergsman, A., Månsson, U., & Holmström, M. (2017). Learning to manage vasoactive drugs-A qualitative interview study with critical care nurses. *Intensive and Critical Care Nursing, 39*, 1-8.

Jansson, M., Ala-Kokko, T., Ylipalosaari, P., Syrjälä, H., & Kyngäs, H. (2013). Critical care nurses' knowledge of, adherence to and barriers towards evidence-based guidelines for the prevention of ventilator-associated pneumonia — A survey study. *Intensive and Critical Care Nursing, 29*, 216-227.

Jansson, M., Ohtonen, P., Syrjälä, H., & Ala-Kokko, T. (2020). The proportion of understaffing and increased nursing workload are associated with multiple organ failure: A cross-sectional study. *Journal of Advanced Nursing, 76*, 2113–2124.

Jansson, M., Syrjälä, H., & Ala-Kokko, T. (2019). Association of nurse staffing and nursing workload with ventilator-associated pneumonia and mortality: a prospective, single-center cohort study. *Journal of Hospital Infection, 101*, 257-263.

Jeon, Y., Lahtinen, P., Meretoja, R., & Leino-Kilpi, H. (2015). Anaesthesia nursing education in the Nordic countries: Literature review. *Nurse Education Today, 35*(5), 680-688.

Jones, A., & Johnstone, M. (2017). Inattentional blindness and failures to rescue the deteriorating patient in critical care, emergency and perioperative settings: four case scenarios. *Australian Critical Care, 30*, 219–223.

Jones, S., Murphy, F., Edwards, M., & James, J. (2008). Doing things differently: advantages and disadvantages of web questionnaires. *Nurse Researcher, 15*(4), 15-26.

Jukarainen, S., Mildh, H., Pettilä, V., Häkkinen, U., Peltola, M., T, A.-K., . . . Vaara, S. (2020). Costs and Cost-Utility of Critical Care and Subsequent Health Care: A Multicenter Prospective Study. *Critical Care Medicine*, e345-e355. doi:10.1097/CCM.0000000000004210

Kaarlola, A., Pettilä, V., & Kekki, P. (2003). Quality of life six years after intensive care. *Intensive Care Medicine, 29*, 1294-1299.

Kajander-Unkuri, S., Leino-Kilpi, H., Katajisto, J., Meretoja, R., Räisänen, A., Saarikoski, M., . . . Suhonen, R. (2016). Congruence between graduating nursing students' self-assessments and mentors' assessments of students' nurse competence. *Collegian, 23*, 303–312.

Kajander-Unkuri, S., Melender, H., Kanerva, A., Korhonen, T., Suikkanen, A., & Silén-Lipponen, M. (2020). Sairaanhoitajan osaamisvaatimukset - suomalainen koulutus 2020-luvulle. In M. Silén-Lipponen, & T. Korhonen, *Osaamisen ja arvioinnin yhtenäistäminen sairaanhoitajakoulutuksessa - yleSHarviointi-hanke* (pp. 22-30). Kuopio: Savonia-ammattikorkeakoulun julkaisusarja. Retrieved from https://www.theseus.fi/handle/10024/347289

Kajander-Unkuri, S., Meretoja, R., Katajisto, J., Saarikoski, M., Salminen, L., Suhonen, R., & Leino-Kilpi, H. (2014). Self-assessed level of competence of graduating nursing students and factors related to it. *Nurse Education Today, 34*, 795–801.

Kallio, H., Pietilä, A., Johnson, M., & Kangasniemi, M. (2016). Systematic methodological review: developing a framework for a qualitative semi-structured interview guide. *Journal of Advanced Nursing, 72*(12), 2954-2965.

Karra, V., Papathanassoglou, E., Lemonidou, C., Sourtzi, P., & Giannakopoulou, M. (2014). Exploration and classification of intensive care nurses' clinical decisions: a Greek perspective. *Nursing in Critical Care, 19*(2), 87–96.

Kaya, H., Kaya, N., Turan, Y., Tan, Y., Terzi, B., & Barlas, B. (2011). Nursing activities in intensive care units in Turkey. *International Journal of Nursing Practice, 17*(3), 304–314.

Kebapçı, A.;Dikeç, G.;& Topçu, S. (2020). Interobserver Reliability of Glasgow Coma Scale Scores for Intensive Care Unit Patients. *Critical Care Nurse, 40*(4), 18–26.

Kelly, D., Kutney-Lee, A., McHugh, M., Sloane, D., & Aiken, L. (2014a). Impact of Critical Care Nursing on 30-Day Mortality of Mechanically Ventilated Older Adults. *Critical Care Medicine, 42*, 1089–1095.

Kelly, F., Fong, K., Hirsch, N., & Nolan, J. (2014b). Intensive care medicine is 60 years old: the history and future of the intensive care unit. *Clinical Medicine, 14*(4), 376-379.

Kerr, R., Bacon, A., Baker, L., Gehrke, J., Hahn, K., Lillegraven, C., . . . SK., S. (2016). Underestimation of Pupil Size by Critical Care and Neurosurgical Nurses. *American Journal of Critical Care, 25*(3), 213–219.

Kiekkas, P., Brokalaki, H., Manolis, E., Samios, A., Skartsani, C., & Baltopoulos, G. (2007). Patient severity as an indicator of nursing workload in the intensive care unit. *Nursing in Critical Care, 12*(1), 34-41.

Kiekkas, P., Theodorakopoulou, G., Spyratos, F., & Baltopoulos, G. (2010). Psychological distress and delusional memories after critical care: a literature review. *International Nursing Review, 57*, 288–296.

Kindle, R., Badawi, O., Celi, L., & Sturland, S. (2019). Intensive Care Unit Telemedicine in the Era of Big Data, Artificial Intelligence, and Computer Clinical Decision Support systems. *Critical Care Clinics, 35*, 483–495.

Kleinpell, R. (2003). The role of the critical care nurse in the assessment and management of the patient with severe sepsis. *Critical Care Nursing Clinics of North America, 15*, 27–43.

Knol, J., & Keller, D. (2019). Cognitive skills training in digital era: A paradigm shift in surgical education using the TaTME model. *The Surgeon, 17*, 28–32.

Kulju, K., Suhonen, R., Puukka, P., Tolvanen, A., & Leino-Kilpi, H. (2020). Self-evaluated ethical competence of a practicing physiotherapist: a national study in Finland. *BMC Medical Ethics, 21:43*.

Kvande, M., Delmar, C., Lykkeslet, E., & Storli, S. (2015). Foresight and awareness of incipient changes in a patient' clinical conditions — Perspectives of intensive care nurses. *Intensive and Critical Care Nursing, 31*, 261–268.

Kvande, M., Delmar, C., Lykkeslet, E., & Storli, S. (2016). Assessing changes in a patient's condition – perspectives of intensive care nurses. *Nursing in Critical Care, 22*(2), 99–104.

Kvande, M., Lykkeslet, E., & Storli, S. (2017). ICU nurses and physicians dialogue regarding patients clinical status and care options—a focus group study. *International Journal of Qualitative Studies on Health and Well-being, 12*(1), 1–8.

Kydonaki, K., Huby, G., Tocher, J., & Aitken, L. (2016). Understanding nurses' decision-making when managing weaning from mechanical ventilation: a study of novice and experienced critical care nurses in Scotland and Greece. *Journal of Clinical Nursing, 25*, 434–444.

Labeau, S., Vandijck, D., Rello, J., Adam, S., Rosa, A., Wenisch, C., . . . Blot, S. (2008). Evidence-based guidelines for the prevention of ventilator-associated pneumonia: results of a knowledge test among European intensive care nurses. *Journal of Hospital Infection, 70*, 180-185.

Lakanmaa, R., Suominen, T., Perttilä, J., Puukka, P., & Leino-Kilpi, H. (2012). Competence requirements in intensive and critical care nursing — Still in need of definition? A Delphi study. *Intensive and critical care nursing, 28*, 329–336.

Lakanmaa, R., Suominen, T., Perttilä, J., Ritmala-Castrén, M., Vahlberg, T., & Leino-Kilpi, H. (2013a). Basic competence in intensive and critical care nursing: development and psychometric testing of a competence scale. *Journal of Clinical Nursing, 23*, 799–810.

Lakanmaa, R., Suominen, T., Perttilä, J., Ritmala-Castrén, M., Vahlberg, T., & Leino-Kilpi, H. (2013b). Graduating nursing students' basic competence in intensive and critical care nursing. *Journal of Clinical Nursing, 23*, 645-653.

Lakanmaa, R., Suominen, T., Ritmala-Castrén, M., Vahlberg, T., & Leino-Kilpi, H. (2015). Basic Competence of Intensive Care Unit Nurses: Cross-Sectional Survey Study. *BioMed Research International*, Article ID 536724, 12 pages.

Lake, S., & McInnes, R. (2012). Exploring cognitive skill development in midwifery education. *Nurse Education in Practice, 12*, 264–268.

Lauri, S., Salanterä, S., Clark Callister, L., Harrison, K., Käppeli, S., & MacLeod, M. (1998). Decision making of nurses practicing in intensive care in Canada, Finland, Northern Ireland, Switzerland, and the United States. *Heart & Lung, 27*(2), 133-142.

Lavoie, P., Pepin, J., & Alderson, M. (2014). Defining patient deterioration through acute care and intensive care nurses' perspectives. *Nursing in Critical Care, 21*, 68–77.

Levett-Jones, T., Hoffman, K., Dempsey, J., Yeun-Sim Jeong, S., Noble, D., Norton, C., . . . Hickey, N. (2010). The'five rights'of clinical reasoning: An educational model to enhance nursing students' ability to identify and manage clinically'at risk'patients. *Nurse Education Today, 30*(6), 515-520.

Li, B., Tang, S., Ma, Y., Tang, J., Wang, B., & Wang, J. (2014). Analysis of bowel sounds application status for gastrointestinal function monitoring in the intensive care unit. *Critical Care Nursing Quarterly, 37*, 199-206.

Lundgrén-Laine, H., & Suominen, T. (2007). Nursing intensity and patient classification at an adult intensive care unit (ICU). *Intensive and Critical Care Nursing, 23*, 97–103.

Lundgrén-Laine, H., Kontio, E., Perttilä, J., Korvenranta, H., Forsström, J., & Salanterä, S. (2011). Managing daily intensive care activities: An observational study concerning ad hoc decision making of charge nurses and intensivists. *Critical Care 2011*, 15:R188.

Maclay, T., & Rephann, A. (2017). The Impact of Early Identification and a Critical Care–Based Sepsis Response Team on Sepsis Outcomes. *Critical Care Nurse, 37*(6), 88–91.

Manias, E., & Street, A. (2001). Nurse-doctor interactions during critical care ward rounds. *Journal of Clinical Nursing, 10*, 442–450.

Marshall, J., Bosco, L., Adhikari, N., Connolly, B., Diaz, J., Dorman, T., . . . Zimmerman, J. (2017). What is an intensive care unit? A report of the task force of the World Federation of Societies of Intensive Care Medicine. *Journal of Critical Care, 37*, 270-276.

McDonald, M. (2018). *The Nurse Educator's Guide to Assessing Learning Outcomes* (Vol. 4). Burlington: Jones & Bartlett Learning.

McGhee, B., & Woods, S. (2001). Critical Care Nurses Knowledge of Arterial Pressure Monitoring. *American Journal of Critical Care, 10*(1), 43–51.

McPeake, J., Bateson, M., & O'Neill, A. (2014). Electronic surveys: how to maximise success. *Nurse Researcher, 21*(3), 24-26.

Medic, G., Kließ, M., Atallah, L., Weichert, J., Panda, S., Postma, M., & EL-Kerdi, A. (2019). Evidence-based Clinical Decision Support Systems for three disease states in critical care: A systematic literature review. *F1000Research, 8*. doi:10.12688/f1000research.20498.2

Meretoja, R., Isoaho, H., & Leino-Kilpi, H. (2004a). Nurse Competence Scale: development and psychometric testing. *Journal of Advanced Nursing, 47*(2), 124–133.

Meretoja, R., Leino-Kilpi, H., & Kaira, A. (2004b). Comparison of nurse competence in different hospital work environments. *Journal of Nursing Management, 12*, 329–336.

Meriläinen, M., Kyngäs, H., & Ala-Kokko, T. (2010). 24-Hour intensive care: An observational study of an environment and events. *Intensive and Critical Care Nursing, 26*, 246-253.

Meriläinen, M., Kyngäs, H., & Ala-Kokko, T. (2013). Patients' interactions in an intensive care unit and their memories of intensive care: A mixed method study. *Intensive and Critical Care Nursing, 29*, 78-87.

Merriam-Webster Dictionary. (2020). *Skill.* Retrieved August 31, 2020, from https://www.merriam-webster.com/dictionary/skill

Milhomme, D., Cagnon, J., & Lechasseur, K. (2018). The clinical surveillance process as carried out by expert nurses in a critical care context: A theoretical explanation. *Intensive and Critical Care Nursing, 44*, 24–30.

Milne, J., & Oberle, K. (2005). Enhancing Rigor in Qualitative Description. Case Study. *Journal of Wound, Ostomy and Continence Nursing, 32*(6), 413-420.

Miranda, D., Nap, R., de Rijk, A., Schaufeli, W., & Iapichino, G. (2003). Nursing activities score. *Critical Care Medicine, 31*(2), 374–382.

Mitchell, M., Strube, P., Vaux, A., West, N., & Auditore, A. (2013). Right Person, Right Skills, Right Job. *JONA: The Journal of Nursing Administration, 43*(10), 543-548.

Moore Jr, D. (2018). Assessment of Learning and Program Evaluation in Health Professions Education Programs. *New Directions for Adult and Continuing Education*(157), 51-64.

Moser, D., Chung, M., McKinley, S., Riegel, B., Kyungeh, A., Cherrington, C., . . . Garvin, B. (2003). Critical care nursing practice regarding patient anxiety assessment and management. *Intensive and Critical Care Nursing, 19*(5), 276–288.

Myers, H., Pugh, J., & Twigg, D. (2018). Identifying nurse-sensitive indicators for stand-alone high acuity areas: A systematic review. *Collegian, 25*, 447-456.

O'Leary, J. (2012). Comparison of self-assessed competence and experience among critical care nurses. *Journal of Nursing Management, 20*, 607–614.

O'Shaughnessy, S., & Joyce, P. (2015). Summative and Formative Assessment in Medicine: The Experience of an Anaesthesia Trainee. *International Journal of Higher Education, 4*, 198-206.

Okumura, M., Ishigaki, T., Mori, K., & Fujiwara, Y. (2019). Development of an easy-to-use questionnaire assessing critical care nursing competence in Japan: A cross-sectional study. . *PLOS ONE*. Retrieved August 31, 2020, from https://doi.org/10.1371/journal.pone.0225668

Opintopolku. (2020). *Sairaanhoitaja (AMK), päivätoteutus.* Retrieved September 18, 2020, from https://opintopolku.fi/app/#!/korkeakoulu/1.2.246.562.17.77035523545

Paakkonen, H. (2008). *The Contemporary and Future Clinical Skills of Emergency Department Nurses. Experts' Perceptions Using Delphi- Technique.* Kuopio University Publications E. Social Sciences 163.

Padilha, K., Sousa, R., Queijo, A., Mendes, A., & Miranda, D. (2008). Nursing Activities Score in the intensive care unit: Analysis of the related factors. *Intensive and Critical Care Nursing, 24*, 197–204.

Panadero, E., & Alonso-Tapia, J. (2013). Self-assessment: Theoretical and practical connotations. When it happens, how is it acquired and what to do to develop it in our students? *Electronic Journal of Research in Educational Psychology, 11*, 551-576.

Papathanassoglou, E., Karanikola, M., Kalafati, M., Giannakopouluo, M., Lemonidou, C., & Albarran, J. (2012). Professional Autonomy, Collaboration with Physicians, and Moral Distress Among European Intensive Care Nurses. *American Journal of Critical Care, 21*(2), 41-52.

Papathanassoglou, E., Tseroni, M., Karydaki, A., Vazaiou, G., Kassikou, J., & Lavdaniti, M. (2005). Practice and clinical decision-making among Hellenic critical care nurses. *Journal of Nursing Management, 13*(2), 154–164.

Pavese, C. (2016a). Skill in epistemology I: Skill and knowledge. *Philosophy Compass, 11*, 642–649.

Pavese, C. (2016b). Skill in epistemology II: Skill and know how. *Philosophy Compass, 11*, 650–660.

Phua, J., Faruq, M., Kulkarni, A., Redjeki, I., Detleuxay, K., Mendsaikhan, N., & Sann, K. f. (2020a). Critical Care Bed Capacity in Asian Countries and Regions. *Critical Care Medicine*. doi:10.1097/CCM.0000000000004222

Phua, J., Weng, L., Ling, L., Egi, M., Lim, C., Divatia, J., . . . Du, B. (2020b). Intensive care management of coronavirus disease 2019 (COVID-19): challenges and recommendations. *Lancet Respiratory Medicine, 8*, 506-517.

Pijl-Zieber, E., Barton, S., Konkin, J., Awusoga, O., & Caine, V. (2014). Competence and competency-based nursing education: Finding our way through the issues. *Nurse Education Today, 34*, 676–678.

Pires, S., Monteiro, S., Pereira, A., Chaló, D., Melo, E., & Rodrigues, A. (2017). Non-technical skills assessment for prelicensure nursing students: An integrative review. *Nurse Education Today, 58*, 19–24.

Polit, D., & Beck, C. (2017). *Nursing Research: Generating and Assessing Evidence for Nursing Practice* (Vol. 10). Philadelphia: Wolter Kluwer.

Polit, D., Beck, C., & Owen, S. (2007). Is the CVI an Acceptable Indicator of Content Validity? Appraisal and Recommendations. *Research in Nursing & Health, 30*, 459-467.

Poncette, A., Mosch, L., Spies, C., Schmieding, M., Schiefenhövel, F., Krampe, H., & Balzer, F. (2020). Improvements in Patient Monitoring in the Intensive Care Unit: Survey Study. *Journal of Medical Internet Research, 22*(6), e19091.

Poncette, A., Spies, C., Mosch, L., Schieler, M., Weber-Carstens, S., Krampe, H., & Balzer, F. (2019). Clinical Requirements of Future Patient Monitoring in the Intensive Care Unit: Qualitative Study. *JMIR Medical Informatics, 7*(2), e13064.

Preston, J., Currey, J., & Considine, J. (2015). Atrial electrogram interpretation improves after an innovative education program. *The Canadian Journal of Critical Care Nursing, 26*, 13-18.

Puntillo, K., Max, A., Timsit, J. R., Chanques, G., Robleda, G., Roche-Campo, F., . . . Azoulay, E. (2018). Pain distress: the negative emotion associated with procedures in ICU patients. *Intensive Care Medicine, 44*, 1493-1501.

Pyykkö, A., Ala-Kokko, T., Laurila, J., Miettunen, J., Finnberg, M., & Hentinen, M. (2004a). Nursing staff resources in direct patient care: comparison of TISS and ICNSS. *Acta Anaesthesiologica Scandinavica, 48*, 1003-1005.

Pyykkö, A., Ala-Kokko, T., Laurila, J., Miettunen, J., Finnberg, M., & Hentinen, M. (2004b). Validation of the new Intensive Care Nursing Scoring System (ICNSS). *Intensive Care Medicine, 30*, 254-259.

Pyykkö, A., Laurila, J., Ala-Kokko, T., & Hentinen, M. (2001). Intensive Care Nursing Scoring System Part 2: Nursing interventions and nursing outcomes. *Intensive and Critical Care Nursing, 17*, 16-28.

Ramezani-Badr, F., Nasrabadi, A., Yekta, Z., & Taleghani, F. (2009). Strategies and criteria for clinical decision making in critical care nurses: A qualitative study. *Journal of Nursing Scholarship, 41*, 351–358.

Rattray, J., & Jones, M. (2007). Essential elements of questionnaire design and development. *Journal of Clinical Nursing, 16*, 234-243.

Reinikainen, M., & Varpula, T. (2018). 2018. Suomalainen tehohoito. *Duodecim, 34*, 161–163.

Reinikainen, M., Loisa, P., Palmu, A., Varpula, T., & Kiiski, O. (2017). Tehohoidon teho - tehohoidon vertaisarviointi Suomessa. *Tehohoito, 35*(1), 11-16.

Reischman, R., & Yarandi, H. (2002). Critical care cardiovascular nurse expert and novice diagnostic cue utilization. *Journal of Advanced Nursing, 39*, 24–34.

Rhodes, A., Chiche, J., & Moreno, R. (2011). Improving the quality of training programs in intensive care: a view from the ESICM. *Intensive Care Medicine, 37*, 377–379.

Rhodes, A., Ferdinande, P., Flaatten, H., Guidet, B., Metnitz, P., & Moreno, R. (2012). The variability of critical care bed numbers in Europe. *Intensive Care Medicine, 38*(10), 1647–1653.

Ritmala-Castrén, M., Virtanen, I., Vahlberg, T., Leivo, S., Kaukonen, K., & Leino-Kilpi, H. (2016). Evaluation of patients' sleep by nurses in an ICU. *Journal of Clinical Nursing, 25*(11-12), 1606–1613.

Ruppel, H., Funk, M., Porter Jayne, H., Prosser Jayne, M., Whittemore, R., Wung, S., . . . Varney, H. (2019). Critical care nurses' clinical reasoning about physiologic monitor alarm customisation: An interpretive descriptive study. *Journal of Clinical Nursing, 28*, 3033-3041.

Sambell, K., McDowell, L., & Montgomery, C. (2012). *Assessment for Learning in Higher Education. New York, NY: Routledge.* New York, New York: Routledge.

Sandelowski, M. (2010). What's in a Name? Qualitative Description Revisited. *Research in Nursing & Health, 33*, 77-84.

Scott Tilley, D. (2008). Competency in Nursing: A Concept Analysis. *The Journal of Continuing Education in Nursing, 39*(2), 58–64.

Scott, T., Hameed, S., Evans, D., Simons, R., & Sidhu, R. (2008). Objective assessment of surgical decision making in trauma after a laboratory-based course: durability of cognitive skills. *The American Journal of Surgery, 195*, 599–603.

Sears, K., Godfrey, C., Luctkar-Flude, M., Ginsburg, L., Tregunno, D., & Ross-White, A. (2014). Measuring competence in healthcare learners and healthcare professionals by comparing self-assessment with objective structured clinical examinations: a systematic review. *JBI Database of Systematic Reviews & Implementation Reports, 12*(11), 221-272.

Seppänen, P., Sund, R., Ala-Kokko, T., Uotila, J., Helminen, M., & Suominen, T. (2018). Health-related quality of life after obstetric intensive care admission: Comparison with the general population. *Journal of Critical Care, 43*, 276-280.

Sharafi, R., Ghahramanian, A., Sheikhalipour, Z., Ghafourifard, M., & Ghasempour, M. (2020). Improving the safety and quality of the intra-hospital transport of critically ill patients. *Nursing in Critical Care*. doi:doi: 10.1111/nicc.12527

Solberg, M., Tandberg, B., & Lerdal, A. (2012). Using didactic model to improve patient observation skills in neonatal intensive care nurse trainees – A pilot study. *Intensive and Critical Care Nursing, 28*, 208–214.

Sowan, A., Vera, A., Fonseca, E., Reed, C., Tarriela, A., & Berndt, A. (2017). Nurse Competence on Physiologic Monitors Use: Toward Eliminating Alarm Fatigue in Intensive Care Units. *The Open Medical Informatics Journal, 11*, 1–11.

Stafseth, S., Solms, D., & Bredal, I. (2011). The characterisation of workloads and nursing staff allocation in intensive care units: A descriptive study using the Nursing Activities Score for the first time in Norway. *Intensive and Critical Care Nursing, 27*, 290-294.

Stafseth, S., Tønnessen, T., Diep, L., & Fagerström, L. (2018). Testing the Reliability and Validity of the Nursing Activities Score in Critical Care Nursing. *Journal of Nursing Measurement, 26*, 141–162.

Stanley, J., & Williamson, T. (2017). Skill. *Noûs, 51*(4), 713–726.

Stinson, K. (2017). Benner's Framework and Clinical Decision-Making in the Critical Care Environment. *Nursing Science Quarterly, 30*(1), 52-57.

Takase, M., Yamamoto, M., & Sato, Y. (2018). The factors related to self-other agreement/disagreement in nursing competence assessment: Comparative and correlational study. *International Journal of Nursing Studies, 80*, 147-154.

Tanner, C. (2006). Thinking Like a Nurse: A Research-Based Model of Clinical Judgment in Nursing. *Journal of Nursing Education, 45*(6), 204-211.

Tanner, C. (2011). The Critical State of Measurement in Nursing Education Research. *Journal of Nursing Education, 50*, 491–492.

The Australian College of Critical Care Nurses. (2002). *ACCCN Competency Standards for Specialist Critical Care Nurses.*

The Critical Care National Network Nurse Leads Forum (CC3N). (2015). *National Competency Framework for Registered Nurses in Adult Critical Care* . Retrieved August 31, 2020, from https://www.cc3n.org.uk/uploads/9/8/4/2/98425184/01_new_step_1_final__1_.pdf

The European Parliament and the Council. (2005). *Directive 2005/36/EC on the recognition of professional qualifications.* Retrieved August 31, 2020, from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32005L0036

The European Parliament and the Council. (2013). *Directive 2013/55/EU on the recognition of professional qualifications.* Retrieved August 31, 2020, from https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32013L0055

The Finnish Society of Intensive Care. (2011). Suomen Tehohoitoyhdistyksen vetoomus tehohoitotyön erityispätevyyden perustamiseksi. *Tehohoito, 29*(1), 78–81.

The Finnish Society of Intensive Care. (2019). *Suomen Tehohoitoyhdistyksen eettiset ohjeet.* Retrieved August 31, 2020, from https://sthy.fi/wp-content/uploads/2019/04/STHY_Eettiset_ohjeet_LOW4.pdf

Thompson, K., Taylor, C., Forde, K., & Hammond, N. (2018). The evolution of Australian intensive care and its related costs: A narrative review. *Australian Critical Care, 31*, 325-330.

Tingsvik, C., Johansson, K., & Mårtenson, J. (2014). Weaning from mechanical ventilation: factors that influence intensive care nurses' decision-making. *Nursing in Critical Care, 20*(1), 16–24.

Toth, J. (2003). Comparing basic knowledge in critical care nursing between nurses from the United States and nurses from other countries. *American Journal of Critical Care, 12*(1), 41–46.

Trinier, R., Liske, L., & Nenadovic, V. (2016). Critical care nursing: Embedded complex systems. *The Canadian Journal of Critical Care Nursing, 27*(1), 11–16.

Tunlind, A., Granström, J., & Engström, Å. (2015). Nursing care in a high-technological environment: Experiences of critical care nurses. *Intensive and Critical Care Nursing, 31*, 116–123.

U.S. National Library of Medicine. (2020a). *Medical Subject Headings. Critical illness.* Retrieved August 31, 2020, from https://www-ncbi-nlm-nih-gov.ezproxy.utu.fi/mesh

U.S. National Library of Medicine. (2020b). *Medical Subject Headings. Critical care nursing.* Retrieved August 31, 2020, from https://www-ncbi-nlm-nih-gov.ezproxy.utu.fi/mesh

U.S. National Library of Medicine. (2020c). *Medical Subject Headings. Physical examination.* Retrieved August 31, 2020, from https://www-ncbi-nlm-nih-gov.ezproxy.utu.fi/mesh

U.S. National Library of Medicine. (2020d). *Medical Subject Headings. Monitoring.* Retrieved August 31, 2020, from Retrieved from https://www-ncbi-nlm-nih-gov.ezproxy.utu.fi/mesh on 18 May 2019

Vaismoradi, M., Turunen, H., & Bondas, T. (2013). Content analysis and thematic analysis: Implications for conducting a qualitative descriptive study. *Nursing and Health Sciences, 15*, 398-405.

Vasileiou, K., Barnett, J., Thorpe, S., & Young, T. (2018). Characterising and justifying sample size sufficiency in interview-based studies: systematic analysis of qualitative health research over a 15-year period. *BMC Medical Research Methodology*, 18:148.

Vincent, J. (2013). Critical care – where have we been and where are we going? *Critical Care, 17*(Suppl 1), S2.

Vincent, J., Marshall, J., Ñamendys-Silva, S., Francois, B., Martin-Loeches, I., Lipman, J., . . . Sakr, Y. (2014). V. Assessment of the worldwide burden of critical illness: the intensive care over nations (ICON) audit. *Lancet Respiratory Medicine, 2*(5), 380-386.

Wallace, D., Angus, D., Seymour, C., Barnato, A., & Kahn, J. (2015). Critical Care Bed Growth in the United States. A Comparison of Regional and National Trends. *American Journal of Respiratory and Critical Care Medicine, 191*(4), 410-416.

Waltz, C., Strickland, O., & Lenz, E. (2016). *Measurement in Nursing and Health Research* (5 ed.). New Yor City: Springer Publishing Company.

Wassenaar, A., Schouten, J., & Schoonhoven, L. (2014). Factors promoting intensive care patients' perception of feeling safe: A systematic review. *International Journal of Nursing Studies, 51*, 261–273.

Wax, R., & Christian, M. (2020). Practical recommendations for critical care and anesthesiology teams caring for novel coronavirus (2019-nCoV) patients. *Canadian Journal of Anesthesia, 67*(5), 568–576.

Wei, W., Niu, Y., & Ge, X. (2018). Core competencies for nurses in Chinese intensive care units: a cross-sectional study. *Nursing in Critical Care, 24*(5), 276–282.

West, E., Barron, D., Harrison, D., Rafferty, A., Rowan, K., & Sanderson, C. (2014). Nurse staffing, medical staffing and mortality in Intensive Care: An observational study. *International Journal of Nursing Studies, 51*, 781–794.

West, S. (2006). Physical assessment: whose role is it anyway? *Nursing in Critical Care, 11*(4), 161–167.

Whittemore, R., & Knafl, K. (2005). The integrative review: updated methodology. *Journal of Advanced Nursing, 52*, 546–553.

Williams, C., & Parry, A. (2018). Knowledge and skills of critical care nurses in assisting with intubation. *British Journal of Nursing, 27*, 204–209.

Williams, G., Schmollgruber, S., & Alberto, L. (2006). Consensus Forum: Worldwide Guidelines on the Critical Care Nursing Workforce and Education Standards. *Critical Care Clinics, 22*(3), 393–406.

Windsor, C., Douglas, C., & Harvey, T. (2012). Nursing and competencies – a natural fit: the politics of skill/competence formation in nursing. *Nursing Inquiry, 19*(3), 213–222.

Word Federation of Critical Care Nurses. (2019). *Position Statement on the Provision of a Critical Care Nursing Workforce.* Retrieved August 31, 2020, from http://wfccn.org/wp-content/uploads/2019/09/WFCCN-Workforce-PS_17.9.19.pdf

World Federation of Critical Care Nurses. (2005). *Position Statement on the Provision of Critical Care Nursing Education - Declaration of Madrid.* Retrieved August 31, 2020, from http://wfccn.org/wp-content/uploads/2018/01/Madrid-declarations.pdf

World Health Organization. (2003). *WHO Europe Critical Care Nursing Curriculum. WHO European Strategy for Continuing Education for Nurses and Midwives.* Retrieved August 31, 2020, from http://www.euro.who.int/__data/assets/pdf_file/0017/102266/e81552.pdf

Yamase, H. (2003). Development of a comprehensive scoring system to measure multifaceted nursing workloads in ICU. *Nursing and Health Sciences, 5*, 299–308.

Yang, R. (2016). Dependency in Critically Ill Patients: A Meta-Synthesis. *Global Qualitative Nursing Research, 3*, 1-10.

Yang, S., Huang, L., Zhao, X., Xing, M., Shao, L., Zhang, M., . . . Gao, C. (2019). Using the Delphi method to establish nursing-sensitive quality indicators for ICU nursing in China. *Research in Nursing & Health, 42*(1), 48-60.

Zhang, X., Meng, K., & Chen, S. (2020). Competency framework for specialist critical care nurses: A modified Delphi study. *Nursing in Critical Care, 25*, 45–52.

Ääri, R., Ritmala-Castrén, M., Leino-Kilpi, H., & Suominen, T. (2004). Biological and physiological knowledge and skills of graduating Finnish nursing students to practice in intensive care. *Nurse Education Today, 24*, 293-300.

Ääri, R., Suominen, T., & Leino-Kilpi, H. (2008). Competence in intensive and critical care nursing: A literature review. *Intensive and Critical Care Nursing, 24*, 78–89.

Appendices

Appendix 1. Previous studies (n=27) describing and evaluating critical care nurses' patient observation skills

Authors, year, country	Purpose of the study	Design and sample	Description of patient observation skills	Evaluation of patient observation skills	Factors associated with patient observation skills
Aitken LM, 2000, Australia	To determine what data were collected, how critical care nurses collected, processed and validated those data, as well as the strategies used to attain the desired outcome of the decision-making process in relation to haemodynamic monitoring.	Thinking aloud method and follow-up interviews. Critical care nurses (n=8).	Critical care nurses use their skills in identifying relevant physiological parameters in haemodynamic monitoring as well as connecting and comparing theses parameters. Critical care nurses are able to make decisions during their observational tasks, and they form diagnoses concerning patients' clinical condition.	Not investigated	Not investigated
Aitken LM, 2003, Australia	To describe the clinical decision-making processes which expert critical care nurses used to incorporate pulmonary artery pressure monitoring into the haemodynamic management of their patients.	Thinking aloud method and follow-up interviews. Critical care nurses (n=8).	Based on haemodynamic observation expert critical care nurses are able to form hypotheses in their decision-making process. Expert critical care nurses collect diverse data to form hypotheses. They evaluate hypotheses constantly	Not investigated	Not investigated

Attin M, Cardin S, Dee V, Doering L, Dunn D, Ellstrom K, Erickson V, Etchepare M, Gawlinski A, Haley T, Henneman E, Keckeisen M, Malmet M & Olson L, 2002, Usa	To evaluate critical care clinicians' knowledge about pulse oximetry and to increase clinicians' knowledge of research-based practices related to the appropriate use of pulse oximetry.	A quasi-experimental study, knowledge test survey before and after educational intervention. Critical care nurses (n=331), physicians (n=88) and respiratory therapists (n=29).	Critical care nurses have to understand the idea of pulse oximetry, clinical condition affecting the measurement, accuracy and reliability of the measurement, correct probe placement, use of pulse oximetry among specific population and the use of pulse oximetry to guide therapy.	Critical care nurses' mean percentage of correct answers was 64% before intervention and 82% after intervention, which indicated significant improvement. Knowledge deficiencies were detected related to the factors affecting the reliability of measurement.	Not investigated
Buchanan Keller K & Raines DA, 2005, USA	To identify and describe critical care nurses' perception of arrhythmia knowledge.	Semi-structured focus group interviews, constant comparison analysis. Critical care nurses (n=25) in five groups.	Three-level knowledge categorization was created for the types of arrhythmias: basic, intermediate and advanced. The categorization represents the arrhythmias that critical care nurses at different knowledge levels should be able to recognise.	Not investigated	Not investigated
Christensen M & Barnes A, 2012, Australia	To assess senior critical care nurses' knowledge related to intra-arterial blood pressure waveform analysis.	A survey using a multiple-choice questionnaire. Critical care nurses (n=20).	Critical care nurses use their skills to assess and interpret the patient's condition using intra-arterial blood pressure monitoring. These	The mean percentage of correct answers was 35.5%, which represents poor knowledge according to authors. Results suggest that critical	There were no differences in knowledge between the different levels of critical care nurses (Band 6 & Band 7).

			skills include interpreting intra-arterial pressure waveforms and understanding the technical aspects of waveforms.	care nurses use experimental knowledge in interpreting the waveforms but they lack understanding in the technical aspects of waveforms.	
Cicolini G, Tomietto M, Simonetti V, Comparcini D, Flacco Me, Carvello M & Manzoli L, 2015, Italy	To describe which of the core techniques of the physical assessment are regularly performed by a sample of Italian nurses.	Cross sectional survey using a self-report questionnaire. Nurses in different clinical settings (n=1182) including critical care nurses (n=251, 21%).	Critical care nurses a wide range of physical assessment skills in their clinical practice.	Overall nurses' physical assessment skills (non-technical, use of senses) were suboptimal. Critical care nurses' skills were better than nurses in other clinical settings, but the scores were not explicitly reported. Authors concluded that the frequency of performing assessment techniques represent nurses' skills in using those techniques.	A higher educational level was associated with higher scores).
Coombs MA & Moorse SE, 2002, UK	To describe use of physical assessment skills within critical care nursing practice.	Theoretical paper introducing case study descriptions.	Physical assessment skills have been defined as a systematic use of inspection, palpation, auscultation, and percussion as well as measuring and recording vital signs (temperature, heart	Not investigated	Not investigated

			rate, blood pressure, respiratory rate).		
Currey J & Botti M, 2005, Australia	To describe variability of nurses' haemodynamic decision-making in the 2-hour period after cardiac surgery	Non-participant observations and follow-up interviews. Critical care nurses (n=38).	Critical care nurses observe a patient's condition using multiple parameters, and furthermore they make decisions based on the onservatiion.	All nurses were able to observe most essential haemodynamic parameters but experienced nurses were able to observe intermittently measured parameters as well. Expert critical care nurses were able to detect and respond to haemodynamic instability. In contrast to inexperienced nurses, they were able to make correct interpretations and anticipate based on their observations. Both experienced and inexperienced nurses did not adhere to evidence-based techniques, which may compromise the reliability of observation.	Clinical expertise in critical care nursing promoted observation skills.
Currey J, Massey D, Allen J & Jones D, 2018, Australia	To identify and describe what nurses involved in a MET consider the most vital areas of knowledge and skill when delivering care to the	A survey using an open-ended questionnaire and thematic analysis. Critical care nurses (n=103).	Critical care nurses have to use their cognitive skills such as diagnostic reasoning skills (interpreting ECG, ABG and pathology data) and be	Not investigated	Not investigated

	deteriorating ward patient.		able to anticipate adverse clinical trajectories when taking care of a deteriorating ward patient.		
Freysdóttir GR, Björnsdóttir K & Svavarsdóttir MH, 2019, Iceland	To explore how cardiovascular nurses use monitors in patient surveillance and the effect that the monitors have on the nurses' work.	A qualitative ethnographic design with semi-structured interviews and a field observation. Nurses (n=8) working in a coronary care unit.	Critical care nurses need to have adequate monitoring skills. They need advanced knowledge, experience and specialised training in monitoring. Analysing the data is an essential element of skills in monitoring.	Nurses found monitors to be complex to use, and some of them had trouble in utilising the monitoring technology appropriately.	The more experienced nurses demonstrate skill in utilising the monitor observation to guide nursing interventions, whereas the less experienced used monitor to collect the data to report cardiologist. The more experienced nurses reported higher confidence in the use of monitors compared to the less experienced.
Giuliano KK & Liu LM, 2006, USA	To describe the clinical pulse oximetry knowledge of a group of critical care nurses.	A survey using a knowledge test questionnaire. Critical care nurses (n=551).	Critical care nurses need to have knowledge about the reliable use and interpretation of pulse oximetry monitoring.	Critical care nurses had sufficient knowledge of pulse oximetry monitoring. Authors did not report a sum-score for the knowledge test but the percentage of critical care nurses knowing the correct answer by items ranged from 63% to 87%.	Not investigated.

Haugdahl HS & Storli SL, 2012, Norway	To explore, describe and contextualize aspects of competency used by intensive care nurses in ventilator weaning.	In-depth interviews and field observations. Critical care nurses (n=3).	When weaning a patient from the ventilator critical care nurses have to be able to evaluate a patient's ability to breath without mechanical support, look for causes for dyspnoea and compare observations with chest X-ray findings.	Not investigated	Not investigated
Hoffman KA, Aitken LM & Duffield C, 2009, Australia	To determine if there were differences between novice and expert nurses in the range and type of cues selected as well as how cues were clustered together when making clinical decisions while caring for post-operative patients in an Intensive Care Unit	Think aloud method combined with retrospective interviews. Novice (n=4) and expert (n=4) critical care nurses.	Critical care nurses collect and organise information about a patient's clinical condition. They use observed information in decision-making.	Expert critical care nurses collected greater variety of cues and they were able to cluster more cues compared to novice nurses. Experts could make more proactive decisions and anticipate based on the observation compared to novice nurses.	Clinical expertise in critical care nursing (expert nurse) promoted observation skills.
Hunt L, Frost SA, Newton PJ, Salamonson Y, Davidson PM, 2017, Australia	To assess the knowledge of critical care nurses about current intra-abdominal hypertension (IAH) and abdominal compartment syndrome (ACS) practice guidelines, measurement	A survey using a knowledge test questionnaire. Critical care nurses (n=86).	Critical care nurses have to be able to identify causes of IAH as well as its clinical manifestations.	Most critical care nurses were able to identify obvious causes of IAH (such as abdominal surgery and peritonitis), whereas less obvious causes (e.g. hypothermia, basal pneumonia) were identified by less than	No correlation between the knowledge and the years of experience or level of professional qualification.

	techniques, predictors for the development of IAH and ACS and to identify barriers in recognizing IAH, ACS and measuring intra-abdominal pressure			20% of critical care nurses. Similarly, most critical care nurses identified apparent clinical manifestations (e.g. impaired GI function) of ACS, while less apparent (e.g. altered level of consciousness) were left identified.	
Häggström M, Bergsman AM, Månsson U & Holmström MR, 2017, Sweden	To describe the experiences of critical care nurses learning to manage vasoactive drugs and to highlight the competence required to manage vasoactive drugs.	Interviews and content analysis. Critical care nurses (n=12).	Critical care nurses have to be able to observe carefully vital signs when titrating vasoactive drugs, as well as relate the observations to the drug effects.	Not investigated	Not investigated
Kebapçi, A, Dikeç G, Topçu S, 2020, Turkey	To evaluate inter-observer reliability of intensive care unit patients' Glasgow Coma Scale (GCS) score	An observational study. Two researchers and critical care nurses (n=21) assessed 202 patients, and GCS assessed by researchers and critical care nurses were compared.	Physical assessment skills include the use of GCS.	Moderate agreement in GCS sum scores and all subcomponents among all 3 observers (ICU nurses and the 2 researchers). Critical care nurses skills in reliable use of GCS may be inadequate.	Not investigated.
Kerr RG, Bacon AM, Baker LI, Gehrke JS, Hahn KD, Lillegraven CL, Hackett Renner C & Spilman SK, 2016, USA	To evaluate nurses' abilities to assess pupil diameter accurately and detect unequal pupils.	Skills test for critical care and neurosurgical nurses: assessment of drawings of eyes with an iris and pupil (n=30), examination of photographs of human	Critical care nurses assess pupil diameter as a part of neurological observation.	Nurses' assessments of pupil diameter were inaccurate, as they tend to underestimate the pupil size. Only 33% of nurses were	Not investigated.

		eyes (n=27), and bedside examination of patients with a head injury (489 assessments).		able to identify unequal pupils.	
Kvande M, Delmar C, Lykkeslet E & Storli SL, 2015, Norway	To explore the phenomenon of becoming aware of incipient changes in patient condition from the perspectives and experiences of intensive care nurses.	Close observations of and in-depth interviews. Critical care nurses (n=11).	Critical care nurses observe small signs that may indicate a change in a patient’s condition using their own senses. They monitor multiple physiological parameters, and assemble them to form a schema of a patient’s condition.	Not investigated	Not investigated
Kydonaki K, Huby G, Tocher J & Aitken LM, 2016, Scotland/Greece	To examine how nurses collect and use cues from respiratory assessment to inform their decisions as they wean patients from ventilator support.	A descriptive ethnographic study using observations and interviews. Critical care nurses (n=13).	Critical care nurses collect and group data in order to provide a patient-centred assessment to guide their decision concerning weaning. Critical care nurses focus on physiological data about a patient’s gas exchange, work of breathing, resolving lung condition and level of consciousness and subjective criteria of patients’ tolerance and response to	Not investigated	Not investigated

			previous reduction of ventilator support.		
McGhee BH & Woods SL, 2001, USA	To describe critical care nurses knowledge of direct monitoring of blood pressure in three content areas: physiology, technical aspect and wavefrom and data interpretation.	A survey using knowledge test questionnaire and self-assessment. Critical care nurses (n=68)	Critical care nurses need have knowledge about physiology and technical principles of direct blood pressure monitoring as well as data interpretation.	Critical care nurses mean percentage of correct answers was 36.7%. None of them achieved the passing score set at 66%. Based on the item-level results, authors conclude that critical care nurses know how to monitor direct blood pressure, but they lack an adequate understanding of basic physiology. There were incongruence between critical care nurses' self-assessed competence in direct blood pressure monitoring and knowledge test scores.	Not investigated.
Preston JL, Currey J & Considine J, 2015, Australia	To investigate whether completing a novel online evidence-based education program on interpreting atrial electrogram would improve critical care nurses' atrial electrogram interpretation.	A quasi-experimental study, a questionnaire survey (case studies) before and after (2 weeks and 8 weeks) an educational intervention. Specialised critical care nurses (n=29).	Interpretation of atrial electrogram belongs to the critical care nurses' skills set.	64% of cardiac rhythms on atrial electrogram were interpreted correctly by critical care nurses prior the intervention. Critical care nurses skills in interpreting atrial electrogram improved significantly after the intervention.	Critical care nurses who had a university level critical care qualification and who worked in a larger hospital had better skills in interpreting atrial electrogram before the intervention.

Reischman RR & Yarandi HN, 2002, USA	To compare diagnostic cue utilisation between expert and novice critical care cardiovascular nurses.	Critical care nurses skills in diagnosing a patient's clinical condition/problem were tested in written simulated scenarios. Novice (n=23) and expert (n=23) critical care nurses.	Critical care nurses' patient observation skills include skills in diagnosing clinical conditions such as left ventricular dysfunction, cardiac tamponade, sepsis, right ventricular failure with infarction and hypovolemia related to internal abdominal haemorrhage.	47% of the diagnosed written simulation scenarios were accurate. Experts were significantly more accurate in diagnosing. Experts were able to recall more highly relevant cues in written simulation scenarios.	Clinical expertise in critical care nursing (expert nurse) promotes diagnostic skills.
Ruppel H, Funk M, Porter Jayne H, Prosser Jayne M, Whittemore R, Wung SF, Bonafide CP, Powell Kennedy H & Varney H, 2019, USA	To explore clinical reasoning about alarm customisation among critical care nurses.	Semi-structured interviews and thematic analysis. Critical care nurses (n=27).	Alarm customisation skills require critical care nurses to have clinical understanding of physiologic changes associated with certain conditions and ability to anticipate patients' clinical trajectories. Alarm customisation skills include skill at synthesising clinical data and manipulating the monitor, hence knowing the patient and technological "know-how".	Not investigated	Not investigated
Sharafi RA, Ghahramanian A, Sheikhalipour Z, Ghafourifard M &	To determine the incidence of adverse events during intra-hospital transport and	A cross-sectional survey. Critical care nurses (n=160).	Critical care nurses have to be able to observe carefully a patient's vital signs,	Not investigated	Not investigated

Ghasempour M, 2020, Iran	to obtain suggestions from critical care nurses for improving the transportation process.		correct placement and functioning of endotracheal tube and iv-lines before, during and after the transport.		
Sowan AK, Vera AG, Fonseca EIM, Reed CC, Tarriela AF & Berndt AE, 2017, USA	To assess nurses' perceived competence on physiologic monitors use in intensive care units (ICUs).	A survey using a self-report instrument. Critical care nurses (n=30).	Critical care nurses' monitoring skills include domains: admit, discharge, and transfer patient; hardware and connectivity; alarm management; appropriate monitoring; advanced functions	Critical care nurses' confidence was highest in the sub-scale "appropriate monitoring" and lowest in "advanced functions". Overall, critical care nurses reported lack of confidence in many skills related to physiologic monitoring.	No associations between the confidence levels and critical care nurses' demographics were found.
Tingsvik C, Johansson K & Mårtensson J, 2014, Sweden	To describe the factors that influence intensive care nurses' decision-making when weaning patients from mechanical ventilation	Semi-structured interviews and content analysis. Critical care nurses (n=22).	Critical care nurses' decisions in weaning are based on their observations. When weaning a patient, critical care nurses have to be able to observe: the patient's breathing parameters (oxygen saturation, artery blood gas and respiration rate), signs of well-being, breathing drive, breathing depth, adequate ability to breathe and shortness of breath,	Not investigated	Not investigated

			haemodynamic status and temperature.		
Tunlind A, Granström J & Engström Å, 2015, Sweden	To describe critical care nurses' experience of performing nursing care in a high technology healthcare environment	Interviews and content analysis. Critical care nurses (n=8).	Critical care nurses' develop clinical gaze, which enables them to see the big picture of a patient's clinical condition. Monitoring technology is a supplement, but critical care nurses have to be able to use non-technological observation methods to determine the clinical condition.	Not investigated	Not investigated

TURUN
YLIOPISTO
UNIVERSITY
OF TURKU

Painosalama Oy, Turku, Finland 2021

ISBN 978-951-29-8457-2 (PRINT)
ISBN 978-951-29-8458-9 (PDF)
ISSN 0355-9483 (Print)
ISSN 2343-3213 (Online)