Building patient safety in intensive care nursing

Patient safety culture, team performance and simulation-based training

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“It may seem a strange principle to enunciate as the very first requirement in a hospital that it should do the sick no harm”.

Florence Nightingale 1859
ABSTRACT

Building patient safety in intensive care nursing
Patient safety culture, team performance and simulation-based training

Aim: The overall aim of the thesis was to investigate patient safety culture, team performance and the use of simulation-based team training for building patient safety in intensive care nursing.

Methods: A descriptive and explorative design with quantitative and qualitative methods was used. In Study I, 220 registered nurses (RNs) from ten intensive care units (ICUs) responded to the questionnaire: Hospital Survey on Patient Safety Culture. Studies II-IV were based on a team training programme with the use of laboratory high-fidelity human simulation. In Studies II-III, a convenience sample of 53 RNs from seven ICUs and ten RNs from an intensive care nurse postgraduate programme (II) were included. Data were collected through the use of the questionnaires: Satisfaction with Learning and Self-Confidence in Learning Scales, Education Practices Simulation Scale, Simulation Design Scale (II), Mayo High Performance Teamwork Scale and Ottawa Crisis Resource Management Global Rating Scale (III). Quantitative data were analysed through the use of statistics (I-III). In Study IV, 18 RNs who had participated in the simulation-based team training programme were interviewed, and the data were analysed with a qualitative content analysis.

Main findings: The RNs had positive perceptions of the outcome of the ICUs’ overall patient safety culture; though, incident reporting was found as an area with potential for improvement. Dimensions found with potential for improvement at the unit level were feedback and communication about errors and organizational learning-continuous improvement, and at the hospital level, hospital management support for patient safety and teamwork across hospital units. Differences in RNs’ perceptions were found between different types of ICUs and between hospitals. The dimensions at the unit level were identified as predictors for the two outcome dimensions (I). The RNs were highly satisfied with simulation-based learning and mostly agreed with the statements about self-confidence in learning. The RNs were generally positive in their evaluation of the implementation of the educational practice and the simulation design/development. Differences in RNs perceptions were found with regard to scenario roles, prior simulation experience and area of intensive care practice (II). The expert raters assessed the teams’ performance in a cardiac arrest situation as advanced novice or competent. Differences were also found between the expert raters’ assessments and the RNs’ self-assessments (III). One main category emerged to illuminate the RNs’ perceptions of simulation-based team training for building patient safety in the ICU: “Regular training increases awareness of clinical practice and acknowledges the importance of structured work in teams”. Three generic categories were found: “realistic training contributes to safe care”, “reflection and openness motivates learning” and “finding a common understanding of team performance” (IV).

Conclusions: Patient safety culture measurements have the potential to identify areas of strength and areas in need of improvement. Simulation-based team training is appropriate for creating awareness of clinical practice and a common understanding of structured work in teams with regard to patient safety.
SAMMENDRAG

Å fremme pasientsikkerhet innen intensiv sykepleie
Pasientsikkerhetskultur, strukturert teamarbeid og simuleringsbasert teamtrening

Hensikt: Avhandlingens overordnede hensikt var å undersøke pasientsikkerhetskultur, strukturert teamarbeid og bruk av simuleringsbasert teamtrening for å fremme pasientsikkerhet intensiv sykepleie.


Konklusjon: Målinger av pasientsikkerhetskulturen har et potensial ved å kunne identifisere sterke og svake sider og dermed avdekke områder med behov for forbedring. Simuleringsbasert teamtrening er hensiktsmessig for å skape bevissthet om egen praksis og en felles forståelse av strukturert teamarbeid for å fremme pasientsikkerhet.
# TABLE OF CONTENT

ABBREVIATIONS ......................................................................................................................... 7  

ORIGINAL PAPER ....................................................................................................................... 8  

INTRODUCTION ......................................................................................................................... 9  

BACKGROUND .......................................................................................................................... 11  
  Theoretical perspectives on patient safety ............................................................................. 11  
  Intensive care nursing and patient safety ............................................................................. 13  
  Patient safety culture ............................................................................................................. 15  
  Team performance ................................................................................................................ 17  
  Simulation-based team training ........................................................................................... 18  
  Rationale for the thesis........................................................................................................... 22  

AIMS ................................................................................................................................................ 23  

METHODS .................................................................................................................................... 24  
  Study design ................................................................................................................................ 24  
  Settings and participants ........................................................................................................... 24  
  Simulation-based team training programme .......................................................................... 26  
  Data collection ............................................................................................................................ 29  
    Questionnaires (I-IV) and measurement scales (III) ....................................................... 29  
    Qualitative interview (IV) ..................................................................................................... 35  
    Procedure ................................................................................................................................ 35  

Data analyses ............................................................................................................................... 36  
  Statistics (I-III) ....................................................................................................................... 36  
  Qualitative content analysis (IV) ......................................................................................... 38  

ETHICAL APPROVAL AND CONSIDERATIONS .................................................................. 39  

MAIN FINDINGS ......................................................................................................................... 41  
  Patient safety culture in intensive care (I) .............................................................................. 41  
  Subgroup comparisons ............................................................................................................ 41  
  Predictors to outcome............................................................................................................. 43
### ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
</tr>
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<tbody>
<tr>
<td>CCU</td>
<td>Coronary care unit</td>
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<td>CRM</td>
<td>Crisis recourse management / Crew recourse management</td>
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<td>EPSS</td>
<td>Educational Practices Simulation Scale</td>
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<td>G-ICU</td>
<td>General intensive care unit</td>
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<tr>
<td>GM-ICU</td>
<td>General/medical intensive care</td>
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<td>HRO</td>
<td>High-reliability organizations</td>
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<td>HSOPSC</td>
<td>Hospital Survey on Patient Safety Culture</td>
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<td>ICU</td>
<td>Intensive care unit</td>
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<td>MHPTS</td>
<td>Mayo High Performance Teamwork Scale</td>
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<td>M-ICU</td>
<td>Medical intensive care unit</td>
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<td>MIX-ICU</td>
<td>Mixed intensive care unit</td>
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<td>NLN</td>
<td>National League for Nursing</td>
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<td>NTS</td>
<td>Non-technical skills</td>
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<td>Ottawa GRS</td>
<td>Ottawa Crisis Resource Management Global Rating Scale</td>
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<tr>
<td>PG-ED</td>
<td>Postgraduate education</td>
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<td>PG-RN</td>
<td>Postgraduate registered nurse</td>
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<td>PG-student</td>
<td>Postgraduate student</td>
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<tr>
<td>RN</td>
<td>Registered nurse</td>
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<tr>
<td>SBTT</td>
<td>Simulation-based team training</td>
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<tr>
<td>SDS</td>
<td>Simulation Design Scale</td>
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<td>WHO</td>
<td>World Health Organization</td>
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ORIGINAL PAPER


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INTRODUCTION

Patient safety is stated as the fundamental principle of good patient care (WHO, 2002), hence research shows that one out of ten patients is harmed while receiving hospital care (WHO, 2007). Patient safety incidents lead to unnecessary suffering and are a major cause of prolonged hospital stays (NOKC, 2012a; WHO, 2008). Human errors are stated as the most common cause of patient safety incidents, although incidents should be seen as a result of complex system failure, rather than as the fault of the individual health care provider (Kohn et al., 2000). Approaches related to high-reliability organizations (HRO) such as aviation have been applied in health care to prevent incidents and to ensure the delivery of proper care (Riley, 2009). Measurements of patient safety culture, teamwork and continuous improvement and organizational learning, including team training with the use of simulation (Wilson et al., 2005) are all HRO approaches (Health Foundation, 2011) recommended as initiatives to improve quality and patient safety in health care (Kohn et al., 2000). Safety cultures are created through changes in health personnel’s safety perspective and work behaviour, and human resource professionals are essential and an important contributor in this development (Palmieri et al. 2010). Human patient simulation-based training is a recommended method to make health care professionals aware of the importance of teamwork and the aspects of team performance (Gaba, 2004; IOM, 2001). Team training programme based on Crew Resource Management (CRM) can be used to improve efficiency, morale and patient safety in health care (West et al., 2012).

With all its complexity, intensive care represents potential patient safety challenges, as critically ill patients are vulnerable to being exposed to incidents as a result of their severe conditions and need of high complexity care (Pronovost et al., 2002; Rothschild et al., 2005; Valentin et al., 2006). Incidents involving critically ill patients frequently appear and are often potentially life threatening (Orgeas et al., 2008; Rothschild et al., 2005). A large proportion of contributory factors underlying critical incidents are attributed to failures in team performance (Reader et al., 2006; Reader et al., 2009).

Human resources are most valuable in health care (Chen et al., 2004), with nurses constituting a large proportion of the health-care personnel. Nurses play a central role in ensuring that patients receive high-quality care and are
protected from injuries (Page, 2004). Nurses are working at the sharp end of practice (Benner et al., 2011; Kohn et al., 2000), in that they monitor patients and carry out most of the ordained therapies and nursing care (Malloch, 2010). To implement safety procedures is not sufficient for intensive care nurses to sustain patient safety. Additionally, they must increase their professional knowledge by an engagement in continuous learning, as well as having an effective communication with colleagues, cooperating in teams and providing a high level of care for critically ill patients. It is essential to build a culture of safety in which the intensive care unit (ICU) personnel perceive safety to be high priority throughout the organizational hierarchy (Livne & Donchin, 2009). Nurses have accountability for delivering a proper professional-, ethical- (ICN, 2012; NNO, 2011) and legal nursing practice (Ministry of Health Care Services, 1999).

With extensive experience as an intensive care nurse, I am quite sure that all nurses have a professional and ethical intention to take care of their patients in a qualified and safe manner. In the ICU we worked in teams, thus we rarely discussed why the team did or did not perform well. I presume that there were those other than me who were not aware of the connection between a unit’s culture, structured work in teams and patient safety. Later on, during a simulation-facilitator education, lessons about patient safety and CRM were presented for me. This motivated me to work for an increased knowledge and awareness about patient safety culture, team performance and simulation-based training as initiatives for building patient safety within intensive care nursing.
BACKGROUND

Theoretical perspectives on patient safety

Florence Nightingale perceived it to be necessary as early as the late 1800s that the very first principle in a hospital was, “to do the sick no harm” (Nightingale, 1863). However, patient safety as a subject was largely neglected until the problem was documented by studies during the 1990s (Vincent, 2010), and further by the Institute of Medicine’s publication, “To Err Is Human: Building a Safer Health System” (Kohn et al., 2000), which delivered data that brought the subject to the top of the policy agenda worldwide and created progress for the patient safety movement of today (Hjort, 2007; Vincent, 2010). With the launch of the World Alliance for Patient Safety in 2004, the subject was further followed up by the WHO, which has invested in campaigns, educational programmes, research and other resources aimed at implementing patient safety activities across the world. The WHO defines patient safety as “the reduction of risk of unnecessary harm associated with health care to an acceptable minimum” and a patient safety incident as “an event or circumstance which could have resulted or did result in unnecessary harm to patients” (WHO, 2009a, p. 15).

Health care views patient safety as a dimension of the quality of care, in which good quality of care is described as safe, effective, patient-centred, timely, efficient and equitable (IOM, 2001; Norwegian Directorate of Health, 2005; WHO, 2006). While quality and safety are interwoven concepts in the effort to deliver exemplary patient care, quality refers to the gap between the ideal and the actual achieved outcomes (Donabedian & Bashshur, 2003; WHO, 2009b), while safety is about the focus on excluding unintended consequences of care delivery (Barnsteiner, 2012; WHO, 2009a). Like quality, safety is understood as a result of both the structures and processes of health care (Vincent, 2010). Donabedian (1968) described the distinction between the structure (external- and internal conditions), process (actions and interactions) and outcome (what we have achieved) of health care in a theoretical framework, which has since become a pillar in patient safety and quality work. The framework provides an understanding that quality and patient safety depend on the relationship between several components that can be studied separately, but which simultaneously hang together as a unit (Pronovost et al., 2006a; Vincent, 2010). The theoretical underpinning of this framework with regard to the ICU is that the correct structure will support with the proper processes, which in turn will
result in a desired patient outcome (Johnson, 2012; Stockwell & Slonim, 2006). The WHO’s World Alliance for Patient Safety classified the causes of patient harm into those arising from structural, process and outcome factors following Donabedian’s longstanding distinction. The structural causes of harm, which are the most appropriate in this thesis, include inadequate staffing, training deficiencies, lack of appropriate knowledge and its transfer, pressure on staff, communication breakdowns and poor organizational safety culture (Jha et al., 2010).

As stated, the human behaviour play a large part in the delivery of safe patient care, although health care has quite recently recognized the importance of the area of human factors (Norris, 2009). Human factors is being described as the human ability or inability to focus on multiple things at once and perform accurately (Vicente, 2004). Errors may be linked to properties of health personnel’s tools, tasks and operating environment, while safety improvement comes from understanding and influencing these connections (Dekker, 2011). Moreover, errors result when one is unfocused, tired, negligent or disturbed which subsequently deviates from safe operating procedures (Reason, 2000). Hence, the focus in health care has turned from an individual’s fault for a given error to analysing the system, and from focusing only on technical skills to including non-technical skills (NTS) (Vincent et al., 2004). According to Reason (2004), all incidents involve a combination of both active failures and latent conditions. Whereas active failures are an unsafe act performed by the people who are in direct contact with the patients, latent conditions are within the system (e.g. a high workload, poor communication, training deficiencies or poor teamwork), where they may stimulate errors and procedural violence. Most errors are inconsequential and are caught by defences; however, the fewer or weaker that the defences are, the greater the probability that errors will have an adverse effect. To enhance defences by focusing on, e.g. teamwork and team training in the ICU, the system will better be able to prevent the negative effect of errors (Reason, 2000; Reason, 2004).

In many sectors of industry, safety has been a primary concern for decades. Despite the inevitability of human errors, HROs such as aviation and nuclear power are able to operate in a complex environment and to maintain a safe workplace (Wilson et al., 2005). These organizations front many of the same challenges which may be experienced in the ICU in that they handles problematic tasks that, involve complex interactions between personnel, in
which they may experience situations with a heavy workload related to time pressure in a stressful environment, which provide major consequences if tasks are done incorrectly (Garrouste-Orgeas et al., 2009). Key features of HROs are among other that they have an organizational engagement to safety, backup steps built into processes, a collective mindfulness and a focus on continuous improvement and learning (Health Foundation, 2011; Weick & Sutcliffe, 2001). In HROs, safety is the hallmark of the organizational culture and professional behaviour (Weick, 2002). An HRO emphasizes well-trained personnel with ongoing training and teamwork (Wilson et al., 2005), and simulation-based training is seen as routine (Leape & Berwick, 2005). According to Page (2004), all workers in an HRO are fully engaged in the process of detecting high-risk situations, and everyone is empowered to act in dangerous situations in the work environment.

**Intensive care nursing and patient safety**

Intensive care nursing is described as a specialized nursing care for acute and critically ill patients with manifest or potential failures of vital functions (NNO, 2006). The first beginning of the specialty was attributed to Florence Nightingale, who pioneered the modern nursing practices during the Crimean War (Adler, 1984), and as early as in the Note on Nursing from 1859, described the importance of the establishment of the recovery room, which did not became widespread until the 1940s (Cutogno, 1992). However, intensive care and the specialty of intensive care nursing are considered as the result of advances in medicine, medical technology and nursing over the last century. The recognition of the need for the ICU and their subsequent development began in the 1960s (Cutogno, 1992). The use of the electrocardiogram (ECG), extracorporeal cardiopulmonary resuscitation (CPR) and electrical defibrillation from the beginning of 1960 made it possible to treat patients with ventricular fibrillation and circulatory failure (Quinn & Thompson, 1999). Additionally, the development of mechanical ventilation, which accelerated during the poliomyelitis epidemic in the 1940s and 1950s, paved the way for the treatment of patients with respiratory failure, while more advanced surgery and anaesthesia made it possible to perform larger and more complex operations with a correspondingly greater risk of complications (Lynaugh & Fairman, 1992). Experience showed that the mortality reduced by gathering patients in different specialized units, e.g. with regard to respiratory and cardiovascular support throughout the 24-hour-period, where a sufficient number of bedside
nurses were observing, recognizing and compensating for a failure of the patients’ vital functions (Adam & Osborne, 2005; Cutogno, 1992).

Over the past few years, the patients in the ICU have become more severely ill or injured and older than previously seen, and the use of technical equipment in the treatment of the patients is more advanced, with consequences for the nurses and the care they deliver (Bergbom, 2007). In Norway, as in Sweden, ICUs are organized mostly dependent on the patients’ diseases and condition, e.g. patients that require respiratory or cardiovascular support. However, the organization may differ between hospitals and type of hospital levels. Intensive care nurses need the highest level of professional knowledge and skills to ensure the quality and safety of patient care and that “there should be congruence between the needs of the patient, and the skills, knowledge and attributes of the nurse caring for the patient” (World Federation of Critical Care Nurses, 2005, p. 28). Kirkevold (1996) describes different categories of nursing situations, in which emergency-, problematic- and problem-identifying situations are conditions nurses meet in their work in the ICU. Emergency situations, which are the most appropriate in this thesis, are characterized in that they are unclear, complex and arise unexpectedly and abruptly, are limited in time and have a dramatic character in which fast actions by competent nurses are crucial for the patient’s outcome (Kirkevold, 1996). Nurses are usually the first health care personnel to respond to a situation through the initiation of resuscitative or emergency activities (Benner et al., 2011). The situations require an appropriate competence of the ICU nurses to provide a qualified and safe care to critically ill patients; hence, it is claimed that the emergency situation is ignored and underestimated because it largely overlaps with established medical practice (Benner, 2001; Kirkevold, 1996).

With regard to patient safety in the ICU, research shows that incidents involving critically ill patients regularly take place (Orgeas et al., 2008; Rothschild et al., 2005). Errors related to medication (Balas et al., 2006; Rothschild et al., 2006; Valentin et al., 2009), and procedures in connection with lines, catheters, drains, artificial airways (Capuzzo et al., 2005; Valentin et al., 2006) and medical equipment are common (Thomas & Galvin, 2008; Valentin et al., 2006). Rothschild et al. (2005) found that most serious errors occurred during the ordering or execution of treatment, and that the main cause were slips and lapses rather than rule- or knowledge-based mistakes. In addition to breakdowns in team processes (Manser, 2009; Reader et al., 2009),
stress (Berland et al., 2008) and workload (Scott et al., 2006; Stone et al., 2007) are associated with a greater risk of incidents. In a systematic review, West et al. (2009) found a relationship between nursing resources and harmful incidents or mortality in two out of 15 studies. Despite the frequent number of incidents, Capuzzo et al. (2005) found that errors were strongly underreported, and Elder et al. (2008) found that ICU nurses felt uncomfortable about reporting errors.

**Patient safety culture**

The term safety culture was originally introduced by the International Atomic Energy Authority following the Chernobyl accident to help categorize organizational deficiencies that directly contributed to the accident (Mearns & Flin, 1999). The WHO (2009b) has confirmed that focusing on culture is one of the most important areas for the improvement of patient safety in hospitals today. The safety culture in health care is an aspect of the wider culture of an organization.

In this thesis, the use of “patient safety culture” is based on The European Network for Patient Safety, which defines the culture of safety as: “an integrated pattern of individual and organizational behavior, based upon shared beliefs and values that continuously seeks to minimize patient harm which may result from the process of care delivery” (EUNetPaS, 2010, p. 4). This definition differs from more neutral definitions, as it reflects a culture of safety in which actions are taken to reduce risk or harm to the patients (EUNetPaS, 2010). Sammer et al. (2010) identified the properties of a patient safety culture as: leadership, teamwork, evidence-based practice, open communication, learning from mistakes, errors recognized as system failures simultaneously holding individuals accountable for their actions, and lastly, patient-centred care. According to Flaatten (2009), teamwork, communication and how to handle incidents are particularly important for patient safety in the ICU.

Measurements of patient safety culture are limited due to the capability to define the measurable components of a culture (Cooper, 2000). However, a request for a relatively low-cost and easy to use assessment of patient safety culture resulted in a support of patient safety climate questionnaires (Nieva & Sorra, 2003). Safety climate is described as the measurable component of safety culture, which is regarded as surface features (Flin et al., 2000) and relates to the employees’ shared perceptions with concern to safety policies, procedures and
practices in their unit and the organization at large (Zohar et al., 2007) at a given point of time (Flin et al., 2000). The concept of safety climate is characterized as multidimensional (Flin et al., 2000), and the most frequent common dimensions measured in most patient safety climate surveys are leadership, policies and procedures, staffing, communication and incident reporting (Colla et al., 2005; Halligan & Zecevic, 2011), in addition to organizational learning, teamwork and a shared belief in the importance of safety (Halligan & Zecevic, 2011). Furthermore, measurements of patient safety culture are useful in raising awareness about patient safety and identifying areas with potential for improvement (Nieva & Sorra, 2003).

A number of instruments that measure patient safety culture are available (Colla et al., 2005; Halligan & Zecevic, 2011), and the instruments mostly used within the ICUs are the Hospital Survey on Patient Safety Culture (HSOPSC) (Sorra & Nieva, 2004), the Safety Attitude Questionnaire (SAQ) (Sexton et al., 2006) and the Safety Climate Survey (SCS) (Sexton & Thomas, 2003). In this thesis, the HSOPSC was used to measure the patient safety culture among ICU nurses, as the study was a part of a patient safety culture measurement project in one hospital trust in Norway.

Studies have demonstrated a variation in the perception of patient safety culture among professions, both within ICUs in different hospitals (France et al., 2010; Huang et al., 2010) and across ICUs in a single institution (Huang et al., 2007). In some studies, a more negative perception of patient safety culture was identified among intensive care nurses compared to physicians (Huang et al., 2007; Sexton et al., 2006), while another study found no differences between the professions (Kho et al., 2009). The perception of a positive patient safety culture has been reported to be associated with fewer patient safety incidents (Pronovost et al., 2005). Nonetheless, incident reporting has been documented as an area for improvement with regard to both nurses and physicians (Snijders et al., 2009). Management and a strong and proactive organizational commitment to safety in ICUs are identified to be associated with patient outcomes (Huang et al., 2010).

Research concerning programme design to improve teamwork and culture in ICUs has shown significant enhancements in overall safety culture (Pronovost et al., 2008a; Sexton et al., 2011; Snijders et al., 2009). Even so, there is still a
limited amount of evidence to support the impact of patient safety culture strategies on patient outcomes (Morello et al., 2013).

Studies have demonstrated that ICU nurses have positive perceptions of teamwork within the unit (Armellino et al., 2010; Chaboyer et al., 2013; France et al., 2010; Snijders et al., 2009). However, while the ICU nurses generally have a positive perception of teamwork, a paradox is that failures are found in ongoing team performance, with coordination, leadership and communication all being contributory factors to patient safety incidents in the ICU (Manojlovich & DeCicco, 2007; Reader et al., 2006).

**Team performance**

Ensuring patient safety in the ICU requires a dependence on team functioning (Stockwell & Slonim, 2006). Just bringing persons together to perform a specified task does not automatically ensure they will function as a team, although, teams make fewer errors than individuals when each team member know his or her responsibility, as well as those of the other members in the team (Sanchez & Barach, 2012). All team members, including both leaders and followers, are involved in performing tasks to help achieve the desired goal to solve a given situation in the best interest of the patients (Van Vugt, 2006; Svensk sjuksköterskeförening & Svenska Läkarsällskapet, 2013). A team can be defined as, “a distinguishable set of two or more people who interact dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform, and who have a limited life-span membership” (Salas et al., 1992, p. 4).

Team performance refers to the actual behaviour enacted by the team (Cambell et al., 1993; Rosen et al., 2010), while team processes are described as the cognitive, verbal and behavioural activities taking place during the team’s performance (Reader et al., 2009; Schmutz & Manser, 2013). These activities may be described as the performance of non-technical skills (NTS), which are defined as the “cognitive, social and personal resource skills that complement technical skills and contribute to a safe and efficient task performance” (Flin et al., 2008, p. 1). NTS include situational awareness, decision-making, communication, team working, leadership and the management of stress and fatigue (Flin et al., 2008). Situation awareness is described as knowing what is
going on in the environment and decision-making as the process of making a judgement or choosing an option to meet the needs of a given situation. Communication is about the exchange of information, response or feedback, ideas and feelings. Team working consists of supporting others, solving conflicts, exchanging information and coordinating activities (Flin et al., 2008). Lastly, leadership is about coordinating and directing the activities of the team members, assessing their performance, establishing a positive atmosphere and motivating and developing knowledge, skills and abilities (Salas et al., 2004).

Poor NTS are identified as contributory factors to critical incidents in the ICU (Reader et al., 2006). Data from ICU incident reporting systems showed that team communication failures have led to patient harm (Pronovost et al., 2006b; Wu et al., 2002), and critical incident studies have indicated the importance of team leadership for guiding the way in which ICU team members interact and coordinate (Pronovost et al., 2006b; Reader et al., 2009). With regard to CPR, the absence of leadership and task distribution has been associated with poor interdisciplinary team performance (Marsch et al., 2004). Moreover, hierarchies have been identified as barriers to a team’s action (Andersen et al., 2010; Hunziker et al., 2011). Research has found that team training improves team performance, and that team behaviour has an impact on clinical practice (Salas et al., 2008b; Schmutz & Manser, 2013). It is recommended that nurses and physicians should conduct both disciplinary and interdisciplinary team training (Kohn et al., 2000).

**Simulation-based team training**

Gaba (2004, p. 2) described simulation as a technique that may be used, “to replace or amplify real experiences with guided experiences that evoke or replicate substantial aspects of the real world in a fully interactive manner”. The techniques used in teaching vary from low-fidelity- to high-fidelity human patient simulation (Jeffries et al., 2005). The human patient simulator is high-fidelity, full-scale, computer-integrated and physiologically responsive mannequin. Human patient simulators used in intensive care nursing have many features, which may include palpable pulses and a programmable heart, a chest wall that rises and falls to simulate respiration and bowel sounds, artificial airways, chest tubes, and the insertion of intravenous- and urinary catheters and nasogastric tubes. Moreover, the simulators interface with a monitor for a real-time numeric and waveform display of blood pressure, heart rate,
electrocardiogram, oxygen saturation and central venous and pulmonary artery pressures (Nagle et al., 2009). Human patient simulation allows for the training of complex skills in a realistic environment without exposing the patient to any unnecessary risk (Rall & Dieckmann, 2005a) and is a recommended method for the ongoing education and assessing of competence of intensive care nurses (Cato & Murray, 2010; Nagle et al., 2009).

Crew Resource Management (CRM) is a team training strategy which creates an awareness of human factors and increases the use of NTS (Glavin & Maran, 2003). This strategy for training teams to cope with stressful situations and error management was developed by the airline industry (Helmreich, 2000), and was transferred to health care by Gaba et al. (1994), who adapted the use of human patient simulation into team training and termed the training programme, Anaesthesia Crisis Resource Management (ACRM), which was later shortened to Crisis Resource Management (CRM) (Rall & Dieckmann, 2005b). In this thesis, the use of the abbreviation CRM concerns the principles of both the Crew- and Crisis Resource Management. CRM aims to coordinate, utilize and apply all available resources to help optimize patient safety and outcome, as well as to prevent errors and minimize the negative consequences of errors that have already occurred. In addition to equipment, resources include all people involved with their abilities, attitudes, skills and limitations (Rall & Dieckmann, 2005b). Simulation used in the CRM programme focuses on high fidelity scenarios in which small groups of participants play active roles, with one as the leader and the others as followers (Gaba et al., 1994). The team treats the simulator as a patient during challenging situations in a realistic environment, with the scenarios designed to be highly engaging and possibly videotaped for subsequent group discussions (debriefing), in which both active- and observer roles are involved (Rall & Dieckmann, 2005a). According to Gaba (2004) simulation training may provide an indirect way to improve safety by acting as a lever for culture changes.

Research suggests that simulation-based training is an effective strategy for improving NTS in both nursing (Lewis et al., 2012) and medicine (Doumouras et al., 2012). Studies have documented that simulation-based team training (SBTT) can improve teamwork in interdisciplinary critical care teams in general (Buljac-Samardzic et al., 2010) and trauma resuscitation in particular (Holcomb et al., 2002; Shapiro et al., 2004), as well as the management of medical emergencies in the ICUs (Frengley et al., 2011; Pascual et al., 2011).
systematic review found that simulation training is consistently associated with large effects for the outcome of knowledge, skills and behaviour, although still moderate effects for patient-related outcome are demonstrated (Cook et al., 2011).

Recently published systematic reviews have found simulation to be a valid method in nursing education (Cant & Cooper, 2010; Lapkin et al., 2010). Students in post-graduate critical care education were confident (Tiffen et al., 2009) and satisfied (Corbridge et al., 2010) with simulation versus other educational methods. RN teams (Sittner et al., 2009) and interdisciplinary teams (Rudy et al., 2007; Shapiro et al., 2004) from critical care areas found simulation-based team training to be a useful educational method. The RNs were confident that skills learned from simulation-based team training could be translated into both regular practice (Sittner et al., 2009) and emergency situations (Gordon & Buckley, 2009). Various factors such as prior simulation experience, years of nursing experience and area of hospital practice have been found to influence RNs' attitudes toward the use of simulation for training (DeCarlo et al., 2008).

The Nursing Education Simulation Framework (Jeffries, 2005), is a widely used framework for evaluating simulation in nursing (LaFond & Van Hulle Vincent, 2012). Based on this framework the evaluation of simulation occurs during the following three phases: outcome, implementation and design/development. The basic declaration of the framework is that learning outcomes are influenced by the simulation instructors, participants, educational practices and simulation design/development characteristics. The most common outcome measures with regard to simulation are learner satisfaction and self-confidence, knowledge and skill performance (Jeffries & Rogers, 2007). To identify skill performance, the evaluation may include both observational expert assessments and self-assessments. An incongruity between self-assessment compared to the observed measure of NTS competence has been documented (Arora et al., 2011; Davis et al., 2006).

There are a variety of currently published instruments for the evaluation of simulation-based training, but many of them have not been shown to be reliable because of the lack of psychometric testing (Cooper et al., 2010; Kardong-Edgren et al., 2010). Some widely used instruments for the evaluation of simulation used for training has been developed by the National League
Nursing (NLN instruments) (Jeffries & Rizzolo, 2007), which are based on the Nursing Education Simulation Framework (Jeffries, 2005). The three NLN instruments deal with the evaluation of the outcome of satisfaction and self-confidence in learning, the implementation of the educational practice and the simulation design/development. However, the instruments are not designed for the evaluation of the outcome of NTS team performance, but some measurements are available; still, few instruments have been adapted to an intensive care setting (Cooper et al., 2010). The instruments most relevant within the ICUs are the Mayo High Performance Teamwork Scale (MHPTS) (Malec et al., 2007) and the Ottawa CRM Global Rating Scale (Ottawa GRS) (Kim et al., 2006), which along with the NLN instruments are used in this thesis.
Rationale for the thesis

Intensive care with its complexity represents potential patient safety challenges for critically ill patients. Human errors are stated as the most common cause of patient safety incidents, with failures in team performance as contributory factors. Promoting a patient safety culture is considered to be the most important area for the improvement of patient safety in hospitals. Patient safety culture measurements are useful in that they raise awareness about patient safety and identify areas with a potential for improvement. Since nurses constitute a large proportion of the ICU personnel, their knowledge, skills, norms, values, beliefs and assumptions contribute to the unit’s overall safety culture, and is therefore an important group to focus on. Teamwork is acknowledged as a key concept regarding patient safety, and simulation-based team training has been proclaimed as a method for improving safety and quality in healthcare. Since intensive care nurses play a key role in interdisciplinary and disciplinary teamwork with regard to caring for critically ill patients, there is a need to investigate team performance and the use of simulation for team training. From intensive care nurses’ perspective, research related to initiatives to patient safety regarding patient safety culture, team performance and simulation-based team training have been reported to a limited degree.
AIMS

The overall aim of the thesis was to investigate patient safety culture, team performance and the use of simulation-based team training for building patient safety in intensive care nursing.

The specific aims were:

I. To investigate registered nurses’ perceptions of the patient safety climate in intensive care units and to explore potential predictors for overall perceptions of safety and frequency of incident reporting.

II. To implement a simulation-based team training programme and to investigate intensive care nurses’ evaluations of simulation used for team training.

III. To explore intensive care nurses’ team performance in a simulation-based emergency situation by using expert raters’ assessments and nurses’ self-assessments in relation to different intensive care specialties.

IV. To describe intensive care nurses’ perceptions of simulation-based team training for building patient safety in intensive care.
METHODS

Study design

This thesis includes four studies (I-IV). In order to address the overall aim a descriptive and explorative design with combining quantitative (I-III) and qualitative methods (IV) was used. This enabled an investigation of the phenomenon “initiatives for building patient safety” through the use of precise measurement and collection of narrative data, which opened for a broad perspective of the phenomenon that was under study (Polit & Beck, 2012). One of the studies in the thesis includes measurements of patient safety culture (I). Three of the studies are based on laboratory high-fidelity human simulation with respect to the evaluation of a team training programme (II-IV). All the studies included registered nurses (RNs) related to intensive care. An overview of the studies is shown in Table 1.

Table 1. Overview of design and methods

<table>
<thead>
<tr>
<th>Study</th>
<th>Design and method</th>
<th>Participants</th>
<th>Data collection</th>
<th>Data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Descriptive</td>
<td>220 RNs</td>
<td>Questionnaire</td>
<td>Statistics</td>
</tr>
<tr>
<td></td>
<td>Cross-sectional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quantitative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>Descriptive</td>
<td>53 RNs</td>
<td>Questionnaires</td>
<td>Statistics</td>
</tr>
<tr>
<td></td>
<td>Quantitative</td>
<td>10 RNs/PG</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>students¹</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>Explorative</td>
<td>53 RNs</td>
<td>Measurement</td>
<td>Statistics</td>
</tr>
<tr>
<td></td>
<td>Quantitative</td>
<td></td>
<td>scales</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>Descriptive</td>
<td>18 RNs</td>
<td>Individual</td>
<td>Qualitative</td>
</tr>
<tr>
<td></td>
<td>Qualitative</td>
<td></td>
<td>interview</td>
<td>content analysis</td>
</tr>
</tbody>
</table>

¹PG-student= postgraduate student

Settings and participants

Participants were recruited from six local hospitals in one hospital trust, and represented different type of ICUs/specialties (Table 2). Additionally, participants were recruited from one intensive care nurse postgraduate education (PG-ED) programme at a university college.
Table 2. Overview of the ICUs

<table>
<thead>
<tr>
<th>Type of ICU/Specialty</th>
<th>n</th>
<th>Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed intensive care (MIX-ICU)</td>
<td>2</td>
<td>I</td>
</tr>
<tr>
<td>Surgical, medical and coronary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>General intensive care (G-ICU)</td>
<td>4</td>
<td>I</td>
</tr>
<tr>
<td>Surgical and medical</td>
<td>3</td>
<td>II-IV</td>
</tr>
<tr>
<td>Medical intensive care (M-ICU)</td>
<td>4</td>
<td>I</td>
</tr>
<tr>
<td>Coronary and medical</td>
<td>3</td>
<td>II-IV</td>
</tr>
<tr>
<td>General/medical intensive care (GM-ICU)</td>
<td>1</td>
<td>II-IV</td>
</tr>
<tr>
<td>Surgical, medical and coronary</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In Study I, the sample consisted of RNs (n=302) from ten ICUs in six hospitals. The RNs represented G-ICUs (n=144, 48%) and M-ICUs (n=96, 32%) from four hospitals and MIX-ICUs (n=62, 20%) from two hospitals. A total of 220 RNs (72%) agreed to participate in the study.

In Studies II-III, a convenience sample of 53 RNs (II, III) from seven ICUs in four hospitals was recruited. The RNs represented G-ICUs (n=26 RNs), M-ICUs (n=14 RNs) and GM-ICUs (n=13 RNs). Additionally, ten RNs were recruited from the last semester in an 18-month intensive care nurse PG-ED programme (II).

The ICU RNs’ participation occurred during scheduled work time. All of the RNs who wanted to participate signed up on a list in the unit, and the ward head nurse/manager allocated the RNs into teams with regard to their work schedules and the staffing resources to ensure a safe care at the unit. Eleven teams participated, where each team consisted of RNs from the same ICU. The RNs represented G-ICUs (five teams), M-ICUs (three teams) and a GM-ICU (three teams) (II, III). All RNs who wanted to participate from the PG-ED programme were allocated into teams (two teams) by a teacher (II).

In Study IV, a strategic sample of 18 RNs was recruited from the sample of 53 ICU RNs from Studies II and III. The RNs represented G-ICUs (n=7), M-ICUs (n=7) and a GM-ICU (n=4). A first request was sent to one or two RNs in each team subsequent to their participation in the simulation-based team training programme. In total, requests were sent to 21 informants, of whom 18 gave their consent to participate.
A description of the participants with regard to background is shown in Table 3 (I-IV).

Table 3. Descriptions of the participants (I-IV)

<table>
<thead>
<tr>
<th>Study</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>M(SD)</td>
<td>n</td>
</tr>
<tr>
<td>Total</td>
<td>220</td>
<td>63</td>
<td>53</td>
<td>18</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>195</td>
<td>91.1</td>
<td>57</td>
<td>90.5</td>
</tr>
<tr>
<td>Male</td>
<td>19</td>
<td>8.9</td>
<td>6</td>
<td>9.5</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 40 years</td>
<td>67</td>
<td>30.6</td>
<td>22</td>
<td>34.9</td>
</tr>
<tr>
<td>41 – 50 years</td>
<td>89</td>
<td>40.6</td>
<td>27</td>
<td>42.9</td>
</tr>
<tr>
<td>≥ 51 years</td>
<td>63</td>
<td>28.8</td>
<td>14</td>
<td>22.2</td>
</tr>
<tr>
<td>Area of intensive care</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>G-ICU</td>
<td>112</td>
<td>50.9</td>
<td>26</td>
<td>41.3</td>
</tr>
<tr>
<td>M-ICU</td>
<td>64</td>
<td>29.1</td>
<td>14</td>
<td>22.2</td>
</tr>
<tr>
<td>GM-ICU</td>
<td>13</td>
<td>20.6</td>
<td>13</td>
<td>24.5</td>
</tr>
<tr>
<td>MIX-ICU</td>
<td>44</td>
<td>20.0</td>
<td>10</td>
<td>15.9</td>
</tr>
<tr>
<td>PG-ED</td>
<td></td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>Education level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Graduate</td>
<td>50</td>
<td>22.7</td>
<td>3</td>
<td>4.7</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>170</td>
<td>77.3</td>
<td>50</td>
<td>79.4</td>
</tr>
<tr>
<td>PG student</td>
<td>10</td>
<td>15.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years as RN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Years as PG-RN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 5 years</td>
<td>50</td>
<td>29.4</td>
<td>17</td>
<td>34.0</td>
</tr>
<tr>
<td>6 – 15 years</td>
<td>68</td>
<td>40.0</td>
<td>20</td>
<td>40.0</td>
</tr>
<tr>
<td>≥ 16 years</td>
<td>52</td>
<td>30.6</td>
<td>13</td>
<td>26.0</td>
</tr>
</tbody>
</table>

Simulation-based team training programme

A SBTT programme based on CRM was developed by the research team. The programme aimed to focus patient safety initiatives as team performance and the use of high-fidelity human patient simulation. The RNs’ participation in the programme provided the basis for the data collection in Studies II-IV. The programme was comprised of two half-days per team, and structured on the basis of the “Simulation setting model” (Dieckmann, 2009; Dieckmann et al., 2012), which distinguishes between seven different prototypical modules (Figure 1).
The author was responsible for the implementation of Module 1, while the implementation of the other modules was shared between four educated simulation instructors with backgrounds as nurses, with extensive experience from intensive care and anaesthesia nursing.

The first half-day referred to the first two modules, “setting introduction” and “theory inputs”, which was carried out for the teams at each of the four hospitals and at the university college. In the “setting introduction”, all the participants received both oral and written information about team learning objectives, the topic of the simulation and recommendations about relevant literature. The “theory inputs” referred to patient safety, the key CRM points (Rall & Dieckmann, 2005b) and simulation as method.

The second half-day of the simulation-based team training programme was carried out two to four weeks after the first half-day, and the implementation of the other five modules took place at a university college’s simulation centre. The “simulator briefing” was carried out in the simulation laboratory, which was created as an ICU environment with a high-fidelity patient simulator. In the “scenario briefing”, the team members were reminded about the team learning objectives (Figure 2), and received information about the scenario case.
Team learning objectives

- Practicing an organized and effective problem solving
- Adapts leadership skills based on the team composition and situation
- Communicates clearly and concisely
- Utilizes available resources
- Constantly reassesses and reevaluates situations

Figure 2. Team learning objectives

The RNs were assigned different roles by the facilitator: three RNs in active roles (a leader, an assistant and a helper as followers) and one to three RNs in passive roles as observers. One scenario involved a patient undergoing cardiac arrest and the other a receipt of a trauma patient. The scenarios were developed in collaboration between the university college and three ICUs (Figure 3). The simulation scenarios were pilot tested by students and RNs not involved in the study, which resulted in some minor revisions.

Cardiac Arrest

A patient (simulator), 55-year-old man arrived at the ICU three days ago with a diagnosis of cardiac arrest. He has been through an effective implementation of 24 hours of therapeutic hypothermia treatment and has been extubated for some hours. He is calling for help and the RNs that had just arrived on duty enter the patient room. The patient is suffering from chest pain and is restless and anxious. A while after the RNs entered the patient's room, the patient suffered cardiac arrest due to ventricular tachycardia displayed on the monitor. With the onset of cardiac arrest, the patient closed his eyes, ceased to speak and to breathe, and his pulse was no longer palpable. Cardiopulmonary resuscitation was expected to be initiated by the RNs. Regardless of the measures taken, the patient stayed in cardiac arrest for many minutes. Thereafter, return to spontaneous circulation (ROSC) could be achieved by defibrillation.

Trauma

A patient (simulator), a 51-year-old man arrived at the ICU after a bicycle accident. He complained about pain in the chest and in his abdomen on the left side, and was hypothermic on arrival. His bicycle helmet was cracked and he had bruises all over his body. Computer tomography identified three cost fractures on his left side and an encapsulated spleen rupture. He had a commotion, but no neck injury. After a while, and when the RNs connected the patient to the monitor and checked him out, the patient vomited, and had more pain, tachycardia and was hypotenive. The patient’s condition improved a bit as a result of proper action by the team, but after a while it was determined that he should be prepared for surgery.

Figure 3. Simulation scenarios cases

The “simulation scenarios” were carried out with instructors, one responsible for facilitating and the other performing the operation of the mannequin software. The simulation scenarios were conducted in varying order, meaning that one team conducted the order going from Cardiac Arrest to Trauma, whereas the next team carried out the order from Trauma to Cardiac Arrest, etc. The observers were placed in another room, and observed the team performance through the use of a screen. One was asked to observe the team’s problem solving-skills, while the other(s) the team’s leadership-, situational awareness-, resource utilization- and communication skills. All team members
actively participated in at least one simulation scenario, and each simulation scenario lasted approximately 12-15 minutes and was videotaped. Subsequently, a 30-minute “debriefing” was conducted by the facilitator, in which both the active roles and observer participated. In the “ending”, summaries were made. Both Cardiac Arrest- and Trauma scenarios were used in Study II and in Study III the Cardiac Arrest scenario was used.

Data collection

_Questionnaires (I-IV) and measurement scales (III)_

The data collection was based on background questions, instruments and measurement scales.

_The background questions_ included gender, age, area of intensive care practice, education level, years as RN, years as post-graduate RN (I-IV) and prior simulation experience (II-IV). The questions with regard to background were comprised of fixed- (I-IV) and open response alternatives (II-IV).

1. _Hospital Survey on Patient Safety Culture (HSOPSC)_ (Sorra & Nieva, 2004) was used to measure opinions about patient safety issues and incident reporting (I). The instrument consisted of 44 items divided into an outcome measure (two dimensions and two items), a unit-level aspect (seven dimensions) and a hospital-level aspect (three dimensions) (Table 4).

All items except for the outcome items used a response scale, rating from 1=strongly disagree to 5=strongly agree or a frequency rating from 1=never to 5=always. The outcome item “number of incidents reported (last 12 months)” is rated from 1=no incident, 2=1-2 incidents, 3=3-5 incidents, 4=6-10 incidents, 5=11-20 incidents and 6≥21 incidents, and the “patient safety grade” from 1=failing to 5=excellent. Positive scores consist of the average percentage of the respondents who scored 4/5 on the items within a given dimension. According to Sorra and Nieva (2004), 75% or higher of the respondents scoring 4/5 was defined as an excellent result and approximately 50% or less as areas with a potential for improvement.
Table 4. HSOPSC

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>Items</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome measure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall perception of safety</td>
<td>4</td>
<td>0.49</td>
</tr>
<tr>
<td>Frequency of incident reporting</td>
<td>3</td>
<td>0.83</td>
</tr>
<tr>
<td>Number of incidents reported (last 12 months)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Patient safety grade</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td><strong>Unit level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervisor/manager expectations and actions promoting safety</td>
<td>4</td>
<td>0.71</td>
</tr>
<tr>
<td>Organizational learning-continuous improvement</td>
<td>3</td>
<td>0.51</td>
</tr>
<tr>
<td>Teamwork within hospital units</td>
<td>4</td>
<td>0.76</td>
</tr>
<tr>
<td>Communication openness</td>
<td>3</td>
<td>0.61</td>
</tr>
<tr>
<td>Feedback and communication about error</td>
<td>3</td>
<td>0.76</td>
</tr>
<tr>
<td>No punitive response to error</td>
<td>3</td>
<td>0.60</td>
</tr>
<tr>
<td>Staffing</td>
<td>4</td>
<td>0.56</td>
</tr>
<tr>
<td><strong>Hospital level</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital management support for patient safety</td>
<td>3</td>
<td>0.76</td>
</tr>
<tr>
<td>Teamwork across hospital units</td>
<td>4</td>
<td>0.70</td>
</tr>
<tr>
<td>Hospital handoffs and transitions</td>
<td>4</td>
<td>0.62</td>
</tr>
</tbody>
</table>

1(Olsen, 2008; Sorra & Nieva, 2004)

HSOPSC is a instrument designed by the Agency for Healthcare Research and Quality. The instrument, based on a literature review conducted in the area of safety management and accidents with regard to organizational and safety culture, was developed on the basis of existing safety climate instruments (Sorra & Nieva, 2004). HSOPSC was designed to be used for a general evaluation of patient safety climate with the option of intra- and inter-institutional comparisons of healthcare settings, in addition to reporting incident rates (Sorra & Dyer, 2010; Sorra & Nieva, 2004). HSOPSC was pilot tested in hospitals across the US, and has been used in multiple countries, including in Norwegian settings (Haugen et al., 2010; Olsen, 2008) and within ICUs (Armellino et al., 2010; Snijders et al., 2009). The Norwegian translation (Olsen, 2008) was tested for validity and reliability among the health-care staff in a hospital, with the results indicating that the psychometric properties of HSOPSC were satisfactory and could be used in Norwegian hospital settings. The Cronbach’s alpha coefficients measured in different Norwegian hospital populations showed variations among the dimensions from 0.51 and 0.82 (Haugen et al., 2010; Olsen, 2008). In Study I, the Cronbach’s alpha coefficients were between 0.49 and 0.83 (Table 4).

2. The Mayo High Performance Teamwork Scale (MHPTS) (Malec et al., 2007) was used to measure team performance with respect to self-assessment and expert raters’ assessments (III). In this study, the first part of the scale was
MHPTS assessment criteria

Table 5. MHPTS assessment criteria

<table>
<thead>
<tr>
<th>Assessment criteria</th>
<th>MHPTS items</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A leader is clearly recognized by all members.</td>
<td></td>
</tr>
<tr>
<td>2. The team leader assures maintenance of an appropriate balance between command authority and team member participation.</td>
<td></td>
</tr>
<tr>
<td>3. Each team member demonstrates a clear understanding of his or her role.</td>
<td></td>
</tr>
<tr>
<td>4. The team prompts each other to attend all significant clinical indicators throughout the procedure/intervention.</td>
<td></td>
</tr>
<tr>
<td>5. When team members are actively involved with the patient, they verbalize their activities aloud.</td>
<td></td>
</tr>
<tr>
<td>6. Team members repeat back or paraphrase instructions and clarifications to indicate that they heard them correctly.</td>
<td></td>
</tr>
<tr>
<td>7. Team members refer to established protocols and checklists for the procedure/intervention.</td>
<td></td>
</tr>
<tr>
<td>8. All members of the team are appropriately involved and participate in the activity.</td>
<td></td>
</tr>
</tbody>
</table>

MHPTS offers a brief, reliable, validated and practical measure of NTS that can be used by participants in teams for self-assessment of CRM training, in which they reflect on and evaluate their team performance. The scale is also recommended to use for expert assessments. MHPTS (16 items) demonstrated a satisfactory internal consistency and construct validity by Rasch and traditional psychometric (Cronbach’s alpha =0.85) indicators (Malec et al., 2007). In Study III, the inter-rater reliability was conducted with regard to percentage agreements between raters, and showed a 60% agreement for the Cardiac Arrest scenario.

3. The Ottawa Crisis Resource Management Global Rating Scale (Ottawa GRS) (Kim et al., 2006) measures team performance, and was used by the expert raters with regard to expert assessments of the RNs’ team performance (III). The Ottawa GRS consists of six categories: one overall CRM performance category (Overall CRM) and five subsets of CRM skills categories with assessment criteria regarding leadership, problem solving, situation awareness, resource utilization and communication (Table 6). All of the categories used a seven-point adjective scale, using a rating from 1-2 = novice (all CRM skills require a significant improvement), 3-4 = advanced novice (many CRM skills require a moderate improvement), 5-6 = competent (most CRM skills require minor improvement) and 7 = clearly superior (few, if any, CRM skills that only require a minor improvement).
Table 6. Ottawa CRM skills categories with assessment criteria

<table>
<thead>
<tr>
<th>Assessment criteria</th>
<th>Ottawa GRS categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership</td>
<td>Stays calm and in control during crisis</td>
</tr>
<tr>
<td></td>
<td>Prompt and firm decision-making</td>
</tr>
<tr>
<td></td>
<td>Maintains global perspective (&quot;Big picture&quot;)</td>
</tr>
<tr>
<td>Problem solving</td>
<td>Organized and efficient problem solving approach (ABC's)</td>
</tr>
<tr>
<td></td>
<td>Quick in implementation (Concurrent management)</td>
</tr>
<tr>
<td></td>
<td>Considers alternatives during crisis</td>
</tr>
<tr>
<td>Situation awareness</td>
<td>Avoid fixation errors</td>
</tr>
<tr>
<td></td>
<td>Reassess and re-evaluates situation constantly</td>
</tr>
<tr>
<td></td>
<td>Anticipates likely events</td>
</tr>
<tr>
<td>Resource utilization</td>
<td>Calls for help appropriately</td>
</tr>
<tr>
<td></td>
<td>Utilizes resources at hand appropriately</td>
</tr>
<tr>
<td></td>
<td>Prioritizes tasks appropriately</td>
</tr>
<tr>
<td>Communication</td>
<td>Communicate clearly and concisely</td>
</tr>
<tr>
<td></td>
<td>Uses directed verbal/non-verbal communication</td>
</tr>
<tr>
<td></td>
<td>Listen to team input</td>
</tr>
</tbody>
</table>

(Kim et al., 2009)

The Ottawa GRS provides a broad measure for teamwork skills specifically aimed towards managing critically ill patients. The Ottawa GRS has been used with regard to training programme with both standardized pre- and post-course simulated resuscitation scenarios (Hicks et al., 2012; Kim et al., 2009). Data obtained from a study using the Ottawa GRS in measuring CRM performance during high-fidelity simulation scenarios supported evidence of construct validity and the measure of inter-rater reliability with regard to Ottawa GRS overall. The categories revealed Intraclass Correlation Coefficient (ICC) scores from .236 to .626 (Kim et al., 2006). Moreover, Study III showed ICC scores ranging from .667 - .854, which implies a moderate to good reliability (Portney & Watkins, 2009).

4. The Satisfaction with Learning and the Self-Confidence in Learning Scales (Jeffries & Rizzolo, 2007) were used to evaluate the outcome of satisfaction with current learning and self-confidence in learning in a simulated learning environment. The instrument consists of 13 items divided into “satisfaction with learning” (five items) and “self-confidence in learning” (eight items), using a five-point, response scale (1= strongly disagree with the statement, 5=strongly agree with the statement). The instrument has been developed by the American National League for Nursing (NLN), based on the Nursing Education Simulation Framework (Jeffries, 2005), and tested during a national, multi-site, multi-method project that took place from 2003 to 2006 (Jeffries & Rizzolo, 2007). The content validity of the Satisfaction with Learning- and the Self-Confidence in Learning Scales was established by nine clinical experts. The Cronbach’s alphas reported from the NLN project were
.94 for satisfaction and .87 for self-confidence (Jeffries & Rizzolo, 2007). Study II showed a Cronbach’s alpha of .89 for satisfaction and .79 for self-confidence regarding the Cardiac Arrest scenario, and .90 and .70 respectively, for the Trauma scenario.

5. The Education Practices Simulation Scale (EPSS) (Jeffries & Rizzolo, 2007) was used to evaluate the implementation of the educational practice. The EPSS consists of 16 items divided into four subscales: “active learning” (10 items), “collaboration” (two items), “diverse ways of learning” (two items) and “high expectations” (two items). The EPSS is composed of two components: The first component asks about the presence of the specific features in the simulation, using a five-point, response scale (1=strongly disagree with the statement, 5=strongly agree with the statement), and with an opportunity to respond not applicable (NA). The second component asks about the importance of those features, and also uses a five-point, response scale (1=not important, 5=very important). Like the previous instrument’s, this instrument is based on the Nursing Education Simulation Framework (Jeffries, 2005) and is tested. The development of the EPSS was based on Chickering and Gamson’s (1999), “The Seven Principles for Good Practice In Undergraduate Education”, and by use of factor analysis these seven principles were reduced to four (Jeffries & Rizzolo, 2007). The Cronbach’s alpha reported for the components of the instrument were .86 for the presence of best practice and .91 for the importance of those features, respectively (Jeffries & Rizzolo, 2007). In Study II, the Cronbach’s alpha was .87 for the presence of best practice and .93 for the importance of those features regarding the Cardiac Arrest scenario, and .90 and .90, respectively, for the Trauma scenario.

6. The Simulation Design Scale (SDS) (Jeffries & Rizzolo, 2007) was used to evaluate the simulation design/development. The SDS consists of 20 items divided into five subscales: “objectives/information” (five items), “support” (four items), “problem solving” (five items), “feedback/guided reflection” (four items) and “fidelity/realism” (two items). The SDS consists of two components: The first component asks about the presence of specific features, using a five-point, response scale (1=strongly disagree with the statement, 5=strongly agree with the statement), as well as the opportunity to respond NA. The second component asks about the importance of those features, using a five-point, response scale (1=not important, 5=very important). Like the previous two instruments, the instrument was developed by the NLN, based on
the Nursing Education Simulation Framework (Jeffries, 2005) and is tested. For the SDS, the content validity was established by ten experts in simulation. The reliability reported using the Cronbach’s alpha was .92 for the presence of the design features and .96 for the importance of those features (Jeffries & Rizzolo, 2007). The Cronbach’s alphas in Study II were .93 for the presence of the design features and .94 for importance of those features regarding the Cardiac Arrest scenario, and .92 and .94, respectively, for the Trauma scenario.

The Satisfaction with Learning- and the Self-Confidence in Learning Scales, the EPSS and the SDS (NLN instruments) have all been widely used in research (LaFond & Van Hulle Vincent, 2012; Thidemann & Söderhamn, 2013). In Study II the instruments were adjusted to the simulation used for team training in emergency situations in the ICU by the research team.

Instruments translation

The Satisfaction with Learning- and the Self-Confidence in Learning Scales, the EPSS and the SDS were translated from English to Norwegian with permission from the NLN (II). The Ottawa GRS and MHPTS (III) were translated into Norwegian with permission obtained from the respective authors. The translations were conducted by using a back translation (Brislin, 1970; Yu et al., 2004), and the following steps were used:

1. The instruments were translated from English to Norwegian by a bilingual nurse lecturer with Norwegian as her native language.
2. The translation was then reviewed by an expert group of simulation instructors with knowledge in the field of Emergency Medicine and CRM, who did not know the English version. Some minor suggestions with regard to conceptual changes were presented, which were approved by the research team (RB, BH, MLHL).
3. The Norwegian translation was then translated back into English, and blinded to the original versions by a bilingual person whose native language was English.
4. The translations back into English were analysed to identify possible differences with the original version by the research team (RB, BH, MLHL), and only minor differences were found.
Pilot test (II, III)

The NLN instruments (II) were pilot tested by PG students (n=9) and RNs representing different areas of intensive care (n=15) not involved in the study, and the testing resulted in some linguistic changes. The Ottawa GRS and MHPTS instruments (III) were tested for both face- and content validity by two expert CRM raters, with only minor linguistic adjustments being required.

Qualitative interview (IV)

An open-ended question was used: “Can you please describe how you perceive simulation-based team training with regard to building patient safety in intensive care?” In addition, follow-up and probing questions were used.

One pilot interview was conducted and transcribed verbatim for a subsequent discussion in the research team. As there were no revisions made the pilot interview was included in the study.

Procedure

In Study I, the data collection took place from December 2008 to February 2009, and the questionnaire was distributed to the RNs in each of the ten ICUs by the ward head nurse or an assistant. The respondents anonymously returned the questionnaires in envelopes, placed them in a sealed box at the unit. One general reminder was given. With regard to Study II and III, the data collection took place from April 2009 to February 2010. The data were collected during the second day of the simulation-based team training programme (II, III) and additionally after all the teams had completed the simulation-based team training programme (III).

An overview of the data collection is shown in Figure 4.
1. **Before the simulation**
   The RNs in each team responded to a questionnaire regarding background.

2. **Immediately after completing each “simulation scenario module”**
   The RNs in each team conducted a team performance self-assessment (MHPTS) for each scenario (III).

3. **Subsequent to the “ending module”**
   The RNs in each team conducted the three NLN instruments for each scenario (II).

4. **After all the teams had completed the simulation-based team training programme**
   Two trained expert raters assessed each of the 11 teams’ NTS team performance with respect to two different measure scales (MHPTS and Ottawa GRS) by use of videotape (III).

Figure 4. Procedure for data collection in Studies II, III

In Study IV, the data collection took place from May to December 2009. The interviews were conducted by the author three-four weeks after the simulation and took place according to the informant’s desire, either in the hospitals or at the university college. The interview took the form of a dialogue where follow-up- and probing questions were used. The interviews lasted from 26-47 minutes (mean=39 minutes), and were digitally recorded and transcribed verbatim.

**Data analyses**

**Statistics (I-III)**

The data analyses were performed using IBM SPSS Statistics, versions 18 (I) and 19 (II, III). The statistical significance was set to \( p < .05 \) (two-tailed) for all tests. The statistical analyses used in Studies I-III (Field, 2009; Pallant, 2010; Tabachnick & Fidell, 2007) are shown in Table 7.
Table 7. The application of statistical analyses (I-III)

<table>
<thead>
<tr>
<th>Statistics</th>
<th>Application of statistical analyses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequencies, percentages, mean, standard deviation</td>
<td>To describe the study sample (I-III).</td>
</tr>
<tr>
<td>Pearson's Chi-square tests</td>
<td>To compare the differences in the RNs' proportions between three types of ICUs and &quot;number of incidents reported (last 12 months)&quot; and &quot;patient safety grade&quot; (I). To compare the differences between the area of intensive practice and RNs prior simulation experience (II).</td>
</tr>
<tr>
<td>Wilcoxon Signed Rank tests</td>
<td>To analyse the differences between the Cardiac Arrest- and Trauma simulation scenarios with respect to the NLN instruments' subscales score (II).</td>
</tr>
<tr>
<td>Kruskal-Wallis tests</td>
<td>To analyse the differences in the sub-groups with regard to ages, years as a PG-RN and area of intensive practice in relation to the NLN instruments' subscales score (II).</td>
</tr>
<tr>
<td>Mann-Whitney U-tests</td>
<td>To analyse the differences between RNs in active roles and RNs as observers in relation to the subscales of satisfaction and self-confidence in learning, as well as for RNs with prior simulation experience and RNs with no prior simulation experience in relation to all subscales in the three NLN instruments (II). To analyse differences between teams from two types of intensive care specialties and the expert raters' assessments and the RNs' self-assessments, as well as between the expert raters' assessments and the RNs' self-assessments (III).</td>
</tr>
<tr>
<td>General Linear Model univariate analysis (two-way ANOVA) with Levene's test and Tukey post-hoc tests</td>
<td>To explore both the main- and interaction effect of two types of units, and four hospitals on the HSOPSC's 12 dimensions. A Levene's test was carried out to investigate whether the variability in scores for each of the groups was similar (p&gt;.050). Tukey post-hoc tests were conducted to identify the differences when the ANOVAs were significant (I).</td>
</tr>
<tr>
<td>Sequential multiple regression analysis</td>
<td>To explore potential predictors for the HSOPSC's two outcome dimensions, &quot;overall perception of safety&quot; and &quot;frequency of incidents reporting&quot;. The analyses were run in two steps: Step 1 included the seven dimensions at the unit level, and Step 2 included the three dimensions at the hospital level (I).</td>
</tr>
<tr>
<td>Intraclass Correlation (ICC) Type III</td>
<td>To test the inter-rater reliability regarding Ottawa GRS CRM categories (II).</td>
</tr>
<tr>
<td>Cronbach's alpha</td>
<td>To test the internal consistency of the instruments (I, II).</td>
</tr>
</tbody>
</table>

Missing data

In Study I the highest number of missing values was in the HSOPSC dimension “hospital management support for patient safety”, which had missing values in 6.4% of the items. In the remaining dimensions, missing values varied from none missing to 4.5%, and all were considered at random.
In Study II the number of missing values in the Satisfaction with Learning- and Self-Confidence in Learning Scales was from none missing to 0.3%. In the EPSS- and SDS subscales, the percentage missing in the presence of the features was from 0.2% to 2%. As for the importance of those features, the missing values in the EPSS subscales were from 3.2% to 11%, with the highest number in “collaboration importance”. In the SDS subscale the missing values varied from 3.2% to 14.3%, with the highest number in “support importance”.

**Qualitative content analysis (IV)**

In Study IV, a qualitative manifest and inductive content analysis was made based on the model of the preparation-, organizing- and reporting phases proposed by Elo and Kyngäs (2008). The analysis was conducted in order to describe the RNs’ perceptions of simulation-based team training for building patient safety in intensive care (Figure 5).

<table>
<thead>
<tr>
<th>Phase</th>
<th>Content analysis</th>
</tr>
</thead>
</table>
| Preparation | The unit of analysis was selected on the basis of the aim of the study  
               The written transcript was read through repeatedly in order to grasp the content and to obtain a sense of the whole.                                                                                 |
| Organization| An open coding with written headings was performed.  
               The headings were collected to coding sheets.  
               The coding sheets headings were grouped by gathering those that were similar into higher order sub-categories named in words, which covered the meaning of the content.  
               Similar sub-categories were grouped together in higher-order generic categories.  
               A main category was generated from the generic categories in order to give a general description of the content of the written material.                                                                 |
| Reporting   | An overview of the abstraction process with the generation of categories was made.                                                                                                                                  |

Figure 5. The content analysis process (IV)
ETHICAL APPROVAL AND CONSIDERATIONS

The studies were approved by the Regional Committee for Medical Research Ethics in East Norway (ref. 24-2008 SI) (I), by the Norwegian Social Science Data Services (ref. 20370) (II-IV) and by the head administration of the hospitals (I-IV).

All studies were conducted according to the ethical guidelines for nursing research (Northern Nurses Federation, 2003). Potential ethical issues concerning the principle of autonomy, the principle of beneficence, the principle of non-maleficence and the principle of justice were considered when the studies were planned, as well as during the research period.

The principle of autonomy was followed and addressed by voluntariness, informed consent and the right to withdraw from the research project at any time, in addition to confidentiality. The initial information and invitation to participate in the study were given to the participants in writing and oral form by the author at meetings, on bulletin boards in the ICUs and via e-mail. The oral and written information included a short rationale, the aim of the studies, the method, the responsible researchers with a contact person, and that the participation was voluntary and that the participant could withdraw from the study at any time without any negative consequences. In Study I, the participants gave their informed consent through their choice of answering the questionnaire as directed in the enclosed information sheet. With regard to Studies II-IV, all the RNs who wanted to participate signed up on a list or gave a remark to the unit nurse/manger or teacher, who allocated the RNs into teams with regard to their work schedules and staffing resources to ensure safe care at the unit, since the participation in the study occurred during the RNs’ scheduled work time. The written consent from the participants was obtained in relation to their attendance to the simulation-based team training programme (II, III) and to the interview (IV). The requirement of confidentiality was obtained through anonymous questionnaires (I), coded questionnaires (II, III) and transcribed interviews (IV). A copy of the videos of each team’s performance (III) was mailed and returned from the expert raters by registered mail, and questionnaires, tapes, transcripts and videos were stored safely and securely. Confidentiality was ensured by analysing data at the group level (I-IV) to make sure that no individual could be identified in the results.
The principle of beneficence was safeguarded by all units receiving their results with regard to positive score on the HSOPSC dimensions, which may contribute to patient safety improvements in the unit (I). Moreover, the participation in the simulation-based team training programme may gain access to new knowledge among RNs, which might possibly provide benefits to critically ill patients in terms of patient safety (II-IV). Additionally, the publication of the results will contribute to patient safety improvements (I-IV).

To safeguard the principle of non-maleficence the researchers did consider the participants’ reactions about answering the questionnaires (I, II, III), the participation in the simulation-based team programme (II, III) and the interviews (IV), offering an opportunity during all studies to consult the researchers with questions or reflections if required.

The principle of justice was ensured in Study I by inviting all RNs working in all ICUs in one hospital trust to participate. In Studies II and III, all RNs working in seven ICUs, or who were students in the last semester of a PG-ED programme were invited to participate.
MAIN FINDINGS

The main findings are presented in the following order: Patient safety culture in intensive care (I), evaluation of simulation used for team training (II), assessment of team performance (III) and simulation-based team training for building patient safety in intensive care (IV).

Patient safety culture in intensive care (I)

The total average percentage positive score for the 12 HSOPSC dimensions was 55%. On the two outcome dimensions the percentage of average positive score was 18% for “frequency of incident reporting” and 69% for “overall perception of safety”. Improvements were considered concerning “frequency of incident reporting”. At the unit level the positive scores varied from 42% to 81% and improvements were considered concerning “feedback and communication about errors” and “organizational learning-continuous improvement”. At the hospital level the positive scores varied from 26% to 57% and improvements were considered concerning “hospital management support for patient safety” and “teamwork across hospital units”.

Fifty percent of the RNs answered that they had not reported any incidents over the past 12 months, while 36% had reported one to two incidents. Most of the RNs (71.6%) considered the patient safety grade as very good.

Subgroup comparisons

Analyses were conducted to explore the main- and interaction effect of two types of units (G-ICU and M-ICU) and four hospitals regarding the 12 dimensions.

There were significant differences between units on five dimensions, one on the outcome, two on the unit- and two on the hospital level. Moreover, the RNs in G-ICUs responded more positively than the RNs in M-ICUs (Table 8).
Table 8. Significant differences between types of ICUs

<table>
<thead>
<tr>
<th>Type of unit</th>
<th>G-ICU (n=112)</th>
<th>M-ICU1 (n=64)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Outcome</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency of incident reporting</td>
<td>2.80 (0.76)</td>
<td>2.53 (0.72)</td>
<td>.010</td>
</tr>
<tr>
<td><strong>Unit level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback and communication about error</td>
<td>3.36 (0.81)</td>
<td>2.97 (0.77)</td>
<td>.000</td>
</tr>
<tr>
<td>Staffing</td>
<td>3.85 (0.46)</td>
<td>3.62 (0.49)</td>
<td>.003</td>
</tr>
<tr>
<td><strong>Hospital level</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital management support for patient safety</td>
<td>2.95 (0.61)</td>
<td>2.64 (0.78)</td>
<td>.001</td>
</tr>
<tr>
<td>Hospital handoffs and transitions</td>
<td>3.54 (0.44)</td>
<td>3.41 (0.52)</td>
<td>.049</td>
</tr>
</tbody>
</table>

1M-ICU=CCU (I), 2General Linear Model univariate analysis (Two-way ANOVA)

A significant main effect was demonstrated for the four hospitals on eight dimensions, including five at the unit- and three at the hospital level. The findings demonstrated that RNs at hospital B responded the lowest with regard to dimensions at the unit level, and that RNs at hospital D responded the lowest with regard to dimensions at the hospital level (Table 9).

Table 9. Significant differences between hospitals

<table>
<thead>
<tr>
<th>PSC dimensions</th>
<th>A (n=46)</th>
<th>B (n=39)</th>
<th>C (n=56)</th>
<th>D (n=35)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organizational learning – continuous</td>
<td>3.41 (0.60)</td>
<td>3.18 (0.46)</td>
<td>3.65 (0.61)†</td>
<td>3.55 (0.62)</td>
<td>.006†</td>
</tr>
<tr>
<td>Improvement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teamwork within hospital units</td>
<td>4.34 (0.40)</td>
<td>3.95 (0.62)</td>
<td>4.17 (0.45)</td>
<td>4.01 (0.51)</td>
<td>.001²</td>
</tr>
<tr>
<td>Communication openness</td>
<td>3.93 (0.58)</td>
<td>3.50 (0.50)</td>
<td>3.83 (0.53)</td>
<td>3.73 (0.46)</td>
<td>.002²</td>
</tr>
<tr>
<td>Feedback and communication about error</td>
<td>3.20 (0.67)</td>
<td>2.58 (0.63)</td>
<td>3.59 (0.71)</td>
<td>3.39 (0.92)</td>
<td>.000⁴</td>
</tr>
<tr>
<td>Staffing</td>
<td>3.87 (0.46)</td>
<td>3.59 (0.51)</td>
<td>3.77 (0.47)</td>
<td>3.80 (0.47)</td>
<td>.035⁵</td>
</tr>
<tr>
<td><strong>Hospital level</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital management support for patient</td>
<td>2.86 (0.61)</td>
<td>2.60 (0.69)</td>
<td>3.16 (0.54)</td>
<td>2.55 (0.83)</td>
<td>.000⁶</td>
</tr>
<tr>
<td>safety</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teamwork across hospital units</td>
<td>3.25 (0.33)</td>
<td>3.06 (0.60)</td>
<td>3.33 (0.42)</td>
<td>3.04 (0.48)</td>
<td>.001⁷</td>
</tr>
<tr>
<td>Hospital handoffs and transitions</td>
<td>3.40 (0.38)</td>
<td>3.47 (0.47)</td>
<td>3.68 (0.46)</td>
<td>3.36 (0.53)</td>
<td>.001⁸</td>
</tr>
</tbody>
</table>

Tukey HSD: 1: B < C (p = .001) and B < D (p = .048) 5: B < A (p = .045) 2: A > B (p = .002) and A > D (p = .020) 6: C > B (p = .000) and C > D (p = .000) 3: B < A (p = .011) 7: C > B (p = .033) and C > D (p = .022) 4: B < A (p = .000) 8: C > A (p = .011) and C > D (p = .008)

*General Linear Model univariate analysis (Two-way ANOVA)
**Predictors to outcome**

An examination of the impact of unit level dimensions and hospital level dimensions on the outcome dimensions, “overall perception of safety” and “frequency of incidents reporting”, showed that dimensions at the unit level explained 30% of the variance on “overall perception of safety” and 31% on “frequency of incidents reporting”. Dimensions at the hospital level gave no further statistically significant contributions.

The unit level dimensions, “supervisor/manager expectations and actions promoting safety”, “teamwork within hospital units” and “feedback and communication about error” made significant contributions on the outcome of “overall perception of safety”. The two dimensions, “supervisor/manager expectations and actions promoting safety” and “feedback and communication about error”, contributed significantly to the outcome of “frequency of incident reporting”.

**Evaluation of simulation used for team training (II)**

The RNs’ evaluation of simulation used for team training was carried out in three phases with regard to the Cardiac Arrest- and Trauma scenarios. The RNs’ agreed to a high extent on (i) the outcome of “satisfaction with current learning” with respect to both simulation scenarios, whereas they scored lower on “self-confidence in learning”. The RNs agreed with the statements on (ii) the implementation of the educational practices with the highest score on the subscale “collaboration”. Furthermore, the RNs agreed highly with the statements of (iii) the simulation design/development elements, with the highest score on the subscale “feedback/guided reflection”.

**Subgroup comparisons**

Comparisons between subgroups were conducted with regard to both simulation scenarios within each of the three phases.

With regard to the Cardiac Arrest scenario, RNs’ evaluation of (i) outcome showed that the RNs in active roles had a significantly higher score on “satisfaction with current learning” than the RNs in observer roles. The RNs with prior simulation experience scored significantly higher on “self-confidence
in learning” than those with no prior simulation experience in both scenarios. With regard to the *Trauma scenario*, significant differences were found among RNs from the four areas of intensive care practice, with RNs from G-ICUs having the lowest scores and RNs from M-ICUs the highest scores (Table 10).

Table 10. Significant differences between RNs’ evaluations of the outcome of satisfaction with current learning and self-confidence in learning

<table>
<thead>
<tr>
<th>Satisfaction with current learning</th>
<th>Self-confidence in learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac arrest</td>
<td>Trauma</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Active (n=39)</td>
<td>4.44 (0.62)</td>
</tr>
<tr>
<td>Observer (n=24)</td>
<td>4.08 (0.56)</td>
</tr>
<tr>
<td>Simulation experience</td>
<td></td>
</tr>
<tr>
<td>Yes (n=27)</td>
<td>4.13 (0.43)</td>
</tr>
<tr>
<td>No (n=36)</td>
<td>3.80 (0.47)</td>
</tr>
<tr>
<td>Areas of ICU practice</td>
<td></td>
</tr>
<tr>
<td>G-ICU (n=26)</td>
<td>4.03 (0.56)</td>
</tr>
<tr>
<td>M-ICU (n=14)</td>
<td>4.51 (0.58)</td>
</tr>
<tr>
<td>GM-ICU (n=23)</td>
<td>4.34 (0.56)</td>
</tr>
<tr>
<td>PG-ED (n=10)</td>
<td>4.40 (0.52)</td>
</tr>
</tbody>
</table>

Table 11. Significant differences between RNs’ evaluations on the implementation of the educational practice in relation to area of intensive care practice

<table>
<thead>
<tr>
<th>Area of intensive care practice</th>
<th>EPSS</th>
<th>G-ICU (n=26)</th>
<th>M-ICU (n=14)</th>
<th>GM-ICU (n=13)</th>
<th>PG-ED (n=10)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Active learning - importance</td>
<td>Trauma</td>
<td>3.76 (0.58)</td>
<td>4.20 (0.50)</td>
<td>3.90 (0.57)</td>
<td>4.28 (0.40)</td>
</tr>
<tr>
<td>High expectation - importance</td>
<td>Trauma</td>
<td>3.96 (0.56)</td>
<td>4.53 (0.54)</td>
<td>4.35 (0.52)</td>
<td>3.83 (1.03)</td>
</tr>
</tbody>
</table>

Table 11. Significant differences between RNs’ evaluations on the implementation of the educational practice in relation to area of intensive care practice

With regard to the *Trauma scenario*, RNs’ evaluation of (ii) the implementation of the educational practice exhibited differences among RNs from the four areas of intensive care practice on two subscales. G-ICU scored lowest on “active learning” (importance) and PG-ED scored the highest. Furthermore, PG-ED scored lowest on “high expectations” (important), while M-ICU scored the highest (Table 11).

With regard to the *Trauma scenario*, RNs’ evaluation of (iii) the simulation design/development showed that RNs with prior simulation experience
scored significantly higher on “important feedback/guided reflection” than those with no prior experience.

Regarding the area of intensive care practice, RNs from G-ICUs mostly evaluated the simulation used for team training as lower than RNs from M-ICUs, GM-ICUs and PG-ED (Table 12).

Table 12. Significant differences between RNs’ evaluations of simulation design/development in relation to area of intensive care practice

<table>
<thead>
<tr>
<th>Area of intensive care practice</th>
<th>SDS</th>
<th>G-ICU (n=26)</th>
<th>M-ICU (n=14)</th>
<th>GM-ICU (n=13)</th>
<th>PG-ED (n=10)</th>
<th>p*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td></td>
</tr>
<tr>
<td>Scenario</td>
<td></td>
<td>Objectives and inform. - presence practice</td>
<td>3.93 (0.41)</td>
<td>4.33 (0.45)</td>
<td>4.29 (0.47)</td>
<td>4.30 (0.59)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Objectives and inform. - importance</td>
<td>3.93 (0.50)</td>
<td>4.38 (0.44)</td>
<td>4.38 (0.38)</td>
<td>4.40 (0.61)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support - presence practice</td>
<td>3.83 (0.56)</td>
<td>4.36 (0.53)</td>
<td>4.15 (0.48)</td>
<td>3.98 (0.92)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support - importance</td>
<td>3.70 (0.63)</td>
<td>4.25 (0.70)</td>
<td>4.19 (0.54)</td>
<td>3.69 (1.14)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fidelity (realism) - presence practice</td>
<td>3.84 (0.89)</td>
<td>4.71 (0.38)</td>
<td>4.31 (0.48)</td>
<td>4.75 (0.42)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fidelity (realism) - importance</td>
<td>4.04 (0.69)</td>
<td>4.75 (0.38)</td>
<td>4.46 (0.52)</td>
<td>4.20 (0.79)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support - presence practice</td>
<td>4.13 (0.65)</td>
<td>4.71 (0.43)</td>
<td>4.54 (0.52)</td>
<td>4.72 (0.44)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Support - importance</td>
<td>4.12 (0.68)</td>
<td>4.82 (0.37)</td>
<td>4.69 (0.48)</td>
<td>4.39 (0.70)</td>
</tr>
</tbody>
</table>

Two components rating: Presence practice, 1=strongly disagree - 5=strongly agree. Importance, 1=not important - 5=very important. *Kruskal-Wallis tests.

Assessment of team performance (III)

An evaluation of the RNs’ team performance in the Cardiac Arrest scenario was conducted by both expert assessment and RNs’ self-assessments.

**Expert assessment**

The expert raters’ assessments based on Ottawa GRS in relation to two different types of ICU specialties showed that the teams’ performances ranged from advanced novice to competent. There were significant differences in all five Ottawa GRS categories, with M-ICU/GM-ICU teams achieving higher scores than teams from the G-ICU.
The expert raters’ assessments based on MHPTS in relation to the two different specialties revealed significant differences among teams in all eight of the MHPTS items, with M-ICU/GM-ICU teams achieving higher scores than the teams from the G-ICU.

RNs’ self-assessments

In relation to the two different specialties, the RNs’ self-assessments based on MHPTS, showed only one significant difference between the teams from the two different specialties. The RNs from the M-ICU/GM-ICU (mean=1.27, SD= 0.40) assessed themselves higher than the RNs from the G-ICU (mean=0.74, SD= 0.19) \((p=.035)\) on the item, “team members refer to established protocols and checklists for the procedure/intervention”.

Expert raters’ assessments vs. RNs’ self-assessments

Significant differences between the expert raters’ assessments and the RNs’ self-assessments based on MHPTS were demonstrated on five items, with the teams from G-ICU having higher scores than the expert raters on two items and the teams from M-ICU/GM-ICU having lower scores than the expert raters on three items (Table 13).

Table 13. Significant differences between expert raters’ assessments and RNs’ self-assessments with regard to specialties

<table>
<thead>
<tr>
<th>MHPTS Item</th>
<th>Expert assessment</th>
<th>RNs' self-assessments</th>
<th>(p^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 A leader is clearly recognized by all members</td>
<td>M-ICU/GM-ICU</td>
<td>1.67 (0.41)</td>
<td>1.22 (0.31)</td>
</tr>
<tr>
<td>2 The team leader assures maintenance of an appropriate balance</td>
<td>G-ICU</td>
<td>0.80 (0.57)</td>
<td>1.45 (0.19)</td>
</tr>
<tr>
<td>3 Each team member demonstrates a clear understanding of his or her role</td>
<td>G-ICU</td>
<td>1.00 (0.35)</td>
<td>1.46 (0.89)</td>
</tr>
<tr>
<td>4 The team prompts each other to attend all significant clinical</td>
<td>M-ICU/GM-ICU</td>
<td>1.83 (0.26)</td>
<td>1.63 (0.18)</td>
</tr>
<tr>
<td>5 When team members are actively involved with the patient, they verbalize their activities aloud</td>
<td>M-ICU/GM-ICU</td>
<td>1.83 (0.26)</td>
<td>1.42 (0.20)</td>
</tr>
</tbody>
</table>

Rating: 0=never or rarely, 1=inconsistently, 2=consistently; \(^b\)Mann-Whitney U-tests
Simulation-based team training for building patient safety (IV)

The nurses’ perceptions of SBTT as an initiative for building patient safety in intensive care were described as: “Regular training increases awareness of clinical practice and acknowledges the importance of structured work in teams”. The nurses experienced that SBTT may contribute to seeing clinical practice in a new way, which helps to facilitate improvements regarding patient safety. Three generic categories emerged: “realistic training contributes to safe care”, “reflection and openness motivates learning” and “finding a common understanding of team performance”, which all included two sub-categories each.

Realistic training contributes to safe care

This generic category, which concerned the fidelity in the human patient simulation training, is related to ensuring patient safety and consists of two subcategories: “without putting the patient to risk” and “transferable to clinical practice”.

“Without putting the patient to risk” included the perceived advantage of SBTT which provided a safe arena for training and facilitated learning without affecting a highly critically ill patient. Regular training was assumed to make intensive care nurses more prepared and confident in handling different emergency situations. The informants described that this type of training could contribute to help manage stress in both emergencies and in their daily work in the ICU since the same feelings of stress were recognized during simulation-based situations. Even though rarely occurring situations were particularly emphasized, simulations of common situations were also found to be necessary to practice.

“Transferable to clinical practice” covered the experienced realism in simulated scenarios, which make them useful and transferable to clinical practice. Being able to observe the simulator’s vital signs was expressed as being important, and enabled the nurses to recognize and compensate for failures in the “patient’s” vital functions. Although it was a simulated situation, the nurses focused on solving the emergency situation similarly to a real situation in the ICU. Some of the nurses experienced the simulation as being less realistic, mostly because of the absence of a physician in the team.
Reflection and openness motivates learning

This generic category concerned the pedagogical method used for learning during SBTT as being transferable to clinical practice to build competencies and patient safety in daily work, and consists of two subcategories: “focusing on one’s own- and others’ competence” and “debriefing facilitates improvement”.

“Focusing on one’s own- and others’ competence” included that SBTT helps nurses to be aware of what they do well and what can be improved. In particular, participating in the training could be useful in building competencies because the informants had to articulate the reasons for their own actions and give feedback to each other, which required reflection. By using SBTT on a regular basis, the informants believed that intensive care nurses would be more familiar with their own reactions when handling various emergencies. Moreover, an awareness of the team's performance will be increased, thereby strengthening the team's preparedness for unexpected situations.

“Debriefing facilitates improvement” includes that regular use of SBTT was perceived as increasing the use of structured debriefing and informal talk after difficult situations in clinical practice. The constructive feedback during the debriefing made the nurses aware of areas for improvement, and the informants experienced that they seldom gave each other feedback during daily work since they have no tradition of doing so. The discussions and reflections, in which each team member had the opportunity to give reasons for their own actions and priorities related to leadership, resource management and communication, were perceived as being of great importance.

Finding a common understanding of team performance

This generic category concerned how team training based on CRM yielded new insight and knowledge of how to work in teams, and consists of two subcategories: “responsibility in roles and use of human resources” and “the importance of clear communication”.

“Responsibility in roles and use of human resources” includes that SBTT was experienced as creating an awareness of the importance of clarifying roles and responsibility within a team. In clinical practice, they experienced an unsystematic approach to teamwork that was dependent on the nurse’s or
physician’s competence, as well as whether the team had experience in working together. It was considered important that the nurses mastered leadership; however, in emergency situations they perceived it most appropriate for the physician to take the leading role. Interdisciplinary team training was described as crucial in clarifying roles and responsibilities, although nurses and physicians currently have no tradition of training together as a team. To optimize the use of personnel resources in teams was conceived to be an area that the ICU needed to improve. The informants described that emergency situations during daytime often became chaotic. They experienced that they performed best at night when fewer staff were present.

*Importance of clear communication* included that both verbal- and non-verbal communication were perceived by the informants as being most important to teamwork within the ICU. The distinct communication that had been emphasized in the simulation-based training should also be integrated into clinical practice, as inadequate communication was perceived as causing a decrease in team performance. The informants referred to various clinical situations in which communication techniques could contribute to proper patient care, and they considered it important to give clear messages. When exposed to a high level of stress, structured and proper verbal- and non-verbal communication in the team might help to calm the situation down. The importance of structured and clear communication with regard to leadership and followership was emphasized by the participants, as well as of open communication across the team. However, the informants described some reservations about open communication when physicians were part of the team, which again supports the need for interdisciplinary team training.
Summary of findings

The RNs had positive perceptions on the outcome of the ICUs’ overall patient safety culture; hence, incident reporting was found to be an area with the potential for improvement. Dimensions found with the potential for improvement at the unit level were “feedback and communication about errors” and “organizational learning-continuous improvement”, and at the hospital level, “hospital management support for patient safety” and “teamwork across hospital units”. The RNs in the general intensive care responded more positively than the RNs in medical intensive care. The HSOPSC dimensions at the unit level were predictors for the outcome dimensions “overall perception of safety” and “frequency of incident reporting” (I).

The intensive care nurses who participated in the SBTT programme (II, III) were highly satisfied with their current learning, though they scored lower on self-confidence in learning. They were generally positive in their evaluation of the implementation of the programme with regard to the educational practice and the simulation design. The RNs from medical intensive care were more positive than RNs from general intensive care. The RNs in active roles and those with prior simulation experience were most positive (II). Expert assessments of the teams’ performance according to a simulation-based cardiac arrest situation revealed that RNs representing specialties with coronary patients exhibiting a higher competence in non-technical skills. The teams representing specialties with coronary patients had lower scores than the expert raters, while teams from the other ICUs had higher scores than the expert raters (III). The nurses perceived that SBTT provided experiences that increased the nurses’ awareness of clinical practice and acknowledged the importance of structured work in teams. The RNs perceived SBTT as being realistic and transferable to clinical practice, which contributed to ensure safe care. The pedagogical method used, was characterized by reflection and openness for motivated learning. The training form the basis for a common understanding of team performance and SBTT should be conducted regularly for building patient safety in intensive care (IV).
METHODOLOGICAL CONSIDERATIONS

Since the methods used in this thesis consist of a combination of quantitative (I-III) and qualitative (IV) methods, several criteria to assess the quality of the studies are required. While validity and reliability are two important criteria in quantitative studies, qualitative research is concerned about enhancing trustworthiness (Polit & Beck, 2012).

Validity and reliability (I-III)

The validity of a quantitative study is about the degree to which the inferences drawn from the study evidence is well-funded and correct. Reliability refers to the accuracy and consistency of information obtained in a study (Polit & Beck, 2012).

Validity

Validity may be divided into statistical conclusion validity, internal validity, construct validity and external validity (Polit & Beck, 2012; Shadish et al., 2002).

Statistical conclusion validity concerns the validity of inferences, and that there is an empirical relationship between variables, which is tested by the use of the appropriate statistical methods (Polit & Beck, 2012). In this thesis both parametric- (I) and non-parametric (I-III) statistical tests were used. The decision regarding the selection of the appropriate test was based on the research design (Greene & D'Oliveira, 2006), the data level of measurement and the sample size (Pallant, 2010). Statistical conclusion validity was ensured by meeting the assumptions of the statistical tests selected to use. Parametric tests make assumptions about the population from which the sample has been drawn and presuppose data measured on interval scales. Non-parametric tests do not have such stringent requirements and are ideal to use when data are measured on nominal and ordinal scales and with regard to small samples (Greene & D'Oliveira, 2006; Pallant, 2010). However, when using an ordinal scale with five or more points calculated to an index level, the data may be considered suitable for parametric tests (Johannessen, 2007). Based on this, a large sample size, and that the parametric tests tend to be more powerful, these tests were used in Study I (Pallant, 2010). Moreover, a high response rate (Study
I = 72%) ensured the validity of the statistical conclusion, which according to Polit and Beck (2012) is considered to be sufficient and the risk of bias relatively small. Furthermore, the missing data were random (I-III) and should not have had any systematic effect on the results. A two-tailed significance level of $p < 0.05$ was used for all tests in the thesis. Nevertheless, in conjunction with a large number of comparisons (III), one could have used a Bonferroni correction to reduce the risk of a Type I error, but this was not done due to increasing the risk of a Type II error, i.e. there were no differences, even though there were. Threats to statistical conclusion validity are measurements with a low reliability, which were countered by the use of initially acceptable accurate measuring tools. Even so, some low Cronbach’s alpha values were found with regard to HSOPSC, and a rater agreement of 60% with regard to MHPTS.

*Internal validity* concerns inferences that the outcome was caused by independent variables rather than by other extraneous factors. Among others, the threats to internal validity include history and instrumentation (Polit & Beck, 2012). The reorganization and efficiency improvement within the hospital trust, which included the various ICUs, took place during the data collection period and may have affected the results with regard to a negative response to “hospital management support for patient safety” and “teamwork across hospital units” (I). In terms of instrumentation, the instruments used in Study II may have been too comprehensive in that the participants answered the instrument with regard to both scenarios, which could have affected the result insofar as the participants became bored and answered randomly. To strengthen the internal validity, all of the teams during the simulation-based team training programme (II-III) were led by the same simulator instructors, who paved the way for similar conditions.

*Construct validity* is a key criterion for assessing the quality of a study, and concerns inferences from a particular example of a study of higher-order constructs that they are intended to represent (Polit & Beck, 2012). Construct validity in this thesis was ensured by the use of validated instruments based on the literature regarding patient safety culture, simulation in healthcare and team processes/CRM. The NLN instruments (II) were validated for evaluation in the use of simulation both in undergraduate- and graduate nursing education, though less so in nursing practices (LaFond & Van Hulle Vincent, 2012). Moreover, the MHPTS and the Ottawa GRS (III) were validated with regard to
interdisciplinary team performance (Kim et al., 2006). However, only the HSOPSC (I) was validated in a Norwegian setting. Since the instruments had different origins with respect to language and culture, Brislin’s back-translation method was used (II, III). The validity of the translated instruments was ensured through the use of expert groups and by pilot testing. Nonetheless, a high percentage of NA with regard to some items in the EPSS and the SDS (II) may reflect the fact that some of the participants were unfamiliar with the simulation concepts presented in the items.

Furthermore, the construct validity was ensured by a thoroughly developed SBTT programme structured on the basis of the “Simulation setting modules” by Dieckmann (2009) and by principles from the science of SBTT learning (Flin et al., 2008; Gaba et al., 2001; Jeffries, 2007; Rosen et al., 2008a; Rosen et al., 2008b) (II, III). Among others, the principles included clear and precise learning objectives, the use of simulation scenarios that represented real-life cases of common emergencies seen in an ICU and developed in collaboration between the university college and three ICUs. The scenarios were also pilot tested by PG students and RNs not involved in the study (II, III), as well as through the use of raters with extensive experience from intensive care nursing, CRM and simulation-based training (III).

Threats to construct validity may be related to “researcher expectancies” and “novelty effects” (Polit & Beck, 2012). These threats are about that the researcher may influence the participants’ responses through their communication. Moreover, both the participants and researchers may change their behaviour when something is new by being either sceptical or enthusiastic, and where the result may reflect the reaction to the novel- rather than intrinsic nature of the intervention (Polit & Beck, 2012). For most of the participants, SBTT represented something new (II, III), though this novel content may have clouded the intervention construct. In order to prevent threats, the research team was not directly involved in the implementation of the simulation-based training programme. However, the construct validity was strengthened in that the implementation of the SBTT programme was shared between four educated simulation instructors, which ensured the representation of the construct. Two of the instructors were responsible for the theory input, and the others for the simulation activity, which may have contributed to a balanced picture of the new intervention. Hence, the participants’ evaluations of
simulation (II) may have been influenced by an initially positive attitude towards the use of simulation, and on this basis they agreed to participate.

*External validity* concerns inferences about the amount to which the study results can be generalized. This type of validity is about whether relationships observed in a study hold true over a variation in people settings (Polit & Beck, 2012). With regard to Study I, the participants worked in small hospitals within a limited area of Norway, while Studies II and III had a small number of participants; thus, generalizability to a larger population must be interpreted with caution. Still, the results from all three studies provide knowledge about patient safety, team processes and the use of simulation-based training, which may be transferred to other intensive care nurses in similar intensive care settings.

**Reliability**

Reliability regarding the use of instruments is about the degree of consistency with which an instrument measures a specific attribute (Polit & Beck, 2012; Streiner & Norman, 2008). To prevent threats, well-known instruments with a good or acceptable reliability were used in all studies (I-III). Cronbach’s alpha was used to measure the internal consistency of the instruments used in the thesis (I, II), thereby resulting in values that were mostly comparable with previous studies (Haugen et al., 2010; Jeffries & Rizzolo, 2007). One exception to this was the Cronbach’s alpha for the HSOPSC dimension “overall perception of safety” (alpha=0.49) (I), which was lower than in previous Norwegian HSOPSC studies (Haugen et al., 2010; Olsen, 2007). Unlike these studies, this thesis had a sample that only consisted of RNs, which could be an explanation.

Reliability with regard to expert rating (III) is linked to interrater reliability, which is described as the degree to which raters operating independently assign the same rating for an attribute being measured (Polit & Beck, 2012; Streiner & Norman, 2008). To help prevent threats, a rater training was conducted in order to standardize the evaluation of team performance and to become familiar with the instruments. However, a 60% agreement was noted with regard to the use of the MHPTS, and some moderate ICC scores were demonstrated regarding the Ottawa GRS, which may reflect some insufficient rater training. The instruments should be considered for use in a formative rather than summative
assessment. Though, the instruments were not validated for Norwegian culture, further psychometric testing is recommended.

**Trustworthiness (IV)**

Trustworthiness is about the confidence that the qualitative researchers have in their data (Polit & Beck, 2012). In this thesis, the trustworthiness was ensured by use of the Lincoln and Guba’s (1985) four criteria of credibility, dependability, conformability and transferability.

*Credibility* is related to confidence in both the truth and interpretation of the data (Lincoln & Guba, 1985; Polit & Beck, 2012). In our study, credibility was first established by interviewing 18 RNs who had knowledge and experience with the phenomenon, in that they all worked in different areas of intensive care and had all attended a simulated-based team training programme. Variations with regard to the RNs’ gender, age, education level, years as a practicing nurse, scenario roles during simulation and simulation experience laid the basis for variations and a broad description of the phenomenon. The author of the thesis, who is an intensive care nurse, performed all the interviews, which can be considered as both a strength and a weakness. The strength was that an intensive care nurse with a long clinical experience in intensive care facilitated the acquisition of rich data from the participants, whereas the weakness was that the knowledge of the area might have influenced the follow-up questions. Credibility was strengthened by the use of a pilot-tested, open-ended interview question in which the participants were encouraged to talk openly, and in which follow-up questions were posed in order to avoid misunderstandings. Moreover, the credibility was further strengthened by a detailed description of the data collection and the analysis with regard to the three phases, as well as by consensus within the research team throughout the data analysis and regarding the result.

*Dependability* refers to the stability of data over time and over conditions (Lincoln & Guba, 1985; Polit & Beck, 2012). To ensure dependability the same introductory open-ended question was posed to each participant, and all interviews were conducted by the first author. Dependability was also strengthened due to the research team’s familiarity with the methodology used.
Confirmability is related to the objectivity of the data, and concerns that the data represents the information provided by the participants and that the interpretation of the data is not fictional (Lincoln & Guba, 1985; Polit & Beck, 2012). Confirmability was achieved by a systematic treatment of the data with repeated readings to help grasp the content and careful generation of categories, which reflected the participants’ voices. Quotations were used to enhance and illuminate the content of the categories, whereas agreement within the research team was addressed concerning that the data represented the information that the participants had provided.

Transferability refers to how the findings have applicability in- or can be transferred to other settings or groups (Lincoln & Guba, 1985; Polit & Beck, 2012). In this context, the researchers have a responsibility to provide detailed descriptive information about the results, which allows the reader to make inferences about extrapolating the results to other settings (Polit & Beck, 2012). Transferability was also demonstrated through a presentation of the study’s research process, the participants and the results in a trustworthy way. Some short quotations were used to clarify the participants’ perceptions of the phenomenon in order to give the reader an opportunity to do self-reflection, thus helping to enhance the possibility of transferability (Graneheim & Lundman, 2004).
DISCUSSION

The overall aim of the thesis was to investigate patient safety culture, team performance and the use of simulation-based team training for building patient safety in intensive care nursing. Patient safety is about “the reduction of risk of unnecessary harm associated with health care to an acceptable minimum” (WHO, 2009a, p. 15). This thesis investigates recommended patient safety initiatives from the intensive care nurses’ perspective. The findings from the measurements of the patient safety culture in intensive care are discussed first (I), while the next two parts focus on simulation used for team training (II, IV) and team performance (III, IV). The last part concerns the knowledge translation for building patient safety into practice (I-IV).

Patient safety culture in intensive care (I)

The findings in this thesis demonstrated variation among the RNs’ perceptions of different aspects of patient safety culture, both on the unit- and hospital level. According to Nieva and Sorra (2003), measurements of patient safety culture are useful in raising awareness about patient safety and identifying areas of strength, as well as areas with a priority for targeting improvements.

The RNs were more positive about patient safety culture at the unit level than at hospital level. Moreover, the findings exhibited significant differences between RNs from different types of ICUs and between RNs in the four hospitals. The RNs in the G-ICU mostly responded more positively than the RNs in the M-ICUs. Differences in perceptions of safety culture between health professions within a unit and between ICUs in a single hospital or between hospitals, are well-documented (France et al., 2010; Huang et al., 2010; Huang et al., 2007), whereas differences within intensive care specialties across hospitals are less documented.

The term “safety culture” in health care is seen as an aspect of the wider “culture” of an organization (Mearns & Flin, 1999). According to Davies et al. (2000), some cultural characteristics may be seen across an organization, while others may be prominent only in some part of the organization or may emerge within different professional groups. The two types of ICUs (G-ICU and M-ICU) represent different intensive care specialties with their own disciplinary traditions and perceptions of patient safety. The G-ICUs had a higher
proportion of post-graduated nurses compared to the M-ICUs. A higher level of expertise may create a difference in their perception of patient safety. According to Davies et al. (2000), integrated cultures occur when there is a consensus on the basic beliefs and appropriateness of behavior, while differentiated cultures occur when groups within an organisation possess dissimilar and often incompatible view and norms.

The findings demonstrated that a high proportion of the RNs responded positively on their overall perception of safety, which are more positive than findings from a previous Norwegian study in an operating environment (Haugen et al., 2010). Promoting patient safety and preventing complications of hospitalization are central in both nursing practice and education (Benner et al., 2011). Nurses are in a unique position to prevent and detect errors since they are ever present and coordinate the patients’ interactions with the health care system. The “monitoring and ensuring the quality of health care practice” is identified by Benner (2001, p. 46) as one of seven domains of nursing practice. This domain of nursing practice is about “providing backup systems to ensure safe medical and nursing care”, “assessing what can be safely omitted from or added to medical orders”, and additionally “getting appropriate and timely responses from physicians” (Benner, 2001, p. 137). Nonetheless, to a great extent, “infallibility” has to be seen as health care’s working hypothesis (Larsson, 2007), which may make it difficult to be open and critical about one’s own and others’ performance and mistakes.

Supervisors’/managers’ expectations and actions to promote safety in the ICUs were positively scored by the RNs, and a key concept of safety culture is a management that creates and encourages the staff in continuous safety improvements (Sammer et al., 2010). Moreover, RNs’ perceptions of teamwork were the area with the highest positive score, and these findings are in accordance with other studies from the ICU environment (Armellino et al., 2010; Chaboyer et al., 2013; France et al., 2010; Snijders et al., 2009). The measurement of teamwork concerns the degree to which staff supports one another, treat one another with respect and work together as a team (Sorra & Nieva, 2004). The findings in this thesis showed that “teamwork within hospital units” made significant contributions to the “overall perception of safety”. Manser (2009) found that a staff’s perception of teamwork and attitudes toward safety-relevant team behaviour were related to the quality and safety of patient care, and that teamwork played an important role in the causation and
prevention of incidents. On the other hand, a breakdown in team performance with regard to poor NTS, such as communication, decision-making, leadership and situational awareness, is confirmed to be contributory factors to incidents in the ICU (Manojlovich & DeCicco, 2007; Reader et al., 2006).

Like other European HSOPSC studies (Haugen et al., 2010; Smits et al., 2009; Snijders et al., 2009), the RNs in this thesis scored more positively on non-punitive responses to error than personnel in United States (Sorra et al., 2010; Sorra et al., 2012). This may be seen as a strength in that a culture with less blame may facilitate a more open communication about, as well as reporting of errors (McFadden et al., 2006; Reason, 2000). In spite of this, the RNs reported incidents to a very limited extent, which is consistent with previous ICU studies (Capuzzo et al., 2005; Henneman, 2007) and Norwegian HSOPSC studies from other settings (Haugen et al., 2010; Olsen, 2007). Time pressure, incidents leading to presence or absence of patients harm (Elder et al., 2008), incidents considered as a routine problem (Henneman, 2007), and a lack of standard definitions and methods for detecting errors (Wilmer et al., 2010), are all found as reasons for underreporting among intensive care nurses. According to Garrouste-Orgeas and Valentin (2013), a huge change is needed in the ICUs to replace the culture of blame and shame by a new culture of learning and systematic improvements that require an open communication.

The findings showed that a supervisor’s/manager’s expectations and actions promoting patient safety and feedback and communication about error were all significant contributors for the frequency of incident reporting. Nonetheless, feedback and communication about errors were responded by the RNs with a low score; consequently, the RNs’ limited incident reporting may therefore also be caused by inadequate feedback and communication about incidents. These demonstrate that management possesses a key role with regard to the improvement of incident reporting at the unit level. Furthermore, incidents must be communicated and used to identify safety hazards, which may improve the value of a reporting system (Pronovost et al., 2008b). Looking at the data collection (I-IV) in retrospect, the reporting of patient safety incidents in Norway has been moved from the sanctioning authority to the Norwegian Knowledge Centre for the Health Services, where a national incident database was established in July 2012 (The Norwegian Directorate of Health, 2012). The intention with moving the reporting was to create a streamlined system for learning and improvement that is not connected to any specific sanctioning
authority, and since the system was implemented, an increase in the number of incidents has been reported (NOKC, 2012b).

At the hospital level, the areas with potential for improvement were the hospital management support for patient safety and the teamwork across hospital units. The RNs generally had a low score on the hospital-level aspects of the patient safety culture, which is in accordance with previous Norwegian HSOPSC studies from other settings (Haugen et al., 2010; Olsen, 2007). The findings may indicate a distance between the RNs’ perceptions of management at the unit-compared to hospital level regarding involvement in patient safety. One of the reasons why health personnel responded with low scores could be that they had been through a major reorganization over the past few years. To achieve success with quality and safety improvement initiatives, leadership from top management and the organizational culture are ranked as being among the most important (Kaplan et al., 2010).

**Simulation used for team training (II, IV)**

The findings in the thesis showed that the SBTT programme, initiated as an organizational learning initiative aimed to motivate patient safety through focusing on team performance and the use of high-fidelity human simulation, was well received by the RNs (II, IV). The RNs were highly satisfied with their simulation-based learning (II), which is consistent with a previous critical care study (Sittner et al., 2009). Satisfaction may help to facilitate further learning and create positive attitudes about the importance of training for building patient safety in intensive care nursing. According to West et al. (2012), simulation-based CRM training can be used to improve efficiency, morale and patient safety in nursing, while also acting as a lever for cultural changes (Gaba, 2004). Significantly higher scores in self-confidence in learning were found among RNs with prior simulation experience compared to RNs without such experience (II). DeCarlo et al. (2008) found that nurses with prior simulation experience generally reported fewer barriers to participation in simulation-based training. The RNs experienced stress regarding the simulation-based training and perceived that these feelings were both connected to managing the situation and to demonstrating their competencies to others (IV), which may have had an impact on their responding with regard to self-confidence (II). By using SBTT on a regular basis, the RNs believed that intensive care nurses would be more familiar with their own reactions in connection to emergencies,
as well as strengthened the team’s preparedness (IV). These findings are confirmed by Meurling et al. (2013), who found SBTT to increase nurses’ and physicians’ self-efficacy.

The RNs were positive to the implementation of the educational practice feature, with the highest score on the subscale “collaboration” (II). Simulation-based training may facilitate collaboration, which is important to- and a central factor in team performance to help ensure patient safety in emergency situations in the ICU. According to Salas et al. (2008a), it is essential for a successful outcome that the training is undertaken in a psychologically safe environment in which errors can be seen as opportunities for learning.

The findings demonstrated a positive evaluation of the simulation design/development, in which the RNs greatly appreciated the feedback/guided reflection carried out in the debriefing module during the SBTT (II, IV). Debriefing is ranked as being the most important feature of simulation-based training towards effective learning in that it allows the health personnel to self-assess their skills and monitors their progress (Issenberg et al., 2005). The RNs perceived that regular training may also have a positive impact on conducting debriefing in clinical practice (IV), though they do not have a tradition for giving feedback to each other during daily work, while debriefing is seen as crucial in creating an environment of continuous learning (Leonard et al., 2013). However, critical and acute care nursing practice is described by Benner et al. (2011) as intellectually and emotionally challenging in that it requires a quick judgement in life-threatening situations in which little margin for error exists. This may indicate that further improvements and learning require a need for a subsequently open communication about both the technical- and nontechnical skills performed. According to the RNs, the use of simulation enabled both self-reflection and feedback on their own and others’ performance, thus paving the way for errors that can be seen as opportunities for learning (IV). The RNs perceived that regular training may help to promote patient safety by creating an awareness of the importance of openness in clinical practice (IV). This is in accordance with the HRO’s theory, which necessitates that high reliability teams must develop shared mental models that permit team members to monitor others’ performance and offer back-up assistance when needed (Wilson et al., 2005).
In accordance with Sandahl et al. (2013), the findings in the thesis confirmed that most of the RNs experienced the SBTT as realistic (II, IV), and thus transferable to clinical practice (IV). Hence, simulation in a small group of nurses from one unit was considered as insufficient in knowledge translation into practice. RNs considered it of importance that all professions in a unit participate in a SBTT programme to attain shared knowledge, attitudes and skills (IV). Similar to Sandahl et al. (2013), the RNs emphasized the importance of having physicians as a part of the team during the simulation. The RNs highlighted the importance of realistic training without exposing patients to any unnecessary risk (IV). Still, moderate effects for patient related outcome are demonstrated, though, simulation training is associated with large effects for the outcome of the knowledge, skills and behaviour of the participants (Cook et al., 2011). Characteristics shared with HROs include well-trained personnel, team working and continuous learning (Wilson et al., 2005).

In the evaluation of simulation, the RNs from the G-ICU were generally found to be less positive than RNs from the M-ICU, GM-ICU and PG-ED (II). Specialties with coronary patients (M-ICU and GM-ICU) may have a longer tradition of low fidelity simulation training in that the specialties were established in an effort to reduce mortality from acute myocardial infarction, and where the nurses from the beginning were a part of the CPR team undergoing regular training with the early simulator of a dying victim known as Resusci-Anne (Cooper & Taqueti, 2004). Moreover, the RNs from postgraduate education may be more familiar as students with different education methods and therefore more positive.

**Team performance (III, IV)**

In the performance of a simulation-based cardiac arrest scenario, variations between teams from different specialties were found (III). The expert raters assessed the teams representing specialties with coronary patients (M-ICU and GM-ICU), with higher scores compared to the G-ICUs. According to the Ottawa GRS criteria, these teams were assessed as “competent”, which means that most CRM skills (NTS) required only minor improvements, while the G-ICU teams were assessed as being “advanced novice”, meaning that many CRM skills (NTS) required moderate improvement. Benner (1984) described the development of nurse competence as a continuum from novice to expert. The model termed the acquisition and development of a skill in five stages from a
rule-governed novice behaviour of “knowing that” to an experienced-based expert behaviour of “knowing how”. The RNs expressed that they generally had a limited experience and awareness of the importance of structured teamwork (IV). Nevertheless, the team performance assessment showed mostly positive ratings, although none of the teams were assessed as being clearly superior and possessing an expert behaviour (III). According to Kuhn (1964) and Polanyi (1958), “knowing that” and “knowing how” are two different types of knowledge, and that there are many different skills in relation to “knowing how” without “knowing that”. This may support the assertion that team performance competencies until now have not been addressed in a systematic way by health care systems (Salas & Rosen, 2013), thereby been a more practical and tacit knowledge. According to Benner (2001), knowledge development in a practical discipline such as nursing consists of extending the practical knowledge through theory-based research and through the mapping of the existent “know-how” developed through clinical experience. In the ICUs, there has traditionally been much more of an inherent emphasis on technical skills than on NTS (Haerkens et al., 2012). According to Reason’s theory (2004), the limited knowledge about NTS and team performance can be regarded as latent conditions in the ICUs’ work environments, thus constituting a threat to patient safety. In this way, team training may be considered as defences built into the system designed to protect against failures (Morath & Turnbull, 2005; Reason, 2004).

The clarity in team roles was highlighted by the RNs as an area in need of improvement, who also saw the importance of mastering both the follower- and team leadership role (IV). According to Reader et al. (2009), the leadership role is seen as a key factor in developing new ways for team members to interact and communicate with each other. Even so, nurses do not have a cultural or professional tradition in taking leadership in teamwork, which is considered to inhibit them from participating in decision-making processes, e.g. in emergencies (Andersen et al., 2010), even though they are responsible for doing just that (Hancock & Easen, 2006). The RNs emphasized the importance of open and clear communication with regard to both disciplinary and interdisciplinary teams. However, the RNs were less open in their communication when physicians were a part of the team, which is also described by Bunkenborg et al. (2012). This supports the need for interdisciplinary team training (IV). The RNs expressed that nurses and physicians had no tradition to train together as a team. Today, interdisciplinary
team training programmes that incorporate proven methods such as simulation are seen as one of the key processes in the safe delivery of patient care (Kohn et al., 2000). Team training based on CRM aims to flatten hierarchies to achieve open communication to help ensure patient safety (Powell & Kimberly Hill, 2006).

The RNs’ limited awareness of NTS and the importance of structure in team performance may be one explanation for the significant differences between the expert raters’ assessments and the RNs’ self-assessments (III). Nonetheless, these assessments may complement each other and contribute to an increased competence in structured teamwork, in addition to helping to articulate this part of nursing practice. Team training has been found to lead to changes in the safety culture as long as the new learning is supported by the work environment (Jones et al., 2013).

The findings showed that RNs representing specialties with coronary patients (M-ICU/MG-ICU) exhibited a higher competence in NTS (III). To help ensure quality and patient safety, all RNs working in ICUs should possess the knowledge, skills and attitudes necessary to be an effective team member in a cardiac arrest situation. However, medical ICU’s long tradition of training CPR as a technical skill (Quinn & Thompson, 1999) may have an influence on the team performance with regard to NTS (III). Nevertheless, the different areas of intensive care practice should be encouraged to learn from each other with regard to building patient safety.

**Building patient safety in intensive care nursing practice (I-IV)**

Building patient safety may be considered as a part of a knowledge translation process described as “the methods for closing the gaps from knowledge to practice” (Straus et al., 2009). According to WHO (2008), more knowledge and better use of that knowledge are crucial for improving patient safety. In accordance with this, the recommended patient safety initiatives such as the measurement of patient safety culture and a simulation-based team training programme for building patient safety in intensive care nursing were implemented and investigated.
For further considerations regarding knowledge translation, an attempt has been made to relate the findings from this thesis to the Promoting Action on Research Implementation in Health Services (PARiHS) framework (Kitson et al., 1998; Kitson et al., 2008). This framework says that a successful implementation is represented as a function of the elements of “nature and type of evidence”, “the qualities of the context in which the new knowledge is being introduced” and “the way the process is facilitated” (Kitson et al., 2008, p. 2). According to Kitson et al. (2008), the framework is best used as a two-stage process, in which data from preliminary measures of the elements of evidence and context are considered as a basis to determine the most appropriate facilitation methods.

With regard to the element of “the nature and type of evidence”, there is strong evidence today that supports the importance of patient safety culture, team performance and simulation-based team training in relation to improvement of the structure and process in health care, though a moderate effect for patient outcome is demonstrated. In this thesis, the simulation-based programme being implemented was broadly accepted by the nurses, and their positive evaluation may be seen as an advantage for further knowledge translations. Knowledge concerning how to perform in a team represented something new for the nurses. Evidence from other domains which reflect a different reality may be positive in terms of changes of behaviour within a system, and thereby is considered to be beneficial (Kitson, 2009).

A successful implementation depends on “the qualities of the context in which the new knowledge is being introduced” (Kitson et al., 2008). The findings in this thesis pointed out differences between different types of ICUs, and according to Kitson, (2008) some cultures are more conducive to the introduction of new ideas, which may be attributed to contexts that have transformational leaders, a learning culture, proper monitoring, in addition to emphasizing evaluation and feedback. The measurements of the patient safety culture may be seen as important as a preliminary diagnostic measure for a further facilitation process by identifying strengths and areas with a potential for improvement. All of the participating ICUs received a report with their own results for the purpose of carrying out improvements. Additionally, in retrospect of the data collection, patient safety initiatives in health care services in Norway have been given a high priority by the launching of the patient safety campaign, “In Safe Hands” (Ministry of Health Care Services, 2012; NOKC,
which may have a positive impact on all levels of health care patient safety culture, thereby help facilitate the knowledge translation of the findings in this thesis.

Facilitations, which represent the third element in the PARiHS framework, are supposed to be most effective when based upon an analysis of the context and an assessment of the nurses’ understanding of the knowledge itself (Kitson et al., 2008). Data regarding the RNs’ perceptions and receptivity to the new knowledge will help determine what kind of new learning and changes are needed (Kitson et al., 2008). Simulation as a pedagogical method may be seen as appropriate for building patient safety into intensive care nursing. Even so, the method itself may be insufficient without trained and inspiring simulation facilitators.

The process of translation knowledge is a dynamic, interactive and complex process (Straus et al., 2009). According to Kitson (2009), the successful translation of new knowledge into a culture is “a function of the level of local autonomy experienced by individuals, teams and unit involved”, and involvements of key stakeholders make the innovation most effective (Kitson, 2009, p. 217). Moreover, collaboration between researchers, educators and clinical nurses is seen as a major advantage (Bjørk et al., 2013).
CONCLUSIONS AND IMPLICATIONS FOR PRACTICE

✓ Patient safety culture measurements have the potential for identifying areas of strength and areas for improvement in a specific local safety culture.

✓ Simulation-based training is an appropriate method for team training of emergency situations in the ICU.

✓ Scenario roles, prior simulation experience and areas of intensive care practice may influence the evaluation of simulation used for team training.

✓ Realistic and regular simulation-based training is perceived to make RNs aware and prepared to care for severely ill patients.

✓ Simulation-based team training creates a common understanding of structured work in teams with regard to patient safety.

✓ Team performance assessment is a suitable method for quantifying aspects of teams’ non-technical skills.

✓ Expert raters’ assessment and RNs’ self-assessments complement each other in helping to verify team performance.

✓ Differences in safety culture between hospitals and across specialties within a hospital trust may help facilitate organizational learning through the exchange of experiences and knowledge for building patient safety.

✓ The findings may inspire educators to develop simulation-based training programmes.

✓ The findings may contribute to creating awareness of RNs’ knowledge, skills and attitudes regarding patient safety, team performance and the meaning of structured team work in order to ensure quality and patient safety in the ICU.
FUTURE RESEARCH

➢ To investigate the effects of an intervention programme in the ICU by measuring changes in patient safety culture both before and after the intervention.

➢ To explore background variables and organizational factors as predictors for RNs’ perception of the patient safety culture.

➢ To explore additional opportunities for simulation-based training as a method for building patient safety in the ICU.

➢ To investigate the impact of team training with regard to patient outcomes.

➢ To develop instruments to assess team process behaviours in the ICU.

➢ To implement and evaluate interdisciplinary, simulation-based team training programmes.

➢ To implement and evaluate simulation-based team training programmes in nursing domains and settings beyond intensive care.
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Building patient safety in intensive care nursing

Intensive care represents potential patient safety challenges for critically ill patients. Human errors are the most common cause of incidents, and failures in team performance are identified as contributory factors. The measurements of patient safety culture and simulation-based team training are recommended initiatives to improve patient safety. The aim of the thesis was to investigate patient safety culture, team performance and the use of simulation-based team training for building patient safety in intensive care nursing. The nurses had a positive perception of the overall patient safety culture. A potential for improvements were found in incident reporting, feedback and communication about errors and organizational learning. The RNs evaluated the simulation-based team training programme in a positive way. The assessments of nurses’ team performance with respect to communication, leadership and decision-making in a simulation-based emergency situation showed a variation in competencies from advanced novice to competent. There were differences between expert raters’ assessments and nurses’ self-assessments. The nurses perceived that simulation-based team training on a regular basis increases the awareness of clinical practice and acknowledges the importance of structured teamwork.