Patient safety during intrahospital transports in intensive care

Hazards, experiences and future measurements

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Till alla mina systrar

”Vi får ta henne genom kulvertarna, det är det enda sättet. Det är väl en kilometer till THIVA säger ST-läkaren. Kinch tittar på mig och säger: förflyttningen blir ingen lek, vi måste rulla din fru i sängen genom kulvertarna med ECMO, medicinpåsar, syrgas, rubbet, THIVA ligger på andra sidan sjukhuset. Det låter långt, säger jag. Inte bara det, det gäller att inte gå in i någonting, säger han […]. Han ber mig gripa tag i kanylen som går ut från Karins ljumske. Håll i den hårt som bara fan, går vi in i någonting och kommer åt kanylen, då tar det slut direkt, säger han. Kanylen är kroppsvarm.

Kinch styr sängen genom korridoren samtidigt som han bär halskanylen som till viss del är fasttejpad längst sängsargen. En sjuksköterska drar en infusionsställning medan hon har en hand på Karins syrgasmask. En annan sjuksköterska skjuter på ECMO-maskinen. Det hänger och ligger påsar med katetrar överallt i patientsängen. Sjuksköterskan vickar försiktigt in ECMO-maskinen mellan hissväggen och syrgastuben, han får inte själv plats och är på gång att springa mot trapphuset när Kinch ropar: Vänta. Sjuksköterskan rusar tillbaka och slår in armen mellan hissdörrarna. Kinch står på sänghjulen, lutar sig över Karin och säger: Vi kommer inte åt hissknapparna, du får springa ner till kulvertarna och trycka ner hissen därifrån. Sjuksköterskan är svettig och klagar på sin kondition när hissdörrarna öppnas mot sjukhusets kulvertsystem. Han bänder långsamt ut ECMO-maskinen och börjar sedan dra till sig sängen. Stopp, vänta, ropar Kinch och lyfter upp urinkatetern som är nära att klämmas mellan sängen och hisschaktet.

Golvet i kulvertarna är av grovbetong, på väggarna sitter vägräckesbalkar, ibland lutar det nedför, ibland uppåt, mest nedåt, vissa passager är så trånga att vi knappt får plats, andra är breda som landsvägar, även om vi lirkar oss fram, steg för steg, måste vi stanna och vila var tionde meter, Kinch blänger upp mot trafikspeglarna vid varje hörn, det droppar svett från hans tinningar, hela tiden möts vi av läkare eller bud på sparkcyklar eller vaktmästare på knallgula truckar med långa släp av korgvagnar. Stanna, ropar sjuksköterskan. Hon hänger med utsträckta armar mellan syrgasmasken och infusionsställningen som har fastnat i en skarv i golvet, Kinch kastar sig över syrgasslangen. Helvete, ropar han. Min hand vitnar mot kanylen, det bränner i fingrarna.

Tom Malmquist (2015, s. 70-73)

ABSTRACT

Patient safety is an attribute of the healthcare system that minimizes the incidence of adverse events (AEs), and that entails identifying the causes of harm and preventive strategies. Intrahospital transport (IHT) of patients in intensive care is a process associated with AEs and patient complications. Despite this, little is known about how contextual, organizational and human factors influence patient safety during the IHT process. The overall aim of this thesis was therefore to explore patient safety during the IHT process in intensive care.

An ethnographical study was conducted, including participant observations (Study I) and interviews with healthcare professionals and patients (Studies II and III). Furthermore, a cross-sectional study was undertaken to develop and evaluate a scale to measure patient safety during IHTs (Study IV).

The findings in this thesis show that the structure of the healthcare system influenced the IHT process. System deficiencies included lack of resources, insufficient transport equipment and poor hospital and workplace design. Teamwork during IHTs was characterized by high team member turnover, unclear team roles and, sometimes, limited communication and cooperation. Task performance was demanding and affected by disturbances and interruptions. Identified skills for safe IHT included knowledge of IHT-related tasks and teamwork, as well as anticipating and preparing for potential patient safety threats. Patients felt safe during the IHT because they trusted the staff to look after their interests. However, safety hazards were common, albeit seldom resulting in harm to patients. The development of the IHT safety scale resulted in a 24-item instrument. The study yielded evidence of construct validity and internal consistency reliability in a sample of Swedish healthcare practitioners.

The conclusion in this thesis is that IHTs of intensive care patients are hazardous, complex and demanding. Despite the existence of system deficiencies, adverse incidents (AIs) are often handled correctly; few patients thus seem to suffer AEs. The findings suggest that safety improvements should aim to (re)design systems that meet the requirements for performing transfers safely, and that the issue of how clinicians' resilience capacity can be supported should also be taken into consideration. The IHT safety scale could be a useful tool to better understand safety prerequisites and improve clinical practice.

Keywords: ethnography, human factors engineering, intensive care, instrument development, intrahospital transport, nursing, patient safety, patient transfers, safety hazards

LIST OF PAPERS

This thesis is based on the following studies, referred to in the text by their Roman numerals.

I. Bergman, L. M., Pettersson, M. E., Chaboyer, W. P., Carlström, E. D. & Ringdal, M. L. Safety Hazards During Intrahospital Transport: A Prospective Observational Study.
Critical Care Medicine 2017;45(10): e1043-e1049.
doi: 10.1097/CCM.0000000000002653.

II. Bergman, L., Pettersson, M., Chaboyer, W., Carlström, E. & Ringdal, M. Improving quality and safety during intrahospital transport of critically ill patients: A critical incident study.
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III. Bergman, L., Pettersson, M., Chaboyer, W., Carlström, E. & Ringdal, M. In safe hands: Patients' experiences of intrahospital transport during intensive care.
Intensive & Critical Care Nursing [In press].
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IV. Bergman, L., Chaboyer, W., Pettersson, M. & Ringdal, M. Development and initial psychometric testing of the intrahospital transport safety scale in intensive care.
Submitted.

CONTENTS

ABBREVIATIONS

AE	Adverse event
AI	Adverse incident
CT	Computed tomography
CVI	Content validity index
CFA	Confirmatory factor analysis
EFA	Exploratory factor analysis
ICU	Intensive care unit
IOM	Institute of Medicine
IHT	Intrahospital transport
MRI	Magnetic resonance imaging
SEIPS	Systems Engineering Initiative for Patient Safety
WHO	World Health Organization

DEFINITIONS

Adverse event	Patient harm caused by medical management (rather than the underlying disease), resulting in prolonged hospitalization, disability at the time of discharge, or both.
Adverse incident	An unexpected event that has the potential to cause patient harm. Can also be described as deviation from standard care and is synonymous with "unexpected event" and "no-harm event".
Error	The act of doing something wrong (commission) or failing to do the right thing (omission) that exposes the patient to a potentially hazardous situation. Similar to active failure (i.e. unsafe acts).
Near miss	Adverse incident that did not cause patient harm because of intervening factors.
Preventable adverse event	Adverse event that could have been anticipated and prepared for, and that occurred because of an error or a system failure.
Risk	The possibility/probability of occurrence or reoccurrence of an event.
Safety hazard	A circumstance, agent or action with the potential of causing patient harm. Similar to latent condition (i.e. inevitable failures in the system), risk factor (in epidemiology) and system failure (in human factors engineering).
Serious adverse event	An adverse event resulting in death or serious physiological or physical injury (or the risk thereof). Also referred to as sentinel event.

INTRODUCTION

This thesis focuses on quality and safety in intensive care, addressing a well-known problem in the clinical setting. Today, critically ill patients frequently require transfers to other areas of the hospital in order to undergo interventions and examinations that cannot be performed bedside at the intensive care unit (ICU). Intrahospital transport (IHT) of patients in intensive care is a complex and high-risk process, associated with patient complications, hazards and adverse events (AEs).[2-4] However, few researchers have studied how to deliver safe and high-quality care during the IHT process.

In recent years, patient safety has been recognized as a public concern and a top priority in healthcare, including in intensive care.[5, 6] Several patient safety challenges are attributable to the intensive care environment's complexity and fast pace. Moreover, critically ill patients may be more vulnerable to injury because of the severity and instability of their illness and their frequent need for medication and other interventions.[7] Today it is recognized that defects in the structure and process of healthcare delivery may result in patient harm.[8] Hence, in order to improve quality and safety, healthcare delivery systems must be designed to reduce hazards and support healthcare practitioners' performance.

Implementation of effective and sustainable safety solutions requires knowledge about the IHT process. This includes a fundamental understanding of safety hazards and of how to support safe actions in healthcare practitioners performing IHTs. The research reported in this thesis explored the IHT process. It was designed to investigate how the structure and process of the healthcare system influence patient safety during IHTs. This included applying systematic approaches to investigate and measure IHT safety, as well as exploring patients' and providers' IHT experiences. Hopefully, the findings will enhance clinical practice and inspire future research.

BACKGROUND

This thesis is situated within the scientific discipline of health and care sciences, exploring a complex healthcare process from the patient safety perspective. The goal of nursing research is to generate knowledge that supports and advances nursing practice, in order to address the health of human beings in the context of their environment.[9, 10] This includes generating knowledge about delivering safe and high-quality care. This chapter introduces the theoretical perspectives and concepts underpinning the research presented in this thesis, followed by an overview of existing knowledge about IHTs and their impact on ICU patients.

Quality and safety

Quality in healthcare is a multidimensional concept. The Institute of Medicine (IOM) defines it as care that is safe, effective, timely, efficient, equitable and patient-centred.[11] This definition has been widely adopted. Efforts have been undertaken worldwide to develop meaningful measurements and to refine and determine how to best improve the concept. Moreover, quality improvement can be addressed at different levels, such as healthcare delivery microsystems (e.g. teams), organizations that house such microsystems (e.g. units, departments or hospitals) or the regulatory and financial level at which those organizations operate (i.e. the macro level).[12] Patient safety is one crucial component and an integral part of the overall quality approach to healthcare delivery.

In early 2000, the authors of the seminal IOM report 'To Err is Human: Building a Safer Health System' estimated that up to 98 000 people died each year in the U.S. due to preventable harm.[13] This estimation was based on extrapolating data from two large studies, The Harvard Medical Practice Study and the Utah and Colorado Study, that investigated the incidence of AEs by reviewing 30 000 and 15 000 patient records, respectively.[14, 15] Although errors in healthcare have been long known, the report represented the beginning of the modern patient safety movement, since 1) it highlighted a serious concern in healthcare previously not extensively discussed, 2) it stated that traditional clinical boundaries and the culture of blame must be broken down in order to achieve safer healthcare and 3) it focused on the importance of building safe healthcare systems that make it easy for people to do the right thing and hard for them to do the wrong.[13] Today, patient safety is one of the top priorities in healthcare. Despite this, the hospital environment still constitutes a risk for iatrogenic injuries and harm, and patient safety remains a public health concern.

In the field of patient safety, the term AE is used to describe patient harm as a result of medical care. Several retrospective records reviews in various countries have concluded that the prevalence of AE is about 10% among hospitalized patients.[16, 17] In intensive care settings, it is estimated that around 20% of the patients suffer AEs.[7, 18] It has been calculated that around 50% of AEs are preventable,[16, 19] suggesting that a better understanding of contributing factors may allow development of systems to make the hospital environment safer for patients. This is particularly relevant in intensive care, where the complexity of care and the severity of illness make patients particularly vulnerable to errors.

Patient safety

From the patient perspective, patient safety is often defined as the absence of accidental injuries or harm.[13] Patient safety is also a discipline that applies safety science methods, with the goal of achieving a trustworthy healthcare delivery system.[20] Furthermore, patient safety can be referred to as an healthcare system attribute that minimizes the incidence and impact of AEs and maximizes recovery from such events. Finally, patient safety can be described as a process, i.e. actions taken by individuals or by healthcare delivery systems, to identify causes of harm and/or preventive strategies to protect patients from harm.[20, 21]

Traditionally, errors in healthcare have been treated as failings of individual providers caused, for example, by forgetfulness, inattention or poor motivation.[22] As a result, healthcare practitioners have not felt safe reporting errors and thus learning from them to prevent reoccurrence. However, in 1990, pioneering work by James Reason revealed that major accidents were not caused by an individual's isolated actions or errors.[23] Rather, most accidents occurred as a result of multiple smaller errors in the environment or the healthcare system. This research led to the development of a systems approach, in which errors reflect predicable human failures in a poorly designed system.

In a system, defensive layers (i.e. safety barriers) protect potential victims from accidents. However, in reality these layers contain weaknesses, often referred to as active failures and latent conditions. Active failures are unsafe acts (e.g. slips, lapses, mistakes) by people who are in direct contact with the patient or the system. Latent conditions are inevitable failures in the system (e.g. poor design, understaffing, time pressure).[22] Nearly all accidents and errors involve a combination of these two factors. Importantly, mishaps tend to fall into recurrent patterns; the same set of circumstances can provoke similar errors, regardless of the people involved.[22, 23]

In safety science, the concept of safety hazard is central, because by identifying and eliminating safety hazards, the risk of injury and patient harm can be reduced. A safety hazard can be described as a circumstance, agent or action with the potential to cause patient harm.[24] Moreover, a safety hazard can be defined as anything that increases the probability of errors or injuries.[25] Thus, safety hazards are an obstacle to the stability of a system, as well as to individual undertakings within that system.[26] Safety hazards can vary in frequency, predictability, duration, location and magnitude. They can also be a contributing factor to AEs. Importantly, safety hazards typically interact with each other and different types of hazards are often revealed nested within an adverse incident (AI).[27] When applying a systems approach, safety hazards associated with the healthcare delivery system (i.e. latent conditions) are often the focus for risk management. Moreover, some healthcare settings, such as the ICU, are known to be particularly prone to safety hazards, contributing to increasing the likelihood and impact of medical errors.[28]

Perspectives on patient safety

Different theoretical perspectives can be applied in order to understand patient safety. The systems approach described above is often referred to as Safety-I. From a Safety-I perspective, safety is often thought of as the absence of accidents and AEs and as a state in which as few things as possible go wrong.[26] This approach presumes that incidents occur due to identifiable failures in the organization. However, it is problematic for several reasons. First, not all patient safety events result in patient harm. Second, focusing on what goes wrong limits understanding of why things most often go right. Third, it assumes a linear relationship between AEs and contributing factors.[26, 29]

To address these limitations, the Safety-II approach has been suggested.[26, 29] Safety-II relates to a system's ability to succeed under various conditions. From a Safety-II perspective, the focus shifts from understanding why things go wrong towards understanding why things go right. Human performance usually goes right despite existing system failures, because people can adjust what they do to match the circumstances of work (referred to as work-as-done). This often differs from work-as-imagined (i.e. how work should be done), since it is impossible in real life settings to anticipate all possible conditions that can exist.[26] A system's ability to adjust its function prior to, during and after changes or disturbances is referred to as resilience.[30] In Safety-II, the primary focus is to understand work-as-done, facilitate work flexibility and increase system resilience.[31]

Importantly, Safety-I and Safety-II represent two complementary, rather than conflicting, views of patient safety. Moreover, considering the increasing complexity in today's healthcare systems, a combination of the two approaches is likely needed. Therefore, the research in this thesis applied both a Safety-I and a Safety-II perspective. Hence, in addition to identifying safety hazards, there is a need to investigate and understand actions and performance leading to providing safe care (i.e. why things go right).

Evaluating patient safety

Retrospective reviews of patients' medical records are currently commonly used to measure the prevalence, incidence and nature of AEs.[32] This method is beneficial in assessing negative healthcare outcomes and the overall rate of harm at a given time, but limitations have also been acknowledged.[33] For example, AE rates do not reflect or provide insight into deviances in care processes and factors that might have contributed to patient harm.[32] Another approach is review of incidents, for example in morbidity and mortality conferences, liability claims from patients and relatives or incident reports. This generally entails assessment of a single event that is not linked to any common denominator, and thus restricts the ability to estimate rates.[34] Of these methods, incident reporting is used increasingly in healthcare. Incident reporting is a system designed to identify safety issues within a healthcare organization; it provides opportunities to learn from incidents and thus prevents recurrence.[35] It is beneficial because the information provided comes from frontline staff, often involved in caring for a patient when an AI or error occurred. Incident reporting also has the advantage of relatively low cost and involves staff in the process of identifying important problems.[35] However, incident reports are a passive form of surveillance that rely on voluntary reporting. The information obtained can be fragmented, incorrect and inadequate. Therefore, more active methods of safety surveillance, such as direct observation, have been suggested as a complement. Importantly, incident reporting is known to be associated with factors such as staff willingness to report and the safety culture at a workplace,[36] and incident report rates should thus be cautiously interpreted as an indicator of safety.

In clinical patient safety work, root cause analysis and failure mode and effect analysis are two common approaches used to assist patient safety management.[37] The first, root cause analysis, retrospectively reviews incidents in order to identify contributing factors within the healthcare system. The second, failure mode and effect analysis, aims to prospectively assess system failures associated with a risky process.[37] They are both used to identify factors contributing to errors and AIs, as well as to find solutions to improve safety in clinical practice. However, the limitations of these approaches include their inability to identify higher-level system factors (i.e. macro level). Furthermore, there is a risk that reporting and analysing incidents will not lead to improvement unless accompanied by standardized measurements.[38] Therefore, creation of a reporting system that includes multiple hospitals and a standardized set of outcome variables such as quality indicators, i.e. specified quantitative measures to assess clinical performance on the hospital and unit levels, has been advocated.[38, 39] Quality indicators can be useful to identify differences in quality of care and initiate quality improvement projects and they enable benchmarking.[39]

Human factors engineering

From a Safety-I perspective, acknowledging that most errors in healthcare do not arise from the actions of individuals, but rather from system design failures, has led to increased attention being devoted to human factors engineering approaches.[28] Moreover, the Safety-II perspective is based on the assumption that healthcare today is more complex, and that the system must be flexible and adapt its function to changes and disturbances (i.e. system resilience).[29] Therefore, this thesis is grounded in the discipline of human factors engineering, in order to understand how system design influences patient safety.

Human factors engineering (also referred to as ergonomics)[40] is a discipline concerned with understanding the interactions among humans and other elements of a system.[41] It focuses on human strengths and limitations in the design of interactive systems to ensure safety, effectiveness and ease of use.[41] Thus, the discipline aims to design or redesign these systems in order to optimize human wellbeing and overall system performance. Human factors engineering has been used to improve safety in other high-risk industries such as aviation and nuclear power, and has more recently also been applied in healthcare settings.[28] During the past decades, it has been acknowledged that healthcare might benefit from human factors engineering in several important ways. These include the awareness 1) that performance is a result of the interaction of a socio-technical system in which a person is one embedded component, 2) that effort must be undertaken to support people through the design of the work system and 3) that design or redesign of systems and processes can improve several patient, employee and organizational outcomes.[42] A human factors engineering approach can be used to address a specific task (or a process or activity) and assess aspects of the work system such as demands, workload, team dynamics and environment.[28, 41] Applications of human factors engineering concepts, techniques and methods have therefore been proposed as one way to improve healthcare system design, and hence patient safety and quality of care.

Theoretical framework

As there are different approaches to patient safety, several models and conceptual frameworks have also been developed with the aim of understanding system design and/or assisting patient safety management. They can broadly be categorized as 1) models of human errors and organizational accidents, 2) models focusing on care processes and system interactions and 3) models linking healthcare professionals' performance to patient safety.[28] For example, there is extensive literature building on James Reason's seminal work on active failures and latent conditions (i.e. models of human errors and accidents).[22, 28] In this thesis, the Systems Engineering Initiative for Patient Safety (SEIPS) model will serve as a theoretical framework that also provides methodological guidance.[42-44] This choice was due to the fact that the model integrates elements from the three categories described above, and because it includes several aspects of patient safety, the focus of this thesis.

The SEIPS model is a framework that originates from human factors engineering. The model builds upon the structure, process and outcome model for evaluation of quality of care, Donabedian's seminal work.[45] According to Donabedian's framework, information about quality of care can be obtained from each of these three domains. The structure refers to the context in which care is delivered. Various factors in the structure, such as physical environment and organizational characteristics, control and influence how providers and patients act. The process is the sum of all actions taken by the providers, patients and their relatives, while the outcome refers to all effects, in relation to healthcare, on patients or a population.[45] Donabedian's model can be applied in diverse healthcare settings and on various levels within a healthcare delivery system.[46]

The SEIPS model provides theoretical and practical guidance to empirically examine system design in relation to patient safety. The initial model was presented in 2006 and has been further developed and refined (i.e. SEIPS 2.0 and SEIPS 3.0).[42-44] The fundamental theory of the model is that the work system (i.e. the structure) in which care is provided affects clinical processes, which further influence patient, employee and organizational outcomes (Figure 1).[42]

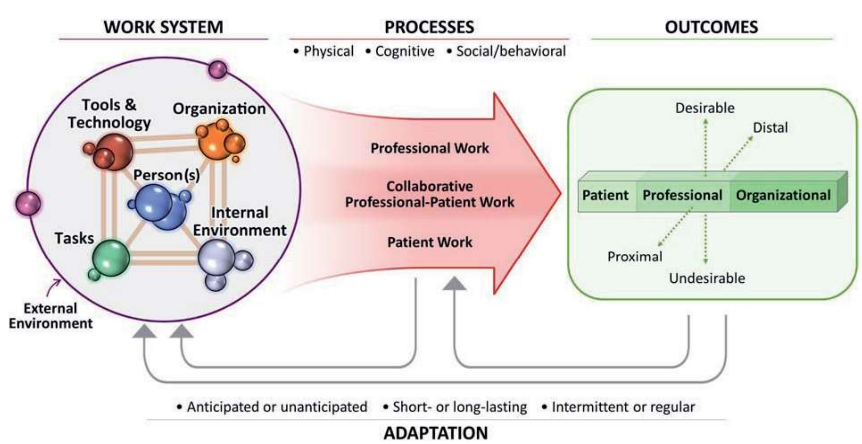

Figure 1. The Systems Engineering Initiative for Patient Safety model (version 2.0). Reprinted from Holden et al.[42] with permission from Taylor & Francis Group (www.tandfonline.com)

First, the SEIPS model defines five work system components: 1) person(s) (i.e. patient, healthcare providers or the team), 2) tasks, 3) tools and technologies, 4) environment and 5) organization. Accordingly, a person performs tasks using tools and technologies. These tasks are performed in a physical environment influenced by organizational conditions. SEIPS 2.0 added the external environment to emphasize how factors outside the organization (e.g. local governance, economic policies) influence the process of care. These work system components interact and influence each other. Moreover, they affect clinical processes.[42, 43]

Second, the SEIPS model defines the process (sometimes referred to as the work process) as *"how care is provided, delivered and managed"* (43, p.i53). The process can be understood as a series of tasks performed by an individual or a team of individuals, using various technologies and tools. The process may occur in several physical environments and may be affected by multiple organizational characteristics. Moreover, other processes that may influence care, such as housekeeping, maintenance and other supply chains, should be considered and designed to support safe care. The process can be further broken down into physical, cognitive and social/behavioural processes (or performances).[42] In SEIPS 3.0, the concept of the process is expanded, focusing on the journey of the patient and the caregiver over space and time.[44] This is because patients commonly interact with numerous healthcare workers belonging to different organizations.

Third, the SEIPS model defines the outcomes influenced by the work system and the process. These include patient, employee and organizational outcome, all of which are important to enable future processes of high-quality and safe patient care. The model specifies feedback loops that represent pathways to (re)design the work system. To design safe systems, the concept of balance is used, meaning that negative elements that are hard to change in the system may be overcome by focusing on other, positive, elements.[43] Several studies have used the SEIPS model in various healthcare settings to identify system factors contributing to AEs, the authors often providing recommendations for safety improvements.[47-49] For example, Gurses et al. identified and classified patient safety hazards during cardiovascular surgery.[49] The model has also been used in the ICU setting to identify factors contributing to medical errors.[48]

The human contribution

As previously described, errors are caused by weaknesses (i.e. active failures and latent conditions) within the work system. However, the frontline personnel and the patient represent the last safety barrier in an organization.[50] Importantly, frontline personnel are not only responsible for active failures such as mishaps and mistakes, but they can often catch and correct their own and others' errors before they cause patient harm.

Hence, in addition to designing healthcare systems that minimize the risk of errors, there is also a need to understand the human contribution (i.e. the human factor) in safe and unsafe care practices.

Technical and non-technical skills

Technical skills are the abilities and knowledge needed to perform a specific task. These are sometimes referred to as hard skills and can be defined and learned, as well as measured and evaluated. Commonly, technical skills are practical and related to mechanical tasks (e.g. use of tools and equipment). The required technical skills vary according to context and job-specific tasks.[51] In addition to technical skills, cognitive, social and personal skills are essential to cope with risks and demands, especially for those working at the 'sharp end' (i.e. performing critical tasks) of an organization.[50] These are often referred to as non-technical skills. Identified non-technical skills for teams in emergency medicine and intensive care include situational awareness, task management, team-working and decision-making. There is emerging evidence that errors and failures in non-technical skills are common contributing factors to AEs.[52, 53] Therefore, multiple instruments have been developed for the assessment of non-technical skills over the past decades. For example, one recently published systematic review identified 76 tools for measuring non-technical skills in healthcare.[54] However, each work environment has its own demands and characteristics that influence the caregivers' roles and responsibilities.[53, 55] Identification of non-technical skills for a given task or process can thus reveal the specific behaviours and skills that are associated with adverse outcomes or their avoidance.

Interprofessional teamwork

Teamwork, especially specific teamwork skills and behaviours (e.g. communication, cooperation and shared mental models), is one important component of non-technical skills.[53] However, the concepts of teams and teamwork extend beyond skills and behaviours of individual team members. Teamwork is an adaptive and dynamic process. It includes components such as a shared identity, clear team roles, tasks, goals and interdependences, as well as shared responsibility. Furthermore, team processes are influenced by conditions such as team composition, context and culture.[56] Importantly, effective and successful teamwork requires both technical task-oriented and non-technical skills, as well as attributes associated with teamwork processes.

Interprofessional teamwork has been associated with improvements in quality and safety,[57, 58] and has been acknowledged as particularly important during high-risk situations and emergencies.[59] For example, managing a crisis situation requires coordinated actions by healthcare practitioners with various training and different professional backgrounds.[60] However, a meta-ethnographic review found that interprofessional teamwork was largely absent in acute care settings.[61] Barriers for interprofessional teamwork include loosely defined teams, hierarchal and authoritative leadership and physicians exhibiting dominance.[61, 62] Notably, an ethnographic study of teamwork in the ICU setting concluded that most interprofessional interactions could be described as collaboration, coordination and networking between professionals rather than as teamwork. The above-mentioned characteristics of teamwork, such as shared identity, clear roles and interdependency, were thus not present.[63]

Nurses' role in patient safety

Nurses plays a critically important role in patient safety. Errors and AIs, which may result in patient harm, are often prevented by nurses because they are responsible for coordination and integration of multiple aspects of patient care, delivered by themselves or by others.[21, 64] Moreover, nurses are present bedside and can ensure safety by monitoring the patients' health status, as well by performing countless tasks to ensure that patients receive safe and high-quality care. Several studies have demonstrated links between nurse staffing ratio,[65] educational level,[66] workload[67] and patient safety. Nurses' promotion of patient safety also includes participation in proactive patient safety work, such as redesigning healthcare in order to improve safety and quality of care.

Patient participation in patient safety activities

Patient participation in patient safety activities has been increasingly recognized. This includes patients as co-designers of patient safety research,[68] patients as health consumers contributing with experiences, perspectives and insights to improving patient safety,[69] as well as patients and relatives acting as the last safety barrier by identifying hazards before they cause harm. This requires a transition of the traditional view on patients as passive recipients of healthcare to integral members of the team redesigning healthcare.[68] This also means a shift from focusing on patient satisfaction to patient experience in assessing the quality of care.[70] Research findings suggest that patient involvement in redesigning healthcare is feasible and can lead to a reduction in hospital admissions, improved quality of life and improved effectiveness and efficiency of health services.[70]

Patient-centred care (i.e. care that is respectful of and responsive to individual preferences, needs and values) is an integral component of the overall quality and safety approach.[11] Patient-centeredness is one of the core principles in human factors engineering. This means that the patient is central in the healthcare system and that the system design should thus support their capabilities and limitations, rather than vice versa.[42] From the patient perspective, patient safety should be considered broadly and longitudinally, i.e. a better understanding of what happens to patients over time and across and between healthcare organizations, thus providing a more complete picture of patient safety.[44] Patients' experiences and perspectives must thus be included in investigating and understanding safety. Moreover, patients can contribute important information, based on their experiences of care, that may lead to improved understanding of the factors that led to harm.[71]

Intensive care

Intensive care is defined by the World Federation of Societies of Intensive and Critical Care Medicine as "a multidisciplinary and interprofessional specialty dedicated to the comprehensive management of patients having, or at risk of developing, acute, life-threating organ dysfunction" (72, p. 271). Internationally, ICUs are often divided into primary (level 1), secondary (level 2) and tertiary (level 3).

Primary ICUs constitute the most basic level, with non-invasive monitoring and limited organ support. Nurses and physicians should have experience of critical care but may not have formal training and the nurse-to-patient ratio is higher than on regular wards.[72]

Secondary ICUs provide basic support in cases of failing organ function. This includes availability of continuous monitoring, basic mechanical ventilatory support and intermittent renal replacement therapy. Nurses should have special qualifications in intensive care. [72] Secondary ICUs often serve as referral units at local hospitals that lack dedicated ICU facilities.

Tertiary ICUs are characterized by their capability to provide the full spectrum of monitoring and life support technologies. The nurse-to-patient ratio is 1:1 to 1:2, and nurses should have additional training in critical care. Moreover, tertiary ICUs have integrated outreach services and, ideally, formal ICU follow-up programs.[72]

In Sweden, where the research underlying this thesis was situated, the term ICU generally refers to a tertiary ICU. Other terms, such as high-dependency units, are generally used for secondary or primary ICUs. Moreover, ICUs can be classified according to specialty or patient population, such as thoracic, neurological or paediatric.[73] Critically ill patients across ICU levels, specialties and populations commonly require transfers within the hospital. The main focus of this thesis is on patients admitted to tertiary ICUs, including all specialities and populations except burn ICUs.

The intensive care environment

In intensive care settings, patients are treated in a highly technological environment. ICUs are located in a specific geographic area in a hospital. However, services and activities undertaken for critically ill patients are often performed in other parts of the hospital, such as in the emergency department or by outreach teams in the hospital wards.[72] Importantly, patients undergoing an IHT for diagnostic or therapeutic purposes generally require the same level of monitoring and care as in the ICU.[74] Patients in Swedish ICUs are often treated by a multidisciplinary team of critical care nurses, assistant nurses, physicians specialized in anaesthesiology and/or intensive care and other professionals such as physiotherapists (collectively referred to as healthcare practitioners in this thesis). In Sweden, the registered nurses referred to as critical care nurses in this thesis are specialised in intensive care. This requires one year of additional coursework at the postgraduate university level, resulting in a one-year master's degree. Critical care nurses are qualified to provide specialist care to patients with, or at risk of developing, life-threating organ dysfunction.[75] This often includes advanced respiratory, hemodynamic or neurological life support. Moreover, working in the frontline of patient care, critical care nurses play a vital role in early identification of potential patient safety threats.

From the patient perspective, being connected to various technical devices and exposed to unsettling noises, smells and lighting can cause both physical and mental stress.[76, 77] Furthermore, the reason for admission to the ICU is often a life-threatening condition for which the outcome may be uncertain. A systematic review found that patients commonly experience fear, anxiety, nightmares and hallucinations during their ICU stay.[78] In an interview study, 250 patients described both pleasant and unpleasant memories of intensive care, such as physical, emotional, perceptual and environmental stress and distress.[79] During their ICU stay, being connected to various technical equipment limits patients' ability to move. Moreover, they often require sedatives and other potent drugs, such as vasopressors. Hence, patients often have little influence over the surrounding environment and activities.[80] Furthermore, they are often dependent on staff or relatives to look after their interest and wellbeing.

Intrahospital transport in intensive care

Patients in intensive care are frequently transferred to other care facilities such as the radiology department, operating theatre or magnetic resonance imaging (MRI). Research on IHT safety dates back to 1970, when Taylor et al. demonstrated that arrhythmias constituting indication for emergency therapy were detected in 44% of 50 transported cardiac disease patients.[81] Despite technological advances, IHTs still constitute a risk for the critically ill patient. The decision to transport a patient should therefore always be preceded by a risk- benefit assessment. Alternative options should be considered, such as diagnostic and therapeutic procedures that can be performed bedside in the ICU. Figure 2 shows a picture of an IHT in a Swedish hospital.

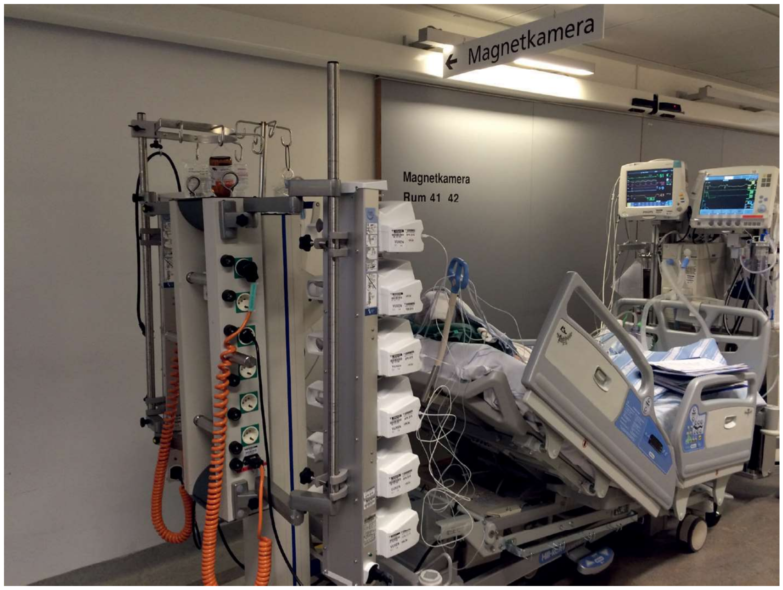

Figure 2. An intrahospital transport at a Swedish hospital

The IHT process can be divided into three sequential phases: pre-, intra-, and post-transport. The pre-transport phase includes preparation and stabilization of the patient, allocation and deployment of staff resources, pre-transport communication and coordination, as well as preparation of equipment and other supplies. During the intra-transport phase, the patient needs continuous monitoring and necessary medical or other interventions. Furthermore, the transport team must carry out the transfer, including perceiving and anticipating risks and hazards that might occur. Depending on the purpose of the IHT, the intra-transport phase may or may not include a clinical handover, defined as a temporary transfer of responsibility for some aspect of care to another professional group.[82] If so, this phase also requires safe information transfer between medical teams. In the post-transport phase, the patient must be safely resettled in the ICU and regular care resumed. This phase includes re-assessment of the patient's medical condition, re-instalment of equipment and other supplies and documentation of transport-related events. The transfer time depends on 1) the purpose and duration of the IHT, 2) hospital design attributes such as length of transport routes and 3) coordination of resources to perform the procedure (e.g. waiting time). One observational study of 503 IHTs showed that the median duration of the transport was 55 minutes (range 10-305).[83]

Adverse events, complications and secondary effects

Researchers use different definitions when describing patient harm and complications related to IHT. The terms AE, AI and patient complications are often used to describe the same events in different studies. Overall, AE incidence rates varies across studies[84-90] and have been known to reach 80%.[85] However, if only clinically significant AEs are considered (e.g. unplanned extubations or complications requiring therapeutic interventions), the incidence rates range from 1.7 % to 8.9%.[86, 88, 89] This substantial variation can thus be attributable to different definitions. Furthermore, contextual factors may vary across study sites. For example, Kue et al., who reported an overall incidence of IHT-related AE of 1.7%, only included clinically significant AEs.[88] On the other hand, Jia et al., who reported an overall rate of 79.8%, defined AE as either an equipment- or staff-related event or any event that affected patient stability (e.g. changes in vital signs or blood gas abnormality).[85] These variations make it difficult to compare studies' results.

Regardless of the selected definition, studies have found associations between IHT and various short- and long-term complications. A complication is an unanticipated problem that arises from a procedure, treatment or illness and may thus arise, or not, a result of an AE.[91] Reported short-term complications include hemodynamic instability,[84, 85] increased intracranial pressure,[92, 93] respiratory alterations[84, 94] and hyper- and hypoglycemia.[4] Hypothermia has also been reported in the neonatal and infant populations.[95] Long-term complications include ventilator-associated pneumonia[4, 96] and deep vein thrombosis.[4] Moreover, IHT has been linked to longer ICU and hospital stays.[4, 97] The effect of IHT on mortality has also been investigated. Voigt el al. reported twice as high post-ICU mortality among transported patients, compared to non-transported patients.[97] On the other hand, Schwebel et al. found no such difference.[4] Therefore, the effect of IHT on mortality remains unclear.

Previous research has identified safety hazards associated with the IHT process, that can be divided into patient-related and system-related hazards. Patient-related safety hazards (i.e. risk factors in epidemiological terms) contributing to the onset of an AE during IHT include mechanical ventilation, positive end expiratory pressure > 6, need for vasoactive support, sedation before IHT and high severity of illness scores.[84-87] System-related safety hazards include equipment-related incidents, lack of training, lack of staff, communication/liaison problems, emergency transports and long transport and waiting times.[2, 3, 87] Importantly, there are usually multiple factors involved in the onset of an IHT-related AE. Furthermore, there is still a lack of clarity concerning complications and their causes, such as the patient's diagnosis and condition and other contributing factors.

During IHTs, patients are exposed to alterations such as acceleration and deceleration, changes in posture and movement from one surface to another. Furthermore, they may be exposed to external sensory disturbances such noise, lighting and thermal changes.[3] The procedure itself might also be a source of discomfort. Whereas the physiological impact of IHT is well documented, little is known about how the patient experiences the transport. A systematic review concerning patients' experiences of inter- and intrahospital transitions, including studies of transfers to or from ICUs, showed that the transfer was experienced as a critical event.[98] However, as transitions often denote a change, for example in the patient's health status; these findings might therefore be less applicable to the IHT process.

Teamwork, technical and non-technical skills

Internationally, IHT is often performed by a team including critical care nurses, physicians and, in some hospitals, respiratory therapists and hospital porters.[74] In Sweden, physicians and critical care nurses together assesses the patient prior to the IHT and selects appropriate staff members, depending on the patient's condition. During IHTs, the transport team must perform various tasks requiring technical skills, such as handling the transport equipment, and must have skills in providing the necessary nursing or medical interventions. IHT has previously been described as a unsafe and stressful task by critical care nurses.[99] Since deficiencies in non-technical skills, such as teamwork, communication and decision-making, have been highlighted as a contributing factor to IHT-related AE,[2, 3] investigating technical and non-technical skills among the transport team might provide important knowledge informing clinical practice and future research.

Guidelines and safety improvements

Intensive and critical care societies have published guidelines and recommendations for IHTs of critically ill adults.[74, 100-104] In addition, recommendations also exist for transfers of critically ill children, obese patients, and patients receiving non-invasive ventilation.[105-107] Some common and basic principles for the IHT process can be identified in the guidelines. For example, minimum standards for equipment and monitoring during the transport. In terms of staffing level, the most common recommendation is that the IHT should be undertaken by a critical care nurse and a physician if the patient is unstable. Guidelines have been developed based on prospective and retrospective studies, as well as on expert opinions for cases that lack published data. However, the majority of identified published guidelines are more than 15 years old, with the most recent published in 2015. To date, there is no published Swedish guideline. Table 1 presents safety recommendations for IHTs in the guidelines identified by the researcher.

Table 1. Recommendations in identified guidelines for intrahospital transports

Guideline						
Author	Warren et al.[74]	Ferdinande[100]	Quenor et al.[101]	Australian and New Zealand College of Anaesthetists[102]	Chang[103]	Gupta et al.[104]
Year published	2004	1999	2012	2015	2002	2004
Country/Region	United States	Europe	France	Australia and New Zealand	United States	India
Safety recommendations						
IHT-related patient safety events defined	✗	✗	✓	✓	✗	✗
Local IHT protocol/policy	✓	✗	✓	✓	✗	✗
Risk/benefit assessment prior to IHT	✓	✓	✓	✗	✓	✗
Contraindications for IHT	✗	✗	✗	✗	✓	✗
Pre-transport stabilization	✗	✓	✓	✓	✗	✗
Anticipation of and preparation for clinical needs during IHT	✗	✗	✓	✓	✗	✓
Notification of relatives	✗	✓	✗	✗	✗	✗
Appropriate staffing and skills levels	✓	✓	✓	✓	✓	✓
Coordination between departments prior to IHT	✓	✓	✓	✓	✗	✓
Clarification of responsibility for patient care during IHT	✗	✗	✗	✓	✗	✓
Planned route mapped prior to departure	✗	✗	✓	✗	✗	✗

Minimum standards for monitoring	✓	✓	✓	✓	✓	✓
Appropriate documentation	✗	✓	✓	✓	✗	✓
Minimum standards for IHT equipment	✓	✓	✓	✓	✓	✓
Securing of endotracheal tube prior to IHT	✓	✗	✓	✓	✗	✗
Manual ventilation avoided	✗	✗	✓	✗	✗	✗
Emergency intervention kit	✓	✓	✓	✓	✗	✓
Training of IHT staff	✓	✗	✓	✓	✗	✗
Registration of performance indicators that allow for benchmarking	✗	✗	✗	✓	✗	✗

Note: ✓= safety recommendation exists; ✗= no safety recommendation. Abbreviation: IHT: intrahospital transport

Interventions aiming at improving quality and safety during IHT, such as checklists, training programs and technical innovations, have been developed, tested and evaluated.[83, 90, 108-120] For example, Choi et al.'s before- and after-intervention trial showed a significant decrease in unexpected events (from 36.8% to 22.1%) after introducing a checklist for IHT of critically ill patients.[109] However, most of these interventional studies were quasi-experimental and lacked control groups. Only two studies could be found applying a randomized design to test the intervention in a clinical environment. Matsumura et al. evaluated equipment for safe and efficient transfer of multiple lines and tubes, with results indicating significantly shorter transfer time.[117] Furthermore, Jiang et al. found a significant reduction in waiting time, transport time and accident rate among patients subject to a nursing intervention. This intervention included an evaluation of the patient's condition before transport, examination of the patient's specific condition during transport and stabilization of vital signs after transport.[110] This study was conducted in an emergency department and the results might thus not be applicable to the ICU. An overview of design, method, and main results of identified interventional studies is presented in the appendix (Table S1).

RATIONALE

Some ICU patients are required to undergo IHTs in order to access the most accurate diagnostics and sometimes life-saving treatments. Moving patients outside the ICU presents several safety challenges. These include the unfamiliar environment during the IHT, difficulty using the most sophisticated monitoring equipment and the reliance on fewer technical, pharmacological and human resources if the patient's condition should deteriorate.

Research has been conducted demonstrating that IHTs are associated with risks, AEs and complications in ICU patients. But little is currently known about how contextual, organizational and human factors influence patient safety during IHT. Improving patient safety also requires understanding of the experiences and practices of those working in the frontline of patient care. Moreover, while there is existing knowledge that IHTs have a clear impact on patients, there is little previous research on how they experience the IHT process. There is thus a need for further research on patient safety during IHT. This knowledge is vital in order to reduce errors and injuries, as well as to guide evidence-based practice. Furthermore, there is a need to standardize and validate assessment of safety during IHTs in order to better understand safety prerequisites, and thus improve practice.

AIM

Overall aim

The overall aim of this thesis was to explore patient safety during the IHT process in intensive care, in order to generate knowledge and contribute to future safety solutions. This was specifically undertaken by identifying transport-related safety hazards and investigating patients' and healthcare practitioners' experiences of the process, as well as by developing and evaluating an instrument for assessing safety prerequisites.

Specific aims

Study I	To identify, classify and describe safety hazards during the IHT process of critically ill patients.
Study II	To explore critical care nurses' and physicians' experiences and practices associated with critical incidents during the IHT process in critically ill patients.
Study III	To explore ICU patients' experiences of the IHT process.
Study IV	To develop and evaluate the psychometric properties of a scale measuring patient safety during the IHT process in intensive care.

METHODS

In this chapter, the methodological aspects of the thesis are presented, followed by an overview of the included studies, a description of the methodological steps undertaken in the ethnographic study (Studies I-III) and a presentation of the instrument development study (Study IV). This is followed by a description of the analytical approach for synthesis of the overall findings in the thesis. Finally, ethical considerations are discussed.

Methodological aspects

The overall methodological approach in this thesis is ethnography and the phenomenon of interest is the IHT process in intensive care. Ethnography entails that the researcher participates in people's daily life, collecting data from multiple sources on issues related to the focus of inquiry.[121] Data analysis involves interpretation of the meaning, functions and consequences of human actions and institutional practices and of how these are implicated in local and wider contexts. Moreover, ethnography allows researchers to immerse themselves in a setting, which generates a rich understanding of actions in different contexts.[121] From a naturalistic philosophical standpoint, the social world cannot be understood in terms of simple causal relationships. This is because human behaviours are influenced by the physical, sociocultural and psychological environment, and actions are based on and influenced by cultural meaning such as intentions, motives, beliefs, rules and values.[121, 122] As a basis for naturalistic inquiry, the empirical world must therefore be investigated from the viewpoint of the person under study. Furthermore, people's actions should be studied in their everyday context rather than under conditions created by the researcher.[121, 122] In ethnography, this is referred to as the emic perspective, while the term etic refers to the outside (observer) perspective. The researcher often shifts between the etic and the emic perspectives in order to understand a phenomenon from different viewpoints.[123]

The ethnographic design was chosen to enhance understanding of the structure, process and outcomes during IHTs of intensive care patients. By nature, ethnographic research is initially exploratory. The research inquiry does, however, become more refined and clearly focused over time, allowing more strategic testing of research questions against existing evidence.[124] Using an ethnographic approach in this thesis, the field was entered with a specific research question. The researcher had contextual knowledge about the ICU setting and the phenomena being investigated. She had previous experience of working as a critical care nurse, as well as previous experience and knowledge of analysing incident reports and performing risk assessments. However, she had no prior relationship with the participants in the study sites.

The research in this thesis is based on a social constructivist paradigm that acknowledges that social reality is constructed by and between individuals and influenced by sociocultural contexts and structural conditions.[125] The researcher is thus a part of the social world that he or she aims to investigate. It is argued that both positivism and naturalism fail to take into account that the research is a part of the social world being studied.[125] A reflexive approach was therefore applied throughout the research process, in order to minimize the effect the researcher might have on the data.[121, 126] This entailed constantly recognizing her influence on the research process and the relationship between the researcher and the participants.

Overview of the studies

Studies I-III were components of an ethnographic study, including participant observations, informal and formal interviews with critical care nurses and physicians and formal interviews with patients. Data for Studies I-III were collected simultaneously, although the data for each study were analysed independently. Study IV was designed to generate additional understanding of the IHT process by developing an instrument to measure patient safety. This study included 1) item development, 2) item refinement and content validation with modified Delphi technique[127] and 3) item reduction and evaluation of psychometric properties with a cross-sectional study in a sample of Swedish healthcare practitioners. Data regarding ICU admission and registered IHTs for participating ICUs were collected from the Swedish Intensive Care Registry (Studies I-IV). Data published at the registry (utdataportalen) is accessible for public use.[128] NVivo (version 11/12; OQR International, Melbourne, Australia) was used to assist qualitative data management. Statistical analysis was performed using IBM SPSS, version 25 (IBM Corp., Armonk, NY, USA). Table 2 presents an overview of the included studies.

Table 2. Overview of the studies

	Study I	**Study II**	**Study III**	**Study IV**
Design	Explorative Descriptive	Explorative	Explorative	Descriptive
Data collection	Participant observations	Semi-structured interviews	Semi-structured interviews	Questionnaire
Participants	51 IHTs	15 CCN 5 physicians	12 patients with experience of IHT	18 experts 315 HCP
Outcome	Safety hazards in the work system during IHTs	IHT experiences and practices	Experiences of IHT safety	IHT safety scale
Sampling	Purposive	Purposive	Convenience	Purposive & snowball Consecutive
Data analysis	Content analysis Descriptive statistics	Content analysis Thematic analysis	Thematic analysis	Content validation Explorative factor analysis Internal consistency reliability

Abbreviations: CCN: critical care nurses; HCP: Healthcare practitioners; IHT: intrahospital transport

The ethnographic study (Studies I-III)

An ethnographic study was undertaken at two ICUs at one intensive care department at a 2 000-bed university hospital in Sweden during the period February-May, 2016. The two included ICUs were respectively specialized in general and trauma intensive care (18 beds) and neurological intensive care (8 beds). During 2016, the units had 2 525 ICU admissions and they performed a total of 1 483 IHTs. At the included units, each critical care nurse cared for two patients, together with an assistant nurse. IHTs were performed by critical care nurses and assistant nurses from the ICU and, if the patient's condition so required, a physician also participated in the transport.

The transport team consisted of at least two people, but five or more could participate if necessary. At the included ICUs, the patients needed to be transported through public hospital corridors and sometimes in elevators to reach the destination. ICU patients were commonly transported in their own beds and monitored with portable devices. The transport team carried a standard set of acute care medications and equipment during the IHT. Depending on the individual patient's medical condition, a portable ventilator, infusions pumps and other medical/technical equipment could be attached to the bed. During fieldwork, the researcher was available at the study sites between 7 am and 10 pm on weekdays. This approach was chosen since data were collected by one single person and since most IHTs occur during office hours. To gain a better understanding of the IHT process, emerging findings were discussed with ICU staff and local guidelines were reviewed. The researcher conducted a total of 345 hours and 45 minutes of fieldwork.

Participant observations

Participant observations of the IHT process were conducted by the researcher. A purposive sample of IHTs was selected, aiming for maximum diversity in team and patient characteristics.[129] Inclusion criteria were that the IHT was performed by ICU staff. Prior to the study, the researcher informed healthcare practitioners at the included units about the study design and purpose at various staff meetings. All staff also received written information about the study. Before each observation, consent was reconfirmed. The observation began when the team started to prepare the patient for departure in the ICU, continued throughout the transport, and ended either when the patient returned to the ICU (and regular care was resumed) or when care was handed over to another medical team.

The degree of involvement and type of participation can be described as moderate participation.[130] Thus, the healthcare practitioners observed were aware of the observer and knew about the overall aim of the investigation. However, the observer was not an insider (i.e. an ordinary member of the group) and did not actively participate in the IHT process. The observations were recorded with field notes containing a detailed description of the IHT process, interactions among participants and verbatim quotes. For each observation, characteristics of the IHT (e.g. date, time, destination, number of participants) were recorded in a case report form and reflective notes (concerning initial analytical ideas) were taken. These field notes and reflective notes were transcribed by the researcher immediately after an observation was completed. The observation lasted between 10 and 125 minutes (median 50), resulting in a total of 44 hours and 38 minutes of observation. Data collection continued until saturation occurred, i.e. until no new information emerged.

Data were analysed with qualitative content analysis.[131] First, data coded for safety hazards were deductively classified using an analytical matrix based on the SEIPS model's work system components and the three different transport phases (pre-, post-, and intra-IHT). A quasi-quantitative approach was applied to estimate hazard frequencies and assess their distribution across the work system components and each transport phase. Furthermore, identified safety hazards' impact on patient safety were assessed using a modified version of Battles' and Lilford's definition of patient safety event types.[27] Second, data within each domain in the analytical matrix were inductively analysed to identify and describe hazard categories, factors contributing to safety hazards and process related-outcomes. The analysis was performed by the research group to strengthen confirmability and trustworthiness of research findings.

Interviews with critical care nurses and physicians

Semi-structured interviews were conducted using the critical incident technique[132], a method aimed at understanding effective and ineffective performances in order to provide solutions to practical problems. The critical incident technique makes it possible to obtain a rich and complete description of the event being explored (i.e. IHTs of ICU patients), the specific action undertaken by the people involved and the outcome of the event, which reflects the effectiveness of their behaviours.[133] For this study, a critical incident was defined as a significant or important event (either with positive or negative outcome) during an IHT.[133]

Potential participants (i.e. critical care nurses and physicians) at the included units were invited by the researcher to participate in a face-to-face interview. A purposive sampling approach was applied, aiming for maximum variation in age, gender, profession and work experience.[129] Oral and written information about the study design were given and informed consent obtained prior to participation. Interviews were carried out in private at the hospital. According to the critical incident technique, participants were asked to describe one or more significant event that they had experienced during an IHT. Probing questions were then asked in order to gain a complete understanding of the incident, as well as behaviours displayed and actions undertaken. Examples of probing questions: 'Could you please describe how the people involved in the incident acted?'; 'How did these actions affect the outcome of the incident?'; ' Was there anything that the people involved could have done differently?'. The interview guide was pilot- tested and probing questions were added or revised, based on emerging findings. All interviews were audiotaped and lasted between 18 and 38 minutes. After each interview, reflective notes were taken. Interviews were transcribed verbatim by the researcher and data were collected until no new information was obtained.

Data were analysed by applying both content and thematic analysis approaches.[131, 134] After reading and rereading all data, critical incidents were identified and defined.

Thereafter, inductive content analysis was performed to analyse practices related to critical incidents. Finally, thematic analysis was used to analyse experiences of the IHT process. The analysis was primarily performed by the researcher, but emerging categories and themes were reviewed and refined by the research group to establish credibility and confirmability.

Interviews with patients

Semi-structured interviews with ICU patients that had experienced an IHT were conducted. A convenience sampling approach was used to identify possible participants.[135] Eligible patients (i.e. patients that had been conscious during the IHT and aware of being transported) were identified by critical care nurses at the included ICUs or staff in the post-ICU unit. The post-ICU unit refers to a follow- up service provided to patients that have been admitted to the ICU. During the fieldwork, there were fewer eligible patients that were willing to participate than expected, and interviews with patients were thus also conducted at a second time-point (February-April, 2017).

Potential participants received oral and written information about the study by the researcher, together with an invitation to participate. A consent form was signed prior to the interview. An interview guide with open-ended questions focusing on the patient's perception of the IHT and experience of safety was used. Questions in the interview guide included: 'During your time in the ICU, you underwent a transport to another facility within the hospital to undergo an exam or intervention. Could you please describe that transport?' and 'How did you experience the transport (prompt sights, sounds, smells)?' Interviews were conducted by the researcher and most were carried out face-to-face when the patient was admitted to a hospital ward. However, two interviews occurred after the patient had been discharged from hospital, either by phone or at a location outside the hospital. The interviews lasted between 7 and 18 minutes, and reflective notes were taken. All interviews were transcribed verbatim by the researcher. Data collected at the first time-point (n=10) did not generate data saturation. However, after conducting the two additional interviews at the second time-point, no new insights emerged.

Data were analysed using a thematic analysis approach.[134] First, data were read repeatedly, together with the reflective notes. Thereafter, data were coded, forming sub-themes and themes. Themes and sub-themes were then reviewed, refined and defined. Data analysis was performed by the research group to enhance the credibility of the findings.

The instrument development study (Study IV)

An instrument development study was performed according to Boateng et al.'s framework for scale development in healthcare settings.[136] First, a conceptual model was developed and items identified. Second, content validity testing was performed by a group of international experts with a modified Delphi study,[127] leading to item refinement. The scale was then translated to Swedish, back-translated and pre-tested. Third, a cross-sectional study was performed to reduce the number of items and evaluate the scale's psychometric properties.

Instrument development

A conceptual model of patient safety during IHTs in ICU patients was developed based on the SEIPS model's five components of the work system (Table 3). Thereafter, items were generated based on participant observations of the IHT process (n=51) and influenced by existing instruments measuring aspects of patient safety, such as the Safety Attitudes Questionnaire[137] and the Agency for Healthcare Research and Quality survey on patient safety culture.[138] The item pool consisted of 91 items distributed, according to the five dimensions, as follows: 27 teamwork items, 12 transport-related task items, 19 tools and technologies items, 13 environment items and 20 organization items. Prior to content validity testing, the item pool was critically assessed several times by the research group.

Table 3. Conceptual model of patient safety during IHTs

Dimension in the IHT safety scale	Conceptual definition	Characteristics
Teamwork	Individuals such as patients, clinicians or teams of healthcare professionals, acting and performing tasks	Team structure (i.e. size, norms, roles, status, cohesiveness) Knowledge, skills and attitudes among team members
Transport-related tasks	Activities or actions performed during a process	Task complexity, difficulty, ambiguity and sequence Perceived workload
Tools and technologies	Objects used to assist in performing tasks	Usability, functionality, accessibility and familiarity with objects
Environment	Physical work setting where tasks are performed that influence the care process	Physical layout, available space and workplace design Factors that might cause sensory disruptions
Organization	The structure that provides and coordinates time, space, resources and activities	Supervision and management support Attitudes toward safety

Abbreviation: IHT: Intrahospital transport

Item refinement and content validation

The modified Delphi technique mentioned above is a method for collecting expert opinions in order to achieve consensus.[127] Experts were recruited internationally from both research and practical fields to ensure diverse expertise and representation from different geographical areas. Eighteen international experts participated in the first Delphi round, of whom 15 completed the second Delphi round as well. The group of experts were from Europe, North America and Australasia and included critical care nurses, physicians and researchers. Data were collected during February to April, 2019, using an online questionnaire (Webropol Oy, Linköping, Sweden). Experts were asked to rate, for each item, 1) relevance on a four-point scale (not relevant-very relevant) and 2) clarity of wording on a four-point scale (very unclear-very clear). Participants were also asked to make comments and/or suggestions, as well as suggest additional items of relevance. The criterion of item-content validity index (CVI) ≥0.78 for relevance and clarity of wording was used to retain items and scale-CVI

≥0.90 was considered to define good content validity.[139] Based on the experts' ratings and comments, items were revised or deleted and new items were added. After the two Delphi rounds, 57 items were accepted for the final scale and four new items added. The English version of the final set of 61 items had a scale-CVI/Average of 0.90 for relevance (range 0.78-1.00) and a scale-CVI/Average of 0.88 for clarity of wording (range 0.60-1.00).

The item set was translated into Swedish using back translation.[140] First, one professional translator translated the items from English to Swedish. Thereafter, the Swedish version was translated back to English by another, independent, professional translator. The two English versions were compared to check translation accuracy. After minor revisions, the Swedish version of the item set was pre-tested among six critical care nurses for clarity of wording, accuracy and appropriateness. This led to additional refinement of the item set and six items were removed. Thus, the final scale consisted of 55 items, reflecting the five dimensions as follows: 16 teamwork items, 9 transport-related tasks items, 12 tools and technologies items, 9 environment items and 9 organization items.

Item reduction and psychometric evaluation

A cross-sectional study was undertaken, applying a two-stage sampling approach,[135] in order to reduce the number of items and evaluate construct validity and internal consistency. First, every ICU in the Västra Götaland and Stockholm regions was invited to participate (n=26). A total of 12 ICUs accepted the invitation and were enrolled in the study. Both university, county and smaller county hospitals were represented, and the included hospitals had between 193 and 2 300 beds. Participating units were all classified as tertiary ICUs, capable of providing the full spectrum of monitoring and life support technologies. Included ICUs varied in size and had between 5 and 14 beds.

Second, a consecutive sampling approach was used. All healthcare practitioners that had participated in an IHT at the enrolled units were invited to complete a questionnaire. Inclusion criteria were 1) transport of a patient from the ICU to undergo a diagnostic or therapeutic procedure within the hospital and 2) IHT performed by staff from the ICU. Exclusion criteria was 1) transport to a step-down unit or a hospital ward. Healthcare practitioners at the included ICUs received written and verbal information about the study and its purpose. Data were collected anonymously and return of completed questionnaire implied consent. Of the variety of suggestions regarding sample size needed for factor analysis, the recommended ratio of five participants per item (5x55=275) was selected.[141] Thus, a sample of 300 participants was targeted.

Questionnaire

The IHT safety scale was constructed as a self-reported paper-and-pencil questionnaire and included 55 items (as described above). The scale used a bipolar Likert-type rating scale with descriptors measuring five levels of agreement (strongly disagree, disagree, neither, agree, strongly agree).[142] In addition, generic safety and demographic questions were included as follows: four single questions about availability and usability of IHT protocols and checklists and the occurrence of AIs and patient-related complications, and seven questions about patient and transport characteristics. The reason for adding these generic questions was to collect information on existing safety routines and complication/AI rates in our sample.

Data collection

Data were collected for six weeks, from May to the end of June, 2019. At each participating ICU, a research assistant was responsible for recruitment and data collection. After performing an IHT, healthcare practitioners were invited to complete the IHT safety scale. The questionnaire was constructed to be completed anonymously by each participating staff member no more than 72 hours after the IHT in order to avoid recall bias. Completed questionnaires were collected by the research assistant and given to the researcher.

Data analysis

The IHT safety scale was psychometrically evaluated using classic item statistics.[143] Item distributional statistics were performed in order to assess items' contribution and to guide item reduction. Item statistics included variance (i.e. item covered full range of response options), floor and ceiling effects (criterion: <75% endorsement of extreme options), missing data (criterion: <5%) and skewness statistics (criterion: <2.0).[144] Items that did not meet the predefined criteria were further assessed for their theoretical contributions to the dimension and the overall underlying construct (i.e. IHT safety). Missing data were then imputed using linear interpolation.

Exploratory factor analysis (EFA) was performed with the purpose of defining the underlying structure among the variables (i.e. items).[145] This exploratory approach was chosen because the IHT safety scale was a recently developed instrument. Thus, it was unknown whether the structure and the interrelationship among variables would match the *a priori* hypothesized conceptual model. Furthermore, EFA was applied to condense the information obtained from the original variables with minimum loss of information.[141, 145] Hence, the objectives for the data analysis were to reduce and summarize data, as well as to identify the structure of the dataset. The Kaiser–Meyer–Olkin index (criterion: >0.8) and Bartlett's test of sphericity ($p < 0.05$) was used to assess factorability of the correlation matrix (i.e. appropriateness of the dataset).[141] Factor extraction was performed using common factor analysis (principal axis factoring). This method was chosen because the primary objective was to identify the constructs represented among variables and because there was little prior knowledge about the amount of specific and error variance.[146, 147] Factor extraction was informed by the latent root criterion (eigenvalues >1) and visual examination of the scree plot.[141] The factor matrix was rotated using oblique rotation methods, since correlations between factors were expected. The rotated factor matrix was then assessed using a systematic approach consisting of 1) identifying significant loadings (criterion: >0.35 based on sample size) for each variable, 2) identifying variables that cross-loaded (i.e. loaded significantly on more than one factor) and 3) assessing whether the variable reached an acceptable level of explanation by examining communalities (criterion: >0.5).[141] Reliability testing included inter-item correlation for each subscale (criterion: <0.7) and corrected item-total correlation (criterion: >0.3, with >0.7 indicating possible redundancy).[144] The internal consistency reliability of each subscale was evaluated using Cronbach's alpha. Since this was a novel scale, alpha values >0.7 were considered acceptable.[148]

Analytical approach for synthesis of findings

In this thesis, the individual findings from Studies I-IV were considered as a whole, i.e. all findings from all four studies were re-examined with the purpose of gaining a deeper understanding of patient safety during IHT. The analytical process was guided methodologically by theoretical thematic analysis, meaning that themes and patterns in the data were identified deductively, driven by theoretical understanding of the area.[134] This can also be referred to as a theory-driven approach, i.e. data was coded based on an existing theory. A theory-driven approach is suitable when conceptual knowledge about the themes already exists.[149, 150] Furthermore, the analytical process was inspired by a mixed-method triangulation design, the purpose of which is to use different but complementary data to best understand the research problem.[151] This design was used to compare and contrast qualitative and quantitative research findings by bringing the separate results together in the interpretation of the results (i.e. in the overall synthesis of findings).

In this analysis, the SEIPS model was used as a conceptual framework to enhance knowledge and understanding of the issues under investigation (i.e. patient safety during IHT).
First, findings from the individual studies were read and reread in order to gain a rich and full understanding of the data.
Second, an analytical framework was created based on the three conceptual domains in the SEIPS model (i.e. work system, process and outcomes).[43]
Third, findings from the individual studies were mapped onto the analytical matrix.

The analytical process was guided by key questions,[150] based on the SEIPS model and the researcher's prior knowledge and understanding of the data. The key questions included 1) 'What characterizes the different components of the work system during IHT (i.e. teamwork, tasks, tools and technologies, environment and organization)?'; 2) 'Which system factors influence the IHT process and how?'; 3) 'Who are the active and passive agents in the process?'; 4) 'How can the IHT process be described and deconstructed?'; 5) 'What are the outcomes in relation to patient safety and how can they be described?' and 6) 'How can outcomes be measured?'.
Fourth, findings were combined, forming themes in relation to each of the conceptual domains. These were subsequently reviewed, refined and described.

Ethical considerations

The design and conduction of each study included in this thesis followed the ethical principles of the World Medical Association's Declaration of Helsinki.[152] These principles state that medical research should be carried out with respect for the health and rights of the human subjects participating. Accordingly, special attention is required for vulnerable research populations, such as those who cannot give or refuse consent for themselves. Each potential participant must be informed about the study design and aim, including the right to withdraw consent to participate without reprisal. Furthermore, precautions must be taken to respect the privacy of research subjects, such as the confidentiality of patient's information. The ethical principles require that any research project involving human subjects should be submitted for consideration to an independent ethical review committee for approval.[152] All studies in this thesis were reviewed and approved by the Swedish Ethical Review Authority (Dnr 1030-15).

To enable potential participants to give informed consent to participate in a research study, proper information is required. For all studies, potential participants were provided with written and oral information about the study design and purpose prior to data collection. In Study I, due to the nature of the observations and the number of possible participants (all staff at the included units), consent was reconfirmed before each observation. If any participant expressed any degree of discomfort regarding the presence of the observer, the observation was ended. Since the researcher in this study primarily observed healthcare practitioners, no written consent was required from patients. However, all patients that were conscious were asked for their approval before the observation began. Informed written consent was obtained in Studies II and III.

When obtaining informed consent from the patients, the possibility of a dependent relationship to the researcher was acknowledged. The researcher therefore clearly stated that she was independent and not involved in or responsible for the patients' care.

In Study IV, return of completed questionnaires implied consent to participate.

Research projects should be preceded by a careful assessment of predicable risks, in comparison to potential benefit to the studied population or others.[152] In the studies included in this thesis, there was no promised benefit for the participants. However, since the observer in Study I was a registered nurse, she was obliged to intervene if any risk was detected that could harm the patient. The findings from the studies in this thesis could potentially improve the quality and safety of care in clinical practice. Moreover, study findings could also support healthcare practitioners in delivering safe and high-quality care during IHTs, which might benefit their own health and safety.

To preserve the anonymity and confidentiality of the participants, all data in Studies I-III were coded before data analysis. In Study IV, all questionnaires were completed anonymously and could only be identified on the group level (each ICU had a specific code for analytical purposes). Furthermore, the results of each study are presented on the aggregate level without the possibility to identify any individual participant. Data are stored in a locked filing cabinet at the university and will be destroyed ten years after publication.

FINDINGS

In this chapter, a summary of individual study findings is presented, including a description of patient and transport characteristics in the respective study population. This is followed by a presentation of the synthetized findings from the re-analysis of each individual study.

Summary of individual study findings

In Study I, participant observations of IHTs were conducted (n=51). Most of the transports were performed by critical care nurses and assistant nurses (n=44; 86%), and more than half of the IHTs were for CT scans (n=32; 62%). Of the transported patients, most were mechanically ventilated (n=41; 80%) and more than half were given continuous sedation (n=31; 61%) and needed vasopressors (n=26; 51%). The study found that during 51 IHTs, 365 safety hazards were identified (median 7; interquartile range 4-10). The deductive analysis revealed that most hazards were related to tools and technology (n=124). Furthermore, the majority of detected hazards were classified as increasing the risk of harm and compromising patient safety (n=204). The inductive analysis resulted in a description of identified safety hazards, contributing factors and process-related outcomes.

In Study II, 15 critical care nurses and five physicians were interviewed about their experiences of critical incidents during IHTs. The participants had a median of 4.5 years of experience in the ICU (range 0.2-26.0). Together, they described a total of 46 critical incidents. The content analysis of practices related to critical incidents resulted in a description of requirements for safe transports, including organizational prerequisites, professional skills and attributes and actions and behaviours to perform transfers safely. Exploring critical care nurses' and physicians' IHT experiences yielded three main themes: A hazardous process, Performing when it matters and Towards safe practice.

In Study III, a total of 12 ICU patients were interviewed about their experiences of being transported within the hospital. Of these, ten were females (83%) and their median age was 59 (range 41–79). Their median length of stay in the ICU was 3.5 days (range 1-9) and most of the patients were being treated for non-traumatic subarachnoid haemorrhage (n=8; 67%). The thematic analysis resulted in the central theme: In safe hands. This was supported by three main themes: Feeling prepared and safeguarded, Being on the move and Entrusting myself to others.

In Study IV, 325 healthcare practitioners completed the IHT safety scale, with questions about their IHT experience. Of these, 10 participants were excluded because the questionnaires were incomplete or the inclusion criteria were not met. Hence, 315 participants were included in the analysis. The majority were critical care nurses (n=217; 69%) and the median length of their ICU experience was eight years (interquartile range 3-19). Almost two-thirds of the transports were for CT (n=219; 69%). The majority of the IHTs were performed during weekdays (n=249; 79%) and more than half occurred during the day (n=204; 65%). Item analysis resulted in 55 items being reduced to 24. The EFA supported a five-factor solution and the original conceptual model of IHT safety was maintained, with regrouping of some items. The results showed acceptable internal consistency reliability for each subscale (Cronbach's alpha >0.7).

Synthesis of findings

The synthesis of findings from Studies I-IV yielded a description of the work system, the process and the outcomes related to IHTs in intensive care. Furthermore, the synthesis included exploratory findings concerning the construct of patient safety during IHTs, as well as initial psychometric evidence (i.e. construct validity and internal consistency reliability) for the IHT safety scale. Table 4 shows an overview of themes identified according to each domain of the analytical framework.

Table 4. Overview of domains and themes from synthesis of findings

Domain	Themes
Work system	Organizational, environmental and technical requirements
	Knowledge, skills and competences needed
Process	Patients' perspective
	Healthcare practitioners' experiences
	Teamwork and task performance
Outcome	Safety hazards in the work system
	Impact of safety hazards
	Accurately measuring IHT safety

Abbreviations: IHT: Intrahospital transport

The work system

The work system refers to the structure of the healthcare delivery system, and hence the contextual factors influencing the IHT process. Overall, the findings revealed system failures (i.e. deficits in the structure), as well as prerequisites enabling safe task performance. The IHT work system is described in the following two themes: Organizational, environmental and technical requirements and Knowledge, skills and competences needed.

Organizational, environmental and technical requirements

The organization is the structure providing resources and support. The inductive analysis of safety hazards during the IHT process showed that limited human (and other) resources, high workload and unclear transport routes, as well as lack of cooperation between hospital units (e.g. poorly coordinated schedules, delays) influenced the process and constituted a risk (Study I). In Study II, critical care nurses and physicians stated that availability of resources was important for safe transfers, as well as to maintain safety and quality of care in the ICU. Since IHT required allocation of human resources from the ICU, participants recognized that while an IHT was under way, the workload and responsibility increased for the remaining staff in the ICU, especially during nights and weekends when the staffing level was lower. In order to spend as little time as possible in 'transit' (i.e. outside the ICU), coordination between the ICU and the receiving unit was highlighted as important. In regard to organizational support, participants emphasized the importance of leaders and managers who were proactive in addressing safety hazards before any incident occurred.

In Study I, poor equipment design and lack of technical solutions resulted in hazards such as equipment errors and equipment-related mishaps. Moreover, poor workplace design in the ICU and destination sites, as well as poor planning of the overall hospital setting, contributed to hazards such as lack of physical space to perform tasks. Obstacles in the surrounding environment were frequently observed when the IHT team was navigating through hallways to reach the destination. In Study II, critical care nurses and physicians emphasized they had to trust that the design of the work system, including the technology used, would support their task performance during IHTs. Participants noted it was an advantage to use the same type of equipment during transport as in the ICU. In order to minimize transport time, but also to be near additional resources if needed, a hospital design with the radiology department located near the ICU, and preferably without transport routes requiring elevators, was suggested.

In Study IV, the selected organizational items comprised statements concerning coordination of IHT preparation, availability of staff resources and the ability to perform IHT tasks uninterrupted. Items reflecting the IHT environment included physical layout and design, as well as items concerning facilitating safe transport routes and the ability to maintain the patient's privacy. Items selected regarding technical requirements (referred to as tools and technology) included reliability and safety of transport equipment, as well as supporting functions such as the ability to monitor the patient. Thus, these items were selected because they exhibited variability (i.e. acceptable distributional statistics) and correlated with each other (i.e. loaded on the same factor), indicating that they measured the underlying constructs of organizational, environmental and technical requirements for safe IHT performance. The participants in Study IV generally scored high on a scale from one to five (i.e. agreed) on items reflecting patient safety related to organizational aspects (mean 4.1-4.5), the IHT environment (mean 3.6-4.0) and tools and technology (mean 4.3-4.5).

Knowledge, skills and competences needed

In Study II, knowledge and experience in performing transport-related tasks, and the individual skill to anticipate and predict possible scenarios that could occur, were highlighted by participants as important in order to perform transfers safely. Furthermore, the collective competence of the transport team was important so that all relevant tasks could be performed. If the patient's condition so required, critical care nurses described that they felt comfortable when two nurses participated in the IHT because then they knew that they could be assisted in performing specific nursing tasks. Safety hazards highlighted in Study I included teamwork deficiencies such as cooperation problems and poor team management, which might be influenced by lack of experience or lack of non-technical competences in individual team members, but could result from lack of organizational support.

In the development of the IHT safety scale (Study IV), knowledge, skills, and competences needed to perform transfers safely were represented in the transport-related task and teamwork subscales. Selected transport-related task items included sufficient skills in the transport team, individual knowledge of task performance and a shared understanding of task sequence. Teamwork was represented by items regarding confirmation and recognition of team roles and responsibilities and safe information transfer between team members. As described in the previous section, distributional statistics and factor loading indicated that these items measured the underlying constructs of transport-related tasks and teamwork requirements for safe IHT performance. The participants in Study IV rated their experience of teamwork and transport-related tasks positively overall, with mean values for the respective subscale ranging from 3.8-4.4 (teamwork items) and 4.5-4.8 (transport-related task items).

The process

The IHT process can be described as actions and activities performed by healthcare practitioners after informing and consulting with the patient. The overall findings showed that the healthcare providers were the primary active agents in the process since the transport team performed most of the transport-related activities. Others, such as the patient, relatives or staff at other units in the hospital, could act as co-agents, that is, as indirect contributors that are recognized in their presence. Importantly, the role as a passive co-agent can shift to that of an active agent in the course of a process. As an example, if the patient can perform some of the transport-related work activities, he or she should be acknowledged as an active agent. Moreover, radiology staff might be active agents at a given time in the process (i.e. in performing the examination). In this thesis, experiences of the process have been investigated from the patients' (Study III) and the providers' (Study II) perspectives. The synthesis of the findings resulted in the following three themes: Patients' perspective, Healthcare practitioners' experiences and Teamwork and task performance.

Patients' perspective

The patients' perspective on IHT was significant because the patient is the person who should feel safe and have confidence in the staff despite the unfamiliar environment. Investigating patients' perceptions of the IHT process in Study III resulted in a central theme: In safe hands. Hence, patients felt safe and secure during the IHT process and entrusted themselves to the ICU staff. To entrust oneself to others included to hand over the control and decision-making, and to rely on others to look after one's interest. Nonetheless, patients described that they were satisfied with the IHT process. This was influenced by factors such as being informed about and prepared for all the steps in the process and the notion that the staff stood by their side and protected them if needed. Therefore, patients valued and emphasized the importance of the being transported by staff from the ICU since they trusted skills and competences of the staff. Notably, patient's memories of the actual transfer were often faint. Expressed worries and concerns were often related to the patients' disease and the results expected from an examination or intervention. Furthermore, they were seldom concerned with the reason to why they needed to be transported and thus accepted that IHTs was a necessary process during their ICU stay.

Healthcare practitioners' experiences

The analysis of critical care nurses' and physicians' experiences of IHTs in Study II showed that caring for critically ill patients outside the ICU setting was associated with worries and concerns, such as being far away from colleagues and other resources if the patient's condition should deteriorate. Moreover, they often expressed concerns about the patient's wellbeing and safety. For example, they were aware of the possibility that the transfer itself could cause more harm to the patient than the possible benefits of the examination. If an incident (i.e. a significant event) did occur, one of the consequences described was that the team had to divert their attention away from the patient in order to solve the problem. They were often determined to continue the IHT despite problematic events, but reflected afterwards that it might have been better to abort the transport. Despite described worries and concerns, the participants felt confident that they would act effectively and in a timely fashion if an incident occurred. Actions undertaken during an incident were often perceived as adequate under the circumstances. However, in reflecting on a critical IHT incident, participants could often identify actions that might have prevented the incident from happening. In order to improve safety during IHTs, the importance of addressing hazards before they caused patient harm was often stressed. This required actions by the individuals performing the IHT (such as enhanced collaboration and teamwork), organizational improvements (as described previously) and altered attitudes to safety, such as considering the IHT to be a high-risk process and acting accordingly.

Teamwork and task performance

Teamwork during IHT was essential since the critically ill patient is dependent on the staff to perform the transport safely. The inductive analysis of safety hazards during the IHT process showed that teamwork was influenced by high team member turnover, lack of human resources and time pressure. During the IHT, uncertainties regarding team roles and unclear or overlapping responsibilities between transport team members (or between teams from different units) affected the team's work. After the IHT, there was often a lack of teamwork, since the team members quickly became re-assimilated with the rest of the workforce. Furthermore, standardized communication tools were not routinely used, which contributed to safety hazards (Study I).

In the interviews with critical care nurses and physicians, teamwork was described as crucial. Behaviours and actions, such as cooperating and communicating, leading the team and adhering to the assigned team role, were important to perform transports safely. Moreover, trust in one's team was necessary in order to feel safe when caring for patients in settings outside the ICU. This included trusting fellow team members to have knowledge about their team role and act accordingly if an incident occurred. Moreover, teamwork during IHT was described as dynamic and changeable, depending on the situation. Hence, the value of supporting each other was often highlighted. Critical care nurses and physicians described their roles and responsibilities during the IHT differently. They also had different expectations regarding interprofessional teamwork. Critical care nurses often stated that they wanted more interprofessional collaboration, whereas physicians expressed satisfaction with the current situation (Study II).

"Tasks" refers to all specific actions and activities undertaken in preparing and performing the IHT, and when resettling the patient back at the ICU. The inductive analysis of safety hazards during the IHT process in Study I revealed that in preparing the patient for the IHT, situations often occurred when the transport team did not have the time to dedicate themselves to the transport-related tasks. This resulted in hazards such as disturbances, interruptions and conflicting tasks. Lack of user-friendly protocols and sometimes limited experience of transport-related tasks contributed to uncertainty in how to perform tasks, as well as ambiguities in regard to task prioritization and task sequence, both of which are safety hazards. Moreover, some transport-related tasks were complex per se and the task itself thus constituted a hazard. Moving the patient from the ICU bed to the examination table or handover procedures that required oral reports to be given while patient care was ongoing are examples.

In the interviews with critical care nurses and physicians in Study II, task performance during IHTs was described as demanding, involving heavy lifting and unsuitable working positions. IHT-related work, for instance when unpredicted incidents had occurred or the realization that their absence would increase the workload for the remaining ICU staff, was also described as causing stress among participants. In Study IV, two-thirds of the participants had an IHT protocol to inform them about routines (n=237; 75%). Of these, 36% strongly agreed that the protocol facilitated their work (n=85). Only one-third responded that they had used a checklist during the IHT (n=84; 27%), but the majority of this group strongly agreed that it had facilitated their work (n=54; 64%).

Outcomes

Outcomes can be described as states or conditions resulting from the work process.

During the IHT process, outcomes can be related to the patient, the professionals and the organization. In this analysis, identified safety hazards are defined as an outcome of the IHT process, while acknowledging that they also represent a description of the work system. The synthesis of the findings resulted in three themes: Safety hazards in the work system, Impact of safety hazards and Accurately measuring IHT safety.

Safety hazards in the work system

In Study I, 365 safety hazards during 51 IHTs were identified. The deductive analysis of safety hazards resulted in a classification according to the five components in the SEIPS models work system: 61 team hazards, 83 task hazards, 124 tools and technologies hazards, 48 environment hazards and 49 organization hazards. Figure 3 shows the distribution of identified safety hazards across the work system.

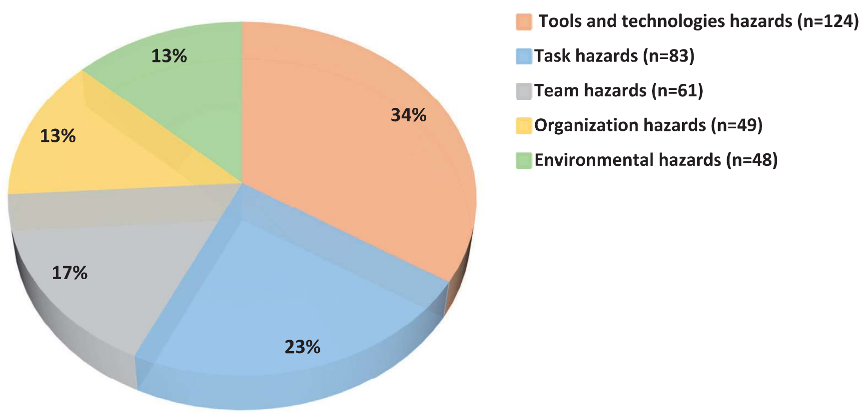

Figure 3. Safety hazards in the work system

The inductive analysis of safety hazards yielded a description of process-related outcomes. Team hazards resulted in ineffective teamwork such as loss of information between team members or tasks not being performed as intended. Task hazards, particularly disturbances and interruptions when preparing the patient for the transport, resulted in digressions from routines such as skipped safety checks, as well as to extended preparation time. Technology-related hazards resulted in equipment errors, mishaps such as disconnection of tubes and cords, as well as stressful situations for involved staff. Importantly, poor equipment and workplace design often led to workarounds, since the staff knew by experience that errors could occur. Furthermore, hazards in the environment resulted in difficulties in task performance and unsatisfactory working conditions. Hazards related to the organization, such as limited resources and lack of cooperation, resulted primarily in delays and extended transport duration, but also affected staff health and safety (Study I).

Impact of safety hazards

In Study I, the 365 identified safety hazards were classified according to a modified version of Battles and Lilford's conceptual model of patient safety events. The majority were classified as increasing the risk of harm (n=204), followed by minor hazards resulting foremost in process-related outcomes (n=81), no-harm events (n=21) and observable AEs (n=3). In Study IV, 7% of participants responded that they had experienced an AI during the IHT (n=22). However, only 0.6% of the participants responded that the patient had experienced a transport-related complication (n=2).

Accurately measuring IHT safety

In Study IV, after the consecutive steps of item generation, scale development and content validation, 55 items were included for psychometric evaluation. Items were reduced based on distributional statistics, initial reliabilities and factor loadings. The final scale consisted of 24 items. The EFA yielded a five-factor solution (explaining 59% of variance). All items loaded significantly on only one factor (i.e. loadings > 0.35). Items identified for each dimension of the IHT safety scale loaded together differently from prior expectations and some items were therefore transferred to new groups. Based on the content of the items, the five-factor solution still supported the conceptual model of the work system as follows: organization (6 items), tools and technologies (5 items), transport-related tasks (4 items), environment (5 items) and teamwork (4 items). Internal consistency reliabilities were acceptable, with Cronbach's alpha ranging from 0.72 to 0.82 for each subscale (i.e. factor) and the corrected inter-item and item-to-total correlations were mostly within the desired range of 0.3-0.7. Table 6 shows characteristics of the 24-item version of the IHT safety scale.

Table 5. Characteristics of the 24-item version of the IHT safety scale

Subscales and items	**Loading**	**ITC**	**α if item deleted**
Organization (α=0.82)			
We had sufficient staff resources to prepare for the transport.	0.78	0.68	0.78
We had enough time to prepare for the IHT.	0.77	0.61	0.80
We had sufficient staff resources to settle the patient back in the ICU.	0.67	0.61	0.79
I was able to perform IHT tasks without being interrupted.	0.59	0.59	0.80
We had enough time to settle the patient back in the ICU.	0.54	0.51	0.81
IHT preparation in the ICU was well coordinated.	0.49	0.58	0.80
Tools and technologies (α=0.79)			
The transport equipment met the requirements to perform the transport safely.	0.79	0.59	0.75
The transport equipment was reliable.	0.76	0.60	0.75
It was easy to monitor the patient throughout the IHT.	0.67	0.66	0.72
Audible alarms supported my work in monitoring the patient.	0.48	0.51	0.77
Medical tools (IV lines, tubes, cords, and so on) were suited to the intended purpose.	0.47	0.52	0.77
Transport-related tasks (α=0.82)			
The skills of the staff in our IHT team overlapped sufficiently so that work could be shared when necessary.	0.90	0.70	0.76
Individual team members knew what tasks they had to perform.	0.72	0.73	0.74
We had a shared understanding of the task sequence during the IHT.	0.65	0.68	0.76
I felt supported by the other team members.	0.48	0.51	0.83

Subscales and items	Loading	ITC	α if item deleted
Environment (α=0.77)			
Hallways were free from obstacles.	0.89	0.61	0.70
The physical layout of the hospital facilitated safe performance of the transport.	0.73	0.62	0.70
Rooms at the destination sites were designed for ICU patients.	0.56	0.54	0.73
The physical layout of the ICU facilitated preparation for the transport.	0.38	0.48	0.75
We were able to maintain the patient's privacy during the transport.	0.37	0.46	0.75
Teamwork (α=0.72)			
We confirmed each other's responsibilities.	0.71	0.62	0.60
We gave each other feedback throughout the transport.	0.65	0.50	0.67
A team leader was clearly recognized.	0.52	0.47	0.69
All team members were present when transfer information was shared.	0.51	0.50	0.68

Abbreviations: IHT: Intrahospital transport; ITC: Item-to-total correlation (corrected); α: alpha

Summary of synthesized findings

The findings show that deficiencies in the work system structure, such as lack of resources, high workload and limited hospital coordination, influence the IHT process. Poor equipment and workplace design were also factors contributing to critical incidents. Patients nonetheless experienced the IHT process as safe because they trusted the staff to care for them. The healthcare practitioners, however, perceived the transfers as a demanding and sometimes unsafe activity. Team members' competences and skills, such as anticipating, predicting, planning and preparing for unexpected events, were identified as important factors contributing to safe transfers. In terms of outcomes reflecting patient safety, the findings demonstrated that safety hazards exist during the pre-, intra- and post-transport phases. These can be related to teamwork, transport-related tasks, tools and technologies, the environment and the organization. Identified hazards resulted in process-related outcomes such as ineffective teamwork, digression from safety routines, equipment-related errors and mishaps, workarounds, delays and extended transport time. Finally, the findings yielded evidence of construct validity and internal consistency reliability of the IHT safety scale, a new tool for accurately measuring patient safety.

DISCUSSION

In this chapter, the main findings from the synthesis are discussed and interpreted in relation to existing patient safety literature and research, followed by methodological considerations. This latter section includes reflections on the contribution of the SEIPS model to understanding patient safety during a complex healthcare process, trustworthiness of qualitative research findings and validity and reliability aspects of the IHT safety scale.

Reflections on the findings

System deficiencies and required competence

In this thesis, findings showed that lack of resources, high workload and limited hospital coordination affected the IHT process. Furthermore, poor equipment and workplace design influenced staff performance and could also contribute to AIs during the IHT. These deficiencies during the IHT process can be attributed to the system input,[25] i.e. the preconditions in a system influencing performance. From a Safety-I perspective, each system has safety barriers (defensive layers) that may prohibit the trajectory of an accident.[22] These deficiencies can contribute to AIs and/or create long-lasting weaknesses in a system (e.g. unworkable procedures or design and construction deficiencies).[22, 23] From a Safety-II perspective, the increased complexity in the structure of healthcare delivery systems has been acknowledged. This requires an understanding of how a system works, and of how different system elements interact and influence each other. This understanding can be developed by looking for patterns across events rather than focusing on identifying the contributing factor to single accidents.[153] Although the theoretical understanding of the system input differs between these two safety perspectives, both include proactive rather than reactive safety management. Importantly, system deficiencies described in this thesis result from exploring work-as-done (i.e. how work actually occurs) during the IHT process, as well as by identifying factors contributing to AIs (i.e. long-lasting weaknesses).

One consequence of deficiencies in a system is that healthcare practitioners tend to adapt their work accordingly. Hence, they continually adjust their work in order to overcome obstacles and provide the best and safest care possible to each patient. This is also known as workarounds, which have been described as actions performed by individuals to cope with system design flaws.[154] However, workarounds are problematic as they can be a strategy to manage system failures without addressing their underlying causes. Moreover, frequently undertaken workarounds can become embedded in a patient care process and therefore be considered to be norms and standard practice.[155] Workarounds may also be known to experienced staff that are familiar with norms and practice at their workplace, but might not be apparent to new staff, which may compromise patient safety. Identifying and correcting system deficiencies might therefore contribute to minimizing the occurrence of workarounds in clinical practice. The studies in this thesis found that system requirements for safe IHTs include sufficient and timely resources, transport equipment that meets the needs of users, as well as a workplace design that supports healthcare practitioners' work.

The findings in this thesis revealed that the transport team members needed sufficient knowledge, skills and experience. This was important both to ensure that all transport-related tasks could be performed and for staff to feel supported if an incident did occur. Hence, staff resources must be evaluated not just from a quantitative perspective (i.e. minimum number of staff required), but also from a qualitative perspective (i.e. competence in technical and non-technical skills). The competence level among staff performing IHTs and the occurrence of AEs has previously been investigated with diverse results.[86, 89, 156] One study found that the AE incidence was lower when a senior physician rather than a junior physician participated in the IHT.[89] However, another study found no such difference.[86] One prospective observational study showed that there was no difference in complication rates with or without physicians present during IHTs of critically ill cardiovascular patients.[156] This study further concluded that the interventions needed to respond to patient complications did not require a physician's presence. The studies in this thesis were undertaken in a Swedish context in which critical care nurses often perform IHTs without physicians, and often together with assistant nurses. Although these studies were not designed to investigate the association between competence level and AE incidence, the findings indicate that most IHTs can be performed safely by critical care nurses. The required staff resources and competences may vary according to the needs of the patient being transported and/or the complexity of the examination or intervention. Hence, suggesting a fixed number of staff might be a simplistic solution, that also potentially wastes valuable human resources and compromises the safety of patients remaining in the ICU. However, clinical decision support, such as IHT triage systems, might assist in identifying the requisite skills and thus in allocating the appropriate human resources.

Implications of patients' experiences for IHT practice

The findings in this thesis demonstrated that patients' memories of the transfer process were faint, although they perceived movements and changes in the surrounding environment. From a quality and safety perspective, they felt safe and secure during IHTs. Feeling safe has previously been identified as an important psychosocial need in ICU patients, and vital during recovery from critical illness.[157, 158] The findings in this thesis furthermore showed that patients trusted the staff to look after their best interests. Being informed and prepared during the process was identified as a factor contributing to a positive IHT experience. This concurs with a systematic review by Wassenaar et al. identifying that nursing care, including taking the time to communicate and provide patients with information about what was happening to them, was the factor reported most frequently when it came to promoting ICU patients' feeling safe.[159] In human factors engineering, the patient is central in the healthcare system, and their capabilities and performances must be supported through the work system design.[42] Patient involvement in patient safety activities has nonetheless been an underappreciated area in both Safety-I and Safety-II, because most approaches and models still focus on healthcare professionals as the central actors in a healthcare system.[160] The findings reported in this thesis are therefore valuable in understanding how the patient perceives the IHT process, and might inspire new actions and activities that promote patient safety.

The findings in this thesis revealed that the patient primarily acted as a co-agent during the IHT process, i.e. indirectly contributing foremost by their presence. A scoping review by Olding et al. concluded that patient participation and involvement is a concept that has not been extensively explored in critical care research.[161] The authors also identified barriers to patient participation and involvement in the ICU setting, including the high-technological ICU environment, objectification of ICU patients, limited abilities to communicate due to critical illness and intubation, as well as assumptions around cognitive ability.[161] Although both the studies in this thesis and previous research confirm that ICU patients' participation has been limited, currently there is a shift towards the patient-centred model of care, including in critical care settings.[162] Moreover, current critical care guidelines advocate the use of effective analgesia and minimal sedation to optimize ICU patients' recovery and outcomes.[163] Thus, these trends in clinical practice might enable patients and their families to be more involved in the care process, including during transfers. This may be beneficial from a patient safety perspective, because patients and their relatives constitute the last safety barrier in the complex healthcare system. Patients educated in their own care or trained in complex technical tasks can detect and prevent errors and AIs.[164] However, enabling patients and relatives to act accordingly requires transparency and awareness of existing risks and hazards, as not informing patients denies them an active role in risk management.[165] This can be problematic. One study investigating physicians' and patients' attitudes regarding disclosure of AEs and near misses found that both physicians and patients thought that harmful events should be disclosed. However, when it came to near misses, patients had mixed opinions: some thought that finding out about a near miss would be upsetting and most physicians opposed full disclosure because this could diminish the patients' trust.[166]

Facilitating safe task performance and teamwork

Professional work during IHTs is demanding, due to the severity of the condition and instability of the transported patient, and since the work is highly dependent on technical equipment and may require interprofessional teamwork and collaboration between specialities. The research in this thesis identified non-technical skills for safe IHT performance. These included collaboration and communication among team members, adhering to team roles and team leadership, as well as anticipating and predicting possible scenarios that might occur and preparing accordingly. These findings concur with previous research finding that non-technical skills, particularly teamwork, were associated with effective and safe healthcare delivery.[167-169] Moreover, one study investigating the association between teamwork, safety climate and AEs during IHTs demonstrated that teamwork was an important determinant for the occurrence of IHT-related AEs.[170] Thus, both the findings in this thesis and previous research indicate that non-technical skills are important in performing IHTs safely and should therefore be supported in clinical practice. Interestingly, teamwork was described as a dynamic process in this thesis findings, with team roles and related responsibilities changing depending on members' competences and occurring situations. In addition to the importance of non-technical skills for safe task performance, team adaptability (i.e. a team's ability to adjust strategies and relocate intra-team resources) has been described as one of the core dimensions of teamwork.[171] Hence, this thesis findings have confirmed that dynamic teamwork and flexible team roles might enable the IHT team to successfully adjust their work to suit the prevailing conditions.

The findings further showed that task performance during IHT is often complex and demanding, affected by disturbances and interruptions, as well as ambiguities concerning tasks and their performance. Hence, healthcare practitioners must perform IHT-related tasks in parallel with other tasks (i.e. multitasking) and are also exposed to interruptions. Interruptions and multitasking have previously been reported to reduce individuals' task performance,[172, 173] and interruption during complex tasks increases the risk of errors.[172] However, studies have also demonstrated that multitasking is a strategy frequently used by clinicians to handle complex demands and manage their workload.[174, 175] Multitasking has also been assessed as a positive attribute and a necessary skill to provide optimal care.[175] Although multitasking is one way of coping with demands such as workload and interruptions, the findings in this thesis implicate that interruptions during IHTs compromised patient safety.

Checklists, implementation of standardized communication tools, training and educational activities may contribute to strengthening both technical and non-technical skills during IHTs. Both checklists and standardized communication tools (such as closed-loop communication and reporting algorithms) are well-validated safety science techniques to improve performance.[176, 177] In the field of IHT research, checklists have been implemented and evaluated, with results indicating positive effects on patient safety.[83, 109, 113] IHT checklists often focus on the preparation phase and include items related to transport equipment, medication, the patient's clinical stability and coordination of staff resources.[83] The findings in this thesis supported the use of IHT checklists in clinical practice. Checklists should probably include items targeting identified task hazards such as disturbances, interruptions, complexity and sequence ambiguity. Furthermore, the importance of anticipating and preparing for potential safety threats should be highlighted in future safety-promoting tools.

Findings from this thesis revealed that knowledge and experience in performing transport-related tasks was important. Educational solutions to potentially address issues that increase risks for patients during IHTs have previously been explored.[178] One qualitative interview study identified training as an underappreciated area. The authors emphasized that training courses must match the reality of day-to-day practise, and that training should involve the different specialities participating in the patients' care.[178] Another safety solution is the deployment of specialist transport teams,[88, 179] an approach commonly used during transports between hospitals.[180] One study of IHT demonstrated that the rate of clinically significant AEs (e.g. changes in vital signs, unplanned extubation or cardiac arrest) was relatively low (1.7%),[88] compared to other studies applying similar definitions.[181, 182] However, this study was single-centred and retrospective; the potential benefits of specialized transport teams must thus be evaluated in prospective and comparative studies. More recently, the possible role of rapid response teams in performing IHTs of ICU patients has been investigated.[183, 184] The potential benefits of dedicated transport personnel includes enhanced competence and experience in performing transport-related tasks. This solution also allows for staff to remain at the ICU, which might have an overall positive effect on patient safety. However, as described previously, the findings in this thesis have identified patients knowing and trusting the ICU staff to look after their interests as one contributing factor to their feeling safe. If future research demonstrates that IHT performance by a specialist transport team provides better outcomes in terms of quality and safety, it might nonetheless be a solution to consider.

Overall, the research in this thesis found that healthcare practitioners are the primary active agent during the IHT process, since the transport team performed most of the transport-related activities. The findings thus highlight the important role of healthcare practitioners, for example in identifying and correcting safety hazards before they cause actual patient harm. From a Safety-I perspective, clinicians act as the last safety barrier in the dynamic and complex healthcare system.[22] However, from a Safety-II perspective, safe task performance is attributed to healthcare practitioners' resilience. Hence, things normally go right because practitioners can adjust what they do to match the conditions.[29, 185] As a consequence, standardization of care processes (such as checklists and routines) do not always contribute to safe practices.[160, 186] Instead, proactive safety management in a complex healthcare system should focus on how everyday performance is usually successful, embrace the diversity of staff performance and increase staff resilience capacity by supporting them in anticipating changes.

Present and future measurement of IHT safety

In this thesis, safety hazards during ICU patients' IHTs were identified related to 1) tools and technologies, 2) transport-related tasks, 3) teamwork, 4) the organisation and 5) the environment. These findings concur with previous research findings that IHT-related safety hazards are common and often related to equipment.[2, 3] Exploring and describing safety hazards during IHT is beneficial because it provides an in-depth understanding of the IHT process, allowing for proactive safety management. Identification of safety hazards also provides opportunities to correct them before they cause actual patient harm. Interestingly, the findings in this thesis further indicated that few safety hazards resulted in AEs. This could be explained by the fact that the healthcare delivery system in which this research was undertaken had functioning safety barriers despite existing safety hazards. However, it could also be attributed to individual team members' resilience, i.e. their capability to adjust and adapt their work according to the conditions. Furthermore, it has been proposed that safety is dynamic rather than static, and that healthcare systems are complex and adaptive rather than traceable and deterministic.[160, 187] In that sense, it could be argued that 1) systems are too complex to be described in a meaningful way and 2) since it is not possible to foresee and thus eliminate all potential safety hazards, the focus for patient safety management should be on supporting individuals' resilience.[29, 160] One way of supporting performance variability and everyday work in clinicians during IHTs is addressing system deficiencies, including correcting the existing safety hazards identified in this thesis.

Thus, the author of this thesis argues that safety hazards as an outcome measure provide opportunities for improvement and might influence system redesign. But are they a good indicator for patient safety during the IHT process? The findings provide evidence that most hazards were not associated with AEs. Furthermore, when healthcare professionals were questioned about their IHT experience, less than 1% reported that the patient had experienced a transport-related complication, although the accuracy of this claim could not be validated. However, several previous studies have provided evidence that complications are common during IHTs. For example, an observational study by Jia et al. found that complications occurred in 80% of transfers.[85] The discrepancy between the findings presented in this thesis and those of previous research might be attributed to 1) normalization of complications and AIs during IHTs or 2) limitations in study design when it came to ascertaining the 'true' incidence of AIs and IHT-related complications. First, it is possible that healthcare practitioners view patient complications (such as respiratory and circulatory disorders) as normal events during IHTs. In safety sciences, normalization of deviance is defined as when people within an organization become so accustomed to deviances (or latent system failures) that they consider them to be normal occurrences.[188, 189] As a result, when practitioners no longer regard events as untoward, these latent errors become imbedded in the healthcare system and enhance its vulnerability.[188] Second, survey data might not provide a reliable and valid measure of complications and AIs; a comparison of the results in this thesis and those of previous research should thus be carefully interpreted.

One fundamental aspect of improving patient safety is the need to first measure it, although measuring safety can be complex, because the concept of safety is multidimensional.[38] Patient safety is also a part of the broader concept of quality in healthcare. Therefore, measurement of quality of care and patient safety are often interrelated. Patient safety can be evaluated via various process or performance measures (i.e. assessing whether providers perform activities within a given process) and outcome measures (e.g. mortality, morbidity or other relevant patient-related outcomes).[38] The choice of appropriate measures depends on the purpose; multiple approaches are often warranted. For example, quality registry data might be useful for comparing safety in hospitals and clinics but might provide limited information on emerging safety threats.[35] The findings in this thesis provide initial evidence of the content and construct validity and internal consistency reliability of the 24-item version of the IHT safety scale. The scale aims to measure structures of the healthcare delivery system, known to influence both the process and outcomes of care.[43] Furthermore, the IHT safety scale aims to measure patient safety from the perspective of something that is present rather than absent. Thus, scale items are positively worded and participants are asked to what extent they agree with statements concerning, for example, availability of resources. This is in line with the Safety-II perspective that defines safety as the presence of abilities.[186] Thus, the IHT safety scale might be useful to identify system strengths and limitations that can contribute to safety improvements. Responses to the IHT safety scale could also serve as predictors or indicators of IHT safety and therefore be used to evaluate the effectiveness of safety interventions. However, the IHT safety scale needs further psychometric evaluation, such as testing its dimensionality using confirmatory factor analysis (CFA).[136] The research reported in this thesis has nonetheless resulted in a preliminary scale to measure IHT safety, which might be a valuable and useful tool in clinical practice.

Methodological considerations

The overall methodological approach in this thesis was ethnographic, aiming at exploring ICU patients' IHT process, and it generated a rich description of the process. Furthermore, data was collected with several methods (i.e. interviews, observations and surveys) and from multiple sources, allowing for data triangulation. Thus, comparing data from multiple sources and with several approaches led to a more comprehensive and nuanced understanding of the research problem, that emerged in the synthesis of findings.[151]

The theoretical framework

In this thesis, the SEIPS model served as a theoretical framework.[42-44] It was particularly useful in guiding the data analysis in Study I, developing the conceptual model in Study IV and guiding the analytical approach for the synthesis of findings. In the latter, the SEIPS model contributed to gaining both a deeper and a broader understanding of the research problem, meaning a deeper understanding of the different components of the work system (i.e. teamwork, transport-related tasks, tools and technologies, environment and organization), as well as of the process and outcomes in relation to patient safety during IHTs of ICU patients. Furthermore, insight and knowledge were obtained concerning how these elements are related, how they influence and inform each other and how patient safety (i.e. the whole) was affected.

The limitations of the SEIPS model have previously been described, and include its complexity compared to other human factors engineering frameworks, lack of research on the feasibility and usability of the model in clinical practice (e.g. for risk assessment) and limited empirical evidence of SEIPS-based quality and safety interventions.[41] During the research underlying this thesis, it became evident that the model was limited when it came to understanding some aspects of patient safety from a Safety-II perspective. This was because the SEIPS model assumes that a given system can be described meaningfully, and that hazards can be identified and the system redesigned. In Safety-II, one of the core aspects in understanding safety is the assumption that healthcare systems are complex and adaptable.[29] This means that the focus should shift to understanding performance variability and system resilience. From a Safety-II perspective, the observations in Study I might have been analysed investigating 'what went right' instead of 'what went wrong' (i.e. identifying hazards). However, there are also some similarities. In the SEIPS model, it is just as important to support the work of the actors within a given process as it is to reduce hazards. Moreover, in SEIPS 2.0, the dynamic and interactive properties of the system are emphasized and the concept of adaption is introduced.[42] Adaption is described as a feedback mechanism with which dynamic systems decrease the gap between actual and ideal performance.[42] The interviews regarding healthcare professionals' experiences of IHT in Study III yielded a description of safety requirements. Importantly, the ethnographic design applied in Studies I-III allowed collection of data concerning people's actions in their everyday context,[121, 190] providing knowledge of and insight into work-as-done, rather than work-as-imagined, during the IHT process of ICU patients. Furthermore, while acknowledging that theoretical models might simplify the complex and adaptive structure of the healthcare system, the author argue the importance of exploring the IHT structure (as in Studies I and IV). This is because the structure provides prerequisites for safe and unsafe practices; addressing limitations in the system structure will thus potentially also support variability and flexibility in everyday work.

Trustworthiness of qualitative research findings

The trustworthiness of qualitative research findings are hereafter discussed, related to the concepts of credibility, dependability, confirmability and transferability.[191] Credibility refers to the truth value and consists of two aspects: research should be conducted so that credibility is enhanced and findings should be presented so that credibility is demonstrated. Dependability refers to whether findings would be consistent if the enquiry was replicated. The concept of confirmability refers to the neutrality or objectivity of research findings (i.e. accuracy, relevance and meaning of data). Finally, transferability refers to the degree to which research findings can be applied in other contexts and settings.[122, 191]

The ethnographic approach used to collect qualitative data in this thesis acknowledges that the researcher cannot be fully neutral to the phenomenon of interest or the research subjects under investigation.[121] Therefore, a reflexive approach was applied,[126] strengthening both the credibility and confirmability of the research findings.[122] During the fieldwork, the researcher used a field diary to record assumptions and preconceptions that might have shaped observations and therefore influenced the analysis. Moreover, reflective notes were taken both during observations and interviews. During data analysis, the researcher's pre-understanding and perception of how the research process had influenced her were constantly acknowledged and reflected upon. This was further enhanced by the other members of the research group questioning the interpretations. Although pre-understanding may affect the neutrality of research findings (i.e. confirmability), the researcher's background as a critical care nurse helped her understand the concepts of IHT safety; furthermore, she engaged in reflection in order to ensure that this pre-understanding did not bias the interpretations.

A purposive sampling approach, aiming for maximum variation, was used for the observations and when recruiting critical care nurses and physicians. Variability is expected in qualitative research and may strengthen the results.[122] Inclusion of atypical and non-normative situations enhances the variability of research findings. However, data were collected at a single hospital and observations were carried out on weekdays by one observer, which might have limited the variability. The interviews with critical care nurses and physicians relied on their recollection of critical incidents and it is possible that their memories might have been distorted. Moreover, the number of recorded critical incidents (in total 46) might be considered as too low to accurately represent participants' behaviours. However, they were described in detail, and previous research has suggested that fewer events than the number originally recommended by Flanagan can be sufficient.[192]

A consecutive sampling approach was used to recruit patients for interviews and data were collected at two time-points because there were fewer eligible patients during the study period than expected. Consequently, purposive sampling was not feasible. The interval between the two data collection periods was due to the need to apply for ethics and hospital approval to continue data collection. It is possible that patients' experiences might have been influenced by other factors (such as any changes in practice between the two time-points). However, data collected during the two periods did not differ much, and it seems unlikely that participants' experiences were influenced by any external factor. Patients also described how they had difficulties recalling and remembering their IHT experience. These limitations must be taken into consideration when interpreting the interview responses. Future research, using other study designs and/or recruitment strategies, should therefore be considered in order to confirm these findings.

To further enhance the creditability and dependability of the findings, follow-up questions were asked during interviews in order to ensure understanding, and the researcher performed repeated observations of the same event. In addition, emerging findings were confirmed by participants at the included ICUs.[191] It is possible that participants changed their performance during observations due to being observed (i.e. the Hawthorne effect). To minimize the researcher's effect on participants' performance, she spent almost 350 hours in the field performing multiple observations, which allowed the participants to become accustomed to being observed over time.[193] Qualitative data in this thesis were collected until saturation was reached (i.e. no new information emerged). Data saturation can also be referred to as richness of data. This means that variation is valued over quantity and that saturation is reached when a detailed and nuanced description of the phenomenon of interest is obtained.[194]

In order to ensure accuracy (i.e. confirmability) of findings, data were transcribed verbatim by the first author, and emerging categories and themes were confirmed by research group members experienced in qualitative methods. In order to demonstrate credibility and confirmability,[131] authentic quotes from the interviews and a rich description of the results were presented to support the identified categories and themes. Since the qualitative research in this thesis was conducted in naturalistic settings, it must be acknowledged that each situation might be unique and less amenable to generalization. However, in order to enable and facilitate transferability of research findings to other contexts, situations, times and populations, a clear description of the study setting and descriptive data pertaining to the participants were presented.

Validity and reliability of the IHT safety scale

The quantitative research findings in this thesis are discussed in relation to the concepts of validity (i.e. to what extent an instrument measures that which is claimed) and reliability (consistency of a measure).[144] With regard to instrument development, the concept of validity is often subdivided into content validity, criterion validity and construct validity (including convergent, discriminant, structural and cross-cultural validity). Reliability can further be categorized as consistency over time (i.e. stability) or consistency between items (i.e. internal reliability).[144]

The IHT safety scale was developed based on a theoretical model. The role of theory in scale and questionnaire development has been increasingly acknowledged,[143] because it is valuable to use a valid model to assess a trait, for example, to ensure that items fully cover the constructs. One limitation of the SEIPS model is that few studies have tested this theory and thus the usefulness of the concepts in clinical practice.[195] In this study, the CVI was used to assess the content validity of items. Content validity concerns the degree to which a scale has an appropriate selection of items to represent the construct being measured.[139] The CVI has been widely used in nursing research and its advantages include its focus on consensus rather than consistency, providing item-level information on relevance, as well as its ease of use and understandability.[196] One limitation of CVI is that it does not consider the possibility of inflated values due to the risk of chance agreement. Therefore, more complex methods such as kappa statistics, a consensus index of multi-rater agreement that adjusts for chance, have been proposed.[197] However, Polit, Beck and Owen translated item-CVI values into modified kappa statistics values, concluding that, after adjustment for chance, item-level CVI 0.78 with three or more experts also yielded good kappa statistics.[196] Moreover, a scale-CVI of 0.9 or higher provides evidence of strong content validity of the overall scale.[196] Thus, findings in this thesis suggest that the IHT safety scale had strong content validity for the items' relevance and just below the cut-off value for clarity of wording, when assessed by a group of international experts in the field of intensive care.

The IHT safety scale was psychometrically evaluated, using a cross-sectional design, by a sample of Swedish healthcare professionals at 12 ICUs. A limitation in the study design was that the questionnaires were distributed completely anonymously (i.e. not coded). However, the possibility of completing the questionnaire completely anonymously minimizes the risk of socially desirable response bias.[143] Also, the sample consisted of ICU staff from just two regions in Sweden. Therefore, the findings may not be generalizable to a larger population. Furthermore, the questionnaire was not pilot-tested among a sample of the target population. This might have resulted in items that were difficult to interpret and thus poor distributional statistics. However, the items were rigorously identified and refined by experts with a Delphi study, as well as by pre-testing among a group of Swedish critical care nurses. Moreover, minimal missing data suggests good acceptability of the instrument.

The actual sample size, just above the recommended ratio of five participants per item, was sufficient for psychometric evaluation,[141] but the sample was too small to apply split-half techniques that would have allowed for confirmatory testing of the identified structure. The EFA technique was thus chosen to address construct validity. This choice was made because EFA is recommended to identify a factor structure and a parsimonious set of items that explains the underlying latent construct being measured.[141, 145] However, since the IHT safety scale was developed based on a theory, it could be argued that CFA was also suitable. CFA is used to test a theory and is often applied when there is a sufficiently strong rationale regarding the factor model.[145, 146] CFA is also considered to provide stronger and more robust evidence for construct validity.[198] It can be used for item reduction, for example by applying a stepwise approach with one-factor congeneric models followed by testing of the multi-factor model.[199, 200] The CFA approach has one limitation because it does not allow items to be grouped differently than as specified in the model. For the IHT safety scale, items were developed and grouped based on an *a priori* hypothesized model. However, it was possible that items might be grouped differently than expected because of the complex interrelationship between the work system components.[42] Furthermore, it is recommended that model modifications using CFA should be undertaken with caution.[146] In fact, it could be argued that CFA becomes exploratory if too many model modifications are undertaken. For example, Hair recommends that the analyst should consider using EFA instead of CFA if more than 20% of items in the original model are refined.[141] The findings from the EFA and individual item statistics helped to reduce the number of items. Moreover, the final factor structure supported the conceptual model of patient safety during IHTs of ICU patients after regrouping of some items. Therefore, EFA rather than CFA was used to assess the construct validity of this newly devised scale. These findings should be confirmed by testing the dimensionality in another sample.[136]

Internal reliability consistency was assessed using Cronbach's alpha, corrected item-to-total correlation and inter-item-correlation.[136] Cronbach's alpha is predominantly used to assess reliability of scales. However, it increases according to the number of items included and should therefore be interpreted with caution. This study revealed that each subscale had alpha values >0.7, which is acknowledged as acceptable for a newly developed scale.[148] Furthermore, almost all items in the final scale had item-to-total and inter-item correlations within the recommended range of 0.3-0.7. This means that items on each subscale are related (i.e. measuring the same construct) but are not redundant.[144] In order to assess consistency over time or between observers (i.e. stability), test-retest, intra- or inter-rater reliability is recommended.[136] It was not possible to assess stability in the research in this thesis due to 1) the cross-sectional study design and 2) the pragmatic choice of distributing questionnaires to participants to be completed directly after an IHT. However, this was the first evaluation of the IHT safety scale, and item reduction was anticipated. More advanced reliability statistics during future evaluations might provide additional evidence.

CONCLUSIONS

The overall conclusion in this thesis is that patient safety during IHT is complex and multifaceted. When it comes to the IHT work system, deficiencies such as high workload, poor equipment and workplace design influence safety during the IHT process. Furthermore, safety hazards are common and the findings indicate that hazards related to tools and technology are the most prevalent. Despite the existence of hazards and identified system deficiencies, AIs are often handled appropriately; few patients thus seem to suffer AEs. The association between perceived and observed risks and patient outcomes must although be investigated in future research. However, identified hazards resulted in process-related outcomes such as digressions from safety routines, workaround and extended transport time.

Furthermore, the findings show that task performance is demanding and that teamwork during IHT is dynamic. This requires IHT teams to be flexible and adaptable in order to adjust their work according to the prevailing circumstances. Technical and non-technical skills, such as teamworking and anticipating, predicting and preparing for unexpected events, are also essential and important for safe IHT performance. Concerning experiences of the IHT process, the findings indicate that healthcare practitioners perceive IHTs to be a risky process, whereas patients experience the transfers as safe because they trust the staff to care for them. Furthermore, the development of a theoretically sound conceptual model of patient safety during IHT enhances understanding of patient safety during a complex process in intensive care. Finally, the findings indicate that patient safety during IHT can measured using the IHT safety scale. In future, the scale can be used to evaluate the IHT process in order to better understand safety prerequisites and improve clinical practice.

Hence, in order to improve the IHT process, and thus potentially reduce the occurrence of AIs and patient complications, IHT safety must be understood from both the Safety-I and Safety-II perspectives. This means that findings presented should contribute to a (re)designed system that meets the requirements for performing transfers safely. It also means that the findings revealing how and why IHTs usually succeed, must be taken into consideration in order to understand how clinicians' resilience capacity can be supported even more. This research contributes important new knowledge about IHT safety, relevant for clinicians, managers and policymakers in intensive care, and provides a foundation for future work in this area.

IMPLICATIONS FOR CARE

Numerous implications to improve patient safety during the IHT process in intensive care can be generated from this thesis. Acknowledging that contextual factors influence the quality of care, findings and suggested solutions must be carefully scrutinized in relation to one's own context, and possibly adapted before being implemented. However, the clinical implications presented below are likely transferrable across settings. This thesis further provides methodological guidance for those wanting to investigate the IHT process in their local setting. These clinical implications can serve as basis upon which to create clinical practice guidelines and model safety interventions. Table 6 provides a list of clinical implications according to the SEIPS model work system components.

Table 6. Clinical implications, recommendations based on the research findings

Work system component	Recommendations
Teamwork	Triage each patient prior to the IHT, to assess required skills and competences of staff. Critically ill patients are accompanied by at least three healthcare practitioners, two of whom are nurses qualified in intensive care. Team roles and related responsibilities are standardized at the local ICU. Perform a "team timeout" prior to departure from the ICU and, if necessary, during the transfer. Communication techniques (such as closed-loop communication) used during critical tasks. If the IHT includes a clinical handover, reporting tools (such as SBAR) are used.
Transport-related tasks	Handover of other duties in the ICU completed before preparing the patient for transport. Avoid disturbances and interruption during the preparation phase. Transport-related tasks mapped and reviewed at the local unit to minimize complexity and enhance ease of task performance. Develop and implement an IHT checklist to support task performance.
Tools and technologies	Develop technical solutions together with users to ensure that they meet the required needs in clinical practice. Transport equipment is easy to use and facilitates safe task performance. Ensure that the IHT team is available to monitor the patient throughout the transfer. Minimize technical errors by continuous maintenance of equipment. Support the development and implementation of new technology with the potential to improve IHT safety.
Environment	Improve the workplace design at the ICU and the destination locations to minimize workarounds. Rebuild and re-plan the hospital setting to shorten transport routes (preferably with hallways reserved for staff). Review local maintenance to minimize environmental disturbances. Map and display transport routes. Provide safe transport passages.

Work system component	Recommendations
Organization	Provide sufficient education, training and practice in required technical and non-technical skills. Introduce IHT routines to new employees. Develop local guidelines. Provide and allocate staff resources to perform IHTs safely.

Abbreviations: IHT: Intrahospital transport; ICU: Intensive care unit; SBAR: Situation, background, assessment, and recommendation

FUTURE PERSPECTIVES

The findings reported in this thesis have indicated the following areas for future research.

First, the in-depth description of contributing factors to IHT-related hazards and AIs provides a foundation for the development of safety interventions. Given that IHT-related risks and hazards are multi-factorial, single simple interventions are unlikely to be successful. Thus, in order to improve patient safety during the IHT process, complex interventions comprising multiple components are likely needed.

Second, specialist transport teams have previously been suggested as a potential safety solution. However, while healthcare professionals described stress related to leaving the ICU because the workload of remaining staff would increase, patients felt safe in being transported by the ICU staff that they knew and trusted. The role of specialist transport teams (or of IHTs being performed by existing rapid response teams) therefore needs to be further investigated.

Third, the findings revealed that few hazards actually caused patients harm. However, the studies in this thesis were not designed to investigate patient outcomes and future research is thus needed to investigate the association between the IHT process, AIs and patient complications.

Fourth, the patients in Study III expressed an overall positive experience of the IHT process. However, they were recruited with a convenience sampling approach. Therefore, the findings in this thesis must be confirmed in future studies.

Fifth, the IHT safety scale requires further evaluation, including testing of dimensionality using CFA, calculation of scale scores and reliability testing such as inter- and intra-rater reliability. Further testing is also needed to investigate whether the scale can predict outcomes such as patient harm or AIs and whether it is valid and reliable in other contexts and settings (e.g. other countries and cultures).

Sixth, the researcher used a theoretical model, specifically to guide the analysis of hazards during the IHT process and to develop the IHT safety scale. The overall findings indicated that the model was feasible to empirically investigate and explore the IHT process in ICU patients. However, future research is needed to address the usability and applicability of the model in clinical practice, as well as to evaluate the effectiveness of interventions based on models from human factors engineering.

Finally, the findings reported in this thesis can contribute to the development of evidence-based clinical practice guidelines for the IHT process. This should follow best practice for guideline development, including a multidisciplinary approach, involvement of consumers, systematic review of IHT safety research and appraisal of evidence.

SAMMANFATTNING PÅ SVENSKA

Sjukhusinterna transporter av patienter som vårdas inom intensivvården är en riskfylld process. Tidigare studier har visat att patientrelaterade komplikationer och avvikande händelser, som kan resultera i en vårdskada, är vanligt förekommande. Intrahospitala transporter (IHT) behöver genomföras då patienten har ett behov av behandlingar och undersökningar utanför intensivvårdsavdelningen (IVA). Exempelvis behöver kritiskt sjuka patienter förflyttas till röntgen, intervention- och hybridsalar samt till operation. Detta är en process som kräver tid och resurser från intensivvården samt ställer höga krav på personalen. Patienter som förflyttas har samma behov av övervakning som på IVA. I Sverige genomförs därför IHT primärt utav intensivvårdssjuksköterskor. Utefter patientens behov bemannas även transporten utav undersköterskor och specialistläkare inom anestesi och intensivvård. Det finns idag begränsad kunskap kring faktorer som påverkar patientsäkerheten vid transporter. Detta inkluderar såväl vilka risker som finns som vilka preventiva åtgärder som bibehåller och främjar säkerheten. Avhandlingens övergripande syfte var därför att undersöka patientsäkerheten vid IHT av patienter som vårdas inom intensivvården. Alla delstudier har erhållit etiskt godkännande ifrån Etikprovningsmyndigheten (Dnr 1030-15).

Avhandlingens första tre delstudier utgjordes av en etnografisk fältstudie vid två intensivvårdsavdelningar på ett universitetssjukhus. Under fältstudien genomfördes deltagande observationer av IHT, intervjuer med läkare och sjuksköterskor samt intervjuer med patienter som hade transporterats. Avhandlingens första delstudie syftade till att identifiera, klassificera och beskriva risker vid IHT. Studiens resultat visade att 365 risker kunde identifieras vid 51 transporter. Dessa risker kunde härledas till teamarbete, transport-relaterade uppgifter, utrustning och teknik, miljön samt organisationen. Utrustning och teknik var det mest framträdande riskområdet (n=124). Studiens resultat påvisade även bakomliggande orsaker till identifierade risker samt hur dessa påverkade transportprocessen. En klassifikation av identifierade riskers inverkan på patientsäkerheten visade att majoriteten utgjorde en risk för att en avvikande händelse skulle kunna inträffa (n=204). I avhandlingens andra delstudie intervjuades 15 intensivvårdssjuksköterskor och fem läkare om deras erfarenheter av kritiska händelser vid transporter. Resultatet visade att IHT upplevdes som en riskfylld process där patients säkerhet ofta var hotad. Trots detta uppfattade personalen att de kunde hantera kritiska händelser ifall de inträffade. Analysen resulterade i en beskrivning av organisatoriska förutsättningar, behov av kompetens och erfarenheter, samt tekniska och icke-tekniska färdigheter för säkra transporter. Avhandlingens tredje delstudie syftade till att undersöka patienters upplevelser utav IHT processen. Intervjuer genomfördes därför med 12 patienter som genomgått en IHT. Resultatet visade att patienterna hade vaga minnen av transporten men kunde beskriva hur de upplevde ljud, ljus och den förändrade miljön. Överlag kände patienterna sig säkra och trygga under transporten. Detta berodde främst på att de kände en tillit till personalen, att de fick information, samt blev förberedda inför kommande händelser.

I avhandlingens fjärde delstudie utvecklades och testades ett instrument för att kunna mäta säkerhet vid transporter. Studien genomfördes i tre faser. Först utvecklades en teoretisk modell över patientsäkerhet vid IHT. Utifrån denna modell samt resultatet ifrån avhandlingens första delstudie utformades sedan potentiella frågor. Därefter testades instruments innehållsvaliditet genom en internationell så kallad Delphistudie. Detta innebär att experter inom området bedömer frågornas relevans och begriplighet. Slutligen utvärderades instrumentets validitet och reliabilitet i en tvärsnittsstudie vid 12 intensivvårdsavdelningar i Sverige. Studiens resultat visade att 55 frågor kunde reduceras till 24. Den explorativa faktoranalysen gav vidare stöd för en modell bestående av fem dimensioner enligt följande: teamarbete (4 frågor), transport-relaterade uppgifter (4 frågor), teknik och utrustning (5 frågor), miljö (5 frågor) samt organisation (6 frågor). Korrelationsanalyser visade vidare att varje dimension hade acceptabel reliabilitet (intern konsistens) med Cronbach's alpha-värden >0.7.

I avhandlingens ram gjordes vidare en syntes av delstudiernas resultat utifrån en systemteoretisk modell (SEIPS-modellen) som bygger på begreppen struktur, process och utfall. Sammanfattningsvis visar avhandlingens resultat att transporter är en riskfylld process. I relation till strukturen kunde bidragande orsaker till risker härledas till brister på systemnivå och bestod bland annat utav bristande resurser, utrustning som ej var anpassad efter transportens behov, brister i sjukhusmiljön samt begränsningar i kommunikation och samordning mellan enheter. I relation till processen identifierades tekniska och icke-tekniska färdigheter som var centrala för att utföra transporter säkert. Detta avser exempelvis kunskap och erfarenhet av transport-relaterade uppgifter, teamarbete (såsom kommunikation, samarbete, teamledarskap och följsamhet till teamroller) samt förmågan att kunna förutse och planera inför oväntade händelser. Teamarbete under transporter kan beskrivas som dynamiskt och påverkades av faktorer som hög rotation av teammedlemmar samt oklar ansvarsfördelning mellan teammedlemmar. Transportrelaterade uppgifter var ofta komplexa och teamets arbete påverkades vidare ofta utav avbrott och störningar. Trots detta kände sig patienterna, som nämnts, säkra och trygga under transporten. I relation till utfall visade resultatet att trots att transporter är en riskfylld process var det få risker som ledde till en observerbar vårdskada eller avvikande händelse. Personal uppfattar också sällan att patienten drabbas utav någon komplikation. Däremot bidrog de identifierade riskerna till exempelvis avsteg från säkerhetsrutiner, ineffektivt teamarbete, misstag relaterat till utrustning samt förlängd transporttid. Slutligen visade de psykometriska analyserna att en enkät bestående av 24 frågor fördelade över fem dimensioner kan mäta sjukvårdspersonals erfarenheter av säkerhet vid transporter.

Avhandlingens resultat ger en fördjupad kunskap om transportprocessen, inklusive risker samt förutsättningar för att kunna genomföra transporter säkert. Avhandlingens bidrar även med ett instrument för att mäta säkerhet vid transporter. Detta resultat kan ligga till grund för utveckling och implementering av framtida interventioner som syftar till att förbättra säkerheten. Vidare kan resultatet utgöra en grund för utformning utav riktlinjer, checklistor samt säkerhetsförbättringar i den kliniska verksamheten.

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APPENDIX

I Review of previous research evaluating interventions aiming to increase safety during intrahospital transport of critically ill patients

II Questionnaire used in Study IV (in Swedish)

Table S1. Review of previous research evaluating interventions aiming to increase safety during intrahospital transport of critically ill patients

Author, year, journal, country	**Aim**	**Design**	**Setting and sample**	**Measurement**	**Intervention/control**	**Main findings**
Mazza et al., 2008. *Sao Paulo Med J* Brazil	To determinate whether IHTs could be safely performed by using a transportation routine	Prospective cohort study with before- and after evaluation	21-bed general ICU in a tertiary university hospital Sample of IHTs (n=37)	Hemodynamic and respiratory parameters measured before and after IHT Complications during IHT were documented	Intervention: unclear description. Seems to include keeping the same ventilation mode as in the ICU and a multidisciplinary team Control: none	Complications occurred in 32.4% of all IHTs
Jarden et al., 2010. *Intensive Crit Care Nurs* New Zealand	To develop an IHT transport tool	1)Literature review 2)Descriptive after audit	14-bed general ICU in a regional hospital Convenience sample of nurses (n=22) for informal interviews	Transport tool implemented during one month and evaluated by an audit Unclear, audit not presented. However, it focused on nurses' perceptions of the tool	Intervention: IHT tool Control: none	Resulted in a framework for ICU nurses to use during IHT
Choi et al., 2012. *Am J Emerg Med* Korea	To explore the effect of an intervention using a checklist program for safe IHT on the incidence of AIs during the transport of emergency patients	Before- and after-interventional trial	ED at an urban tertiary teaching hospital Pre- intervention (n=597) Post- intervention (n=539)	Study protocol filled in by nurses at target room pre- and post-intervention Total AIs, serious AIs, and proportion of physicians accompanying transports	Intervention: education of transporters, including development of guideline for safe transports, one-hour training session for emergency nurses, introduction of pre-transport checklist Control: none	AIs decreased significantly, from 36.8% to 22.1% Serious AIs were also significantly lower, decreasing from 9.1% to 5.2%

Author, year, journal, country	Aim	Design	Setting and sample	Measurement	Intervention/control	Main findings
Bérubé et al., 2013 *Intensive Crit Care Nurs* Canada	To determine the effect of an interdisciplinary preventive programme for all ICU team members involved in IHTs	Pre- and post-intervention design	Tertiary care hospital, 24-bed ICU Patients pre- (n=180) Patients post- (n=187) Data collected by HCP performing IHT	Incidents collected via report grid and complications categorized Demographics, technologies and equipment used, indication for IHT, APACHE II, and TISS recorded	Intervention: quality improvement audit (preventive program called SecurEX) Control: none	A 20% absolute reduction of incidents was observed Significant reduction in technical problems and problems related to mobilization
Comeau et al., 2015 *Crit Care Nurse* United States	To develop a checklist for transport that is easy to use and effective in preparing patients for transport	1) Literature review 2) After only evaluation	Four adult ICUs 2 506 IHTs	Outcomes collected through checklists, reported by staff. Included assessment of AIs	Intervention: transport checklist Control: none	97.6% of all transports involved no reported complication
Brunsveld-Reinders et. al., 2015. *Crit Care* The Netherlands	To develop a checklist to increase safety of IHT in critically ill patients	Literature review, analysis of IHT incidents and an inventory assessing what go wrong Feasibility and usability testing of the checklist	29-bed adult mixed tertiary ICU Interviews: physicians (n=10), nurses (n=15) Feasibility data collected during one month (n=41)	Feasibility data collected by self-reported questionnaire (including time to fill in the checklist and experience of using the checklist)	Intervention: a checklist for ICU physicians and nurses, implemented in the patient data management system Control: none	Checklist used in 29 of 41 IHTs during one month Average time to fill in the checklist was 4.5 min (range 3 to 10) per checklist part

Author, year, journal, country	Aim	Design	Setting and sample	Measurement	Intervention/control	Main findings
Matsumura et al., 2015 *Acute Med Surg* Japan	To evaluate the efficacy and safety of the transfer board tree	Prospective observational study	Study subjects on MV and transported patients within the hospital for CT Patients enrolled (n=40) randomly assigned to either control or intervention group	Recording of transfer time, changes in physiological data before and after IHT and AEs related to lines and tubes	Intervention: transfer board tree (i.e. integrates patient, transfer board and medical equipment) Control: conventional treatment	Transfer board tree related to significantly shorter transfer time No significant trend in either group for changes in physiological parameters
Beigmohammadi et al., 2016. *Acta Med Iran* Iran	To evaluate effect of clinical course on promotion of physicians' abilities in IHTs of critically ill patients	Interventional study	Operation room and ICU/lecture hall Physicians (n=320) assigned to two groups	Skills evaluated based on a checklist and scoring in educational items and recorded AE rates	Intervention: one-day clinical course in small groups Control: lecture-based learning	Improvement in knowledge and abilities: intubation, use of defibrillator, portable ventilator Significant decrease in AEs after intervention
Jones et al., 2016 *Dimens Crit Care Nurs* Unites States	To evaluate the implementation of a standardized evaluation plan for IHT to/from adult ICUs	Single-centred observational study, quantitative/ qualitative design	Level 1 trauma and academic centre Conven- ience sample of critically ill adults in the ICU (n=502)	Demographic patient data, including APACHE II Audit, including AIs, completed by nurses before and after transport	Intervention: standardized evaluation plan Control: none. However, comparison between dedicated transport team and bedside ICU nurses	Most nurses were compliant with the policy, except the stabilization process

Author, year, journal, country	Aim	Design	Setting and sample	Measurement	Intervention/control	Main findings
Jiang et al., 2016. *Int J Clin Exp Med* China	To investigate the application values of safe transport combined with prospective nursing intervention in emergency IHTs of critically ill patients	Randomized controlled trial	ED Patients (n=546), randomly enrolled and divided into groups	Waiting time, transport time, nursing care, patient satisfaction and monitoring items Unclear how data (e.g. transport time) were recorded Questionnaire filled in by enrolled patients and nurses	Intervention: safe transport combined with a nursing intervention, including evaluation of patient's condition before transport, examination of patient's specific condition during transport and stabilization of vital signs after transport. Control: conventional nursing	Reduced waiting time, transport time, accident rate and lower probability of AI Increased stable vital signs, nursing score and respiratory management
Song et al., 2018 *Clin Exp Emerg Med* Korea	To compare the time required for transport to CT, with versus without the use of the ETAD; examine complications during patient transport, verify convenience of the newly developed ETAD	Prospective randomized controlled study	Simulation using a training mannequin Nurses and medical technicians (n=60)	Time and complications Convenience was measured using a numeric scale from 0 to 10	Intervention: ETAD Control: conventional method	ETAD significantly decreased transport time to CT scan Less complications with ETAD and new method found to be more convenient
Chang et al., 2018 *Journal of interprofessional care* Taiwan	To assess the effectiveness of an in-situ interprofessional simulation-based training model for junior transport team members	Quasi-experimental study	Newly registered postgraduate nurses, physicians and RTs (n=36). Participants randomly assigned	Assessment of technical and non-technical skills	Both groups had 2-hour introduction of simulated scenario. Intervention: an in-situ interprofessional simulation-based training model Control: only introduction	Intervention group achieved significantly higher level of personal skills and the team functionality was significantly higher, compared to the control group

Author, year, journal, country	Aim	Design	Setting and sample	Measurement	Intervention/control	Main findings
Akrami et al., 2019 *Med Surg Nurs J* Iran	To explore the effect of training and usage of safe transfer checklists on the quality of IHT of critical patients	Quasi-experimental study	ED & ICU Convenience sample of a total of 130 critical patients (65 in each group)	Checklist for assessing the quality of the transfer completed by the researcher	Intervention: a two-hour workshop for nurses, including learning how to use a safe transfer checklist Control: not described	Significant difference in mean score of IHT quality, intervention group scored higher than control group
Williams et al., 2020 *Aus Crit Care* Australia	To compare compliance with the intercollegiate IHT guideline before and after the introduction of an IHT checklist	Pre- and post-intervention study	ICU A sample of 76 IHTs (38 before and 38 after)	Guideline compliance	Intervention: introduction of IHT checklist followed by a one-week educational phase Control: none	Compliance to national IHT guideline improved significantly
Jansen et al., 2020 *Eur J Anaesthesiol* German	To evaluate chest compression quality according to provider's position during IHT	Observational study	Simulation using a training mannequin 20 paramedics	Quality of compressions was measured according to quality metrics and participants assessed their own subjective feelings of safety	Intervention: three groups 1) walking beside the bed, 2) kneeling on the bed beside the mannequin, 3) kneeling on the bed astride the mannequin Control: provider kneeling beside mannequin on the floor	Compression quality did not differ between groups 2 and 3 but was significantly worse in group 1 compared to control. Participants predominantly preferred position 3

Abbreviations: AE: adverse event; AI: adverse incident; APACHE II: Acute Physiology and Chronic Health Evaluation; CT: computed tomography; ED: emergency department; ETAD: easy tube arrange device; HCP: Healthcare practitioners; IHT: intrahospital transport; MV: mechanical ventilation; RT: respiratory therapists; TISS: Therapeutic Intervention Scoring System

Kod nr:_______

Säkerhet vid intrahospitala transporter av intensivvårdspatienter

Enkäten är utvecklad för att mäta kvalitet och säkerhet under intrahospitala transporter (IHT), när patienter som vårdas inom intensivvården (IVA) behöver förflyttas till andra delar utav sjukhuset för att genomgå behandling och/eller undersökning. Vänligen tänk tillbaka på din nyligen genomförda transport när du besvarar enkätens frågor. Sätt ett kryss i den ruta som motsvarar din åsikt. Tänk på att svaren ska återspegla dina egna erfarenheter.

Teamarbete

Med team avser vi i denna enkät de personer som gemensamt utförde transporten. Var vänlig och svara på följande påståenden om *teamarbetet* utifrån dina erfarenheter ifrån transporten.

	Instämmer inte alls	Instämmer delvis	Varken eller	Instämmer mestadels	Instämmer helt
1. Vi hade de kunskaper och färdigheter som krävdes i teamet för att genomföra transporten säkert	☐	☐	☐	☐	☐
2. Vi hade de kunskaper och färdigheter som krävdes i teamet för att arbetet vid behov kunde delas upp	☐	☐	☐	☐	☐
3. Varje teammedlem visste vilka uppgifter han/hon skulle utföra	☐	☐	☐	☐	☐
4. Det framkom tydligt vem som var teamledare	☐	☐	☐	☐	☐
5. Medlemmarna i teamet respekterade teamledarens roll	☐	☐	☐	☐	☐
6. Vi bekräftade varandras ansvarsområden inom teamet	☐	☐	☐	☐	☐
7. Vi gav varandra feedback innan- under och/eller efter transporten	☐	☐	☐	☐	☐
8. Vi hade en gemensam förståelse för patientens behov inom teamet	☐	☐	☐	☐	☐
9. Om en person i teamet hade mycket att göra hjälpte de andra till	☐	☐	☐	☐	☐
10. Vi kommunicerade tydligt inom teamet	☐	☐	☐	☐	☐
11. Alla medlemmar i teamet var närvarande när information om transporten gavs	☐	☐	☐	☐	☐
12. Jag kunde be om förtydligande om jag inte förstod den information som gavs	☐	☐	☐	☐	☐
13. De andra medlemmarna i teamet lyssnade på vad jag hade att säga	☐	☐	☐	☐	☐
14. Jag kunde be de andra medlemmarna i teamet om hjälp ifall jag behövde det	☐	☐	☐	☐	☐
15. Jag fick stöd av de andra medlemmarna i teamet	☐	☐	☐	☐	☐
16. Jag upplevde att medlemmarna i teamet behandlade varandra med respekt	☐	☐	☐	☐	☐

<u>Transportrelaterade uppgifter</u>

Med transportrelaterade uppgifter avser vi i denna enkät alla aktiviteter och handlingar som utförs under en transport. Exempelvis: *förbereda inför transporten* (besluta om transport, bedöma/förbereda patienten, kontrollera utrustning, koppla över patienten, förbereda läkemedel, informera patient/närstående), *genomföra transporten* (flytta patienten, övervaka patienten, utföra behandlingen/undersökningen, utföra nödvändiga omvårdnads- eller medicinska åtgärder*), återinstallera patienten på IVA* (koppla tillbaka patienten, återställa utrustning, stabilisera patienten, dokumentera transportrelaterade händelser). Var vänlig och svara på följande påståenden om *transportrelaterad uppgifter* utifrån dina erfarenheter ifrån transporten.

	Instämmer inte alls	**Instämmer delvis**	**Varken eller**	**Instämmer mestadels**	**Instämmer helt**
17. Vi hade en gemensam förståelse inom teamet för vilka uppgifter som skulle utföras	☐	☐	☐	☐	☐
18. Vi hade en gemensam förståelse inom teamet för i vilken ordning uppgifterna skulle utföras under transporten	☐	☐	☐	☐	☐
19. Vi hade tillräckligt med *förberedelsetid* inför transporten	☐	☐	☐	☐	☐
20. Vi hade tillräckligt med tid på oss att *genomföra* transporten på ett säkert sätt	☐	☐	☐	☐	☐
21. Vi hade tillräckligt med tid på oss *efter* transporten för att återinstallera patienten på IVA	☐	☐	☐	☐	☐
22. Jag kunde utföra alla transportrelaterade uppgifter utan att riskera patientens säkerhet	☐	☐	☐	☐	☐
23. Jag kunde utföra transportrelaterade uppgifter utan bli avbruten	☐	☐	☐	☐	☐
24. Jag litade på mina kunskaper och förmågor att utföra transportrelaterade uppgifter	☐	☐	☐	☐	☐
25. Jag kände mig nöjd med hur vi utförde alla transportrelaterade uppgifter	☐	☐	☐	☐	☐

<u>Utrustning och teknik</u>

Med utrustning och teknik avser vi i denna enkät alla de föremål som används för att utföra transportrelaterade uppgifter. Exempelvis: transportventilatorer, övervakningsutrustning, medicinskteknisk utrustning, samt material (ventilatorslangar, droppslangar/aggregat, sladdar, läkemedel, infusionsvätskor). Var vänlig och svara på följande påståenden om *utrustning och teknik* utifrån dina erfarenheter ifrån transporten.

	Instämmer inte alls	**Instämmer delvis**	**Varken eller**	**Instämmer mestadels**	**Instämmer helt**
26. Transportutrustningen var enkel att använda	☐	☐	☐	☐	☐
27. Transportutrustningen uppfyllde de behov som krävdes för att kunna genomföra transporten säkert	☐	☐	☐	☐	☐

	Instämmer inte alls	Instämmer delvis	Varken eller	Instämmer mestadels	Instämmer helt
28. Transportutrustningen var tillförlitlig	☐	☐	☐	☐	☐
29. Medicinskteknisk utrustning samt material var anpassade efter de behov som fanns under transporten (t.ex. ventilatorslangar, droppslangar, sladdar)	☐	☐	☐	☐	☐
30. Det var enkelt att övervaka patienten under transporten	☐	☐	☐	☐	☐
31. Utrustningens larm var ett stöd i mitt arbete med att övervaka patienten	☐	☐	☐	☐	☐
32. Vi hade tillgång till den patientinformation vi behövde under transporten	☐	☐	☐	☐	☐
33. Vi hade tillgång till de läkemedel som patienten behövde under transporten	☐	☐	☐	☐	☐
34. Vi hade tillgång den akututrustning som vi behövde under transporten	☐	☐	☐	☐	☐
35. Utrustning och teknik underlättade dokumentationen under transporten	☐	☐	☐	☐	☐
36. Jag hade tillräckligt med kunskap om transportutrustningen	☐	☐	☐	☐	☐
37. Jag kände mig trygg med att använda transportutrustningen	☐	☐	☐	☐	☐

Miljö

Med miljö avser vi i denna enkät den fysiska omgivning där transporten äger rum. Innan och efter transporten utgörs miljön utav IVA medan den under transporten utgörs utav sjukhusmiljön samt den fysiska utformningen utav mottagande avdelning. Var vänlig och svara på följande påståenden om *miljön* utifrån dina erfarenheter ifrån transporten.

	Instämmer inte alls	Instämmer delvis	Varken eller	Instämmer mestadels	Instämmer helt
38. Den fysiska omgivningen på IVA underlättade förberedelserna inför transporten	☐	☐	☐	☐	☐
39. Jag hade tillräckligt med arbetsutrymme på IVA för att förbereda inför transporten	☐	☐	☐	☐	☐
40. Det var lätt att hitta till rätt mottagande avdelning för transporten (ex. MR, röntgen, OP)	☐	☐	☐	☐	☐
41. Den fysiska omgivningen på sjukhuset underlättade för att utföra transporten på ett säkert sätt	☐	☐	☐	☐	☐
42. Korridorerna var fria från hinder/blockeringar	☐	☐	☐	☐	☐
43. Undersökningsrummen vid mottagande avdelning var anpassad för intensivvårdspatienter	☐	☐	☐	☐	☐

	Instämmer inte alls	Instämmer delvis	Varken eller	Instämmer mestadels	Instämmer helt
44. Vi hade möjlighet att observera patienten under hela transporten	☐	☐	☐	☐	☐
45. Vi hade möjlighet att utföra de åtgärder som var nödvändiga för patienten under transporten	☐	☐	☐	☐	☐
46. Vi kunde bibehålla patientens integritet under transporten	☐	☐	☐	☐	☐

Organisation

Med *organisation* avser vi i denna enkät den lokala organisationen på IVA samt den sjukhusövergripande organisationen som påverkar transportrelaterade uppgifter. Var vänlig och svara på följande påståenden om *organisationen* utifrån dina erfarenheter ifrån transporten.

	Instämmer inte alls	Instämmer delvis	Varken eller	Instämmer mestadels	Instämmer helt
47. Det framgick tydligt vem/vilka som skulle utföra transporten	☐	☐	☐	☐	☐
48. Arbetet var väl samordnat när vi *förberedde* patienten inför transport	☐	☐	☐	☐	☐
49. Transporten var väl samordnad mellan de avdelningar på sjukhuset som deltog i patientens vård under transporten (ex. MR, röntgen, OP)	☐	☐	☐	☐	☐
50. Arbetet var väl samordnat *efter* transporten när vi återinstallerade patienten på IVA	☐	☐	☐	☐	☐
51. Vi hade tillräckliga personalresurser för att *förbereda* oss inför transporten	☐	☐	☐	☐	☐
52. Vi hade tillräckliga personalresurser för att *utföra* transporten	☐	☐	☐	☐	☐
53. Vi hade tillräckligt med personalresurser *efter* transporten för att återinstallera patienten på IVA	☐	☐	☐	☐	☐
54. Jag kunde uttrycka min oro om säkerhetsrisker under transporten ifall det behövdes	☐	☐	☐	☐	☐
55. Jag kunde korrigera andras misstag om de inträffade under transporten för att se till att rutinerna följdes på rätt sätt	☐	☐	☐	☐	☐
56 a) Vi har en lokal rutin/riktlinje för intrahospitala transporter	☐ **Ja** ☐ **Nej** ☐ **Vet ej**				
b) Om ja, rutinen/riktlinjen underlättade vårt arbete	☐	☐	☐	☐	☐
57 a) Vi använde checklista för intrahospitala transporter	☐ **Ja** ☐ **Nej** ☐ **Vet ej**				

	Instämmer inte alls	Instämmer delvis	Varken eller	Instämmer mestadels	Instämmer helt
b) Om ja, checklistan underlättade vårt arbete	☐	☐	☐	☐	☐
58 a) Inträffade det någon avvikande händelse (dvs. något som inte stämmer med normal rutin/förväntade vårdförlopp) under transporten?	☐ **Ja** ☐ **Nej** ☐ **Vet ej**				
b) Om ja, den avvikande händelsen hanterades enligt lokala rutiner	☐	☐	☐	☐	☐
59. Drabbades patienten utav någon komplikation under transporten?	☐ **Ja** ☐ **Nej** ☐ **Vet ej**				

Bakgrundsinformation

60. Transportteamet bestod utav:	1-2 personer ☐	3-4 personer ☐	5 eller fler personer ☐
61. Transporten gick till:	CT ☐	MR ☐	OP ☐
	☐ Annat (vänligen specificera):		
62. Transporten utfördes:	Dagtid (07-16) ☐	Kvällstid (16-22) ☐	Natt (22-07) ☐
	Vardag ☐		Helg (eller röd dag) ☐
63. Jag är:	Sjuksköterska ☐	Undersköterska ☐	Läkare ☐
	☐ Annat (vänligen specificera):		
64. Vänligen ange hur många års erfarenhet du har utav intensivvård:			
65. Vänligen ange hur många år du har arbetat vid din nuvarande arbetsplats:			
66. Vänligen ange tid och datum då transporten genomfördes:			

Tack så mycket för din medverkan!

Vänligen lämna ifylld enkät till kontaktperson för studien vid er avdelning