Safe Work Practices in Interdisciplinary Surgical Teamwork

Model Development and Validation

by

Sindre Høyland

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University of Stavanger

N-4036 Stavanger
NORWAY

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To my dearest family, I dedicate this thesis.

Your ideals and belief in me will always be my compass in life.

My deepest love belongs to you.

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Summary

This thesis identifies needs in health research literature on quality and safety to explore the nature of teamwork and develop models that can be applied to, and integrate findings from, such explorations. This triggers an interest in exploring how safe work practices are achieved in interdisciplinary surgical teamwork, and also a related interest in developing and validating a model for such explorations. Accordingly, surgical operations are explored by means of observations, conversations, and interviews. As part of this exploration, a literature review process produces a framework for exploring safe work practices, comprising a knowledge and system dimension. These dimensions are operationalized through a field research protocol and a semi-structured interview guide to serve as a general frame of reference during the fieldwork. The emergent findings from the exploration, in turn, establish a scientific model by refining and validating the dimensions of the framework. The exploration and model development and validation efforts are supported by a balanced methodology, emphasizing both structure/transparency and in-depth descriptions in the gathering, analysis, and presentation of data.

This thesis finds that safe work practices are achieved through the ability and variety that individuals demonstrate in handling multiple sources of information before reaching a particular decision; the variety of ways in which awareness or anticipation of future events are expressed; and the different ways in which the individual team members handle sudden and unexpected situations. Safe work practices are also achieved by means of the team's ability to compensate, through system buffers and experience from exclusive exposure to one section, for vulnerabilities and disruptions that arise through various combinations of system factors. Finally, safe work practices are achieved through the individual's ability to disregard stress/pressure and properly apply the time and considerations necessary for the job, and sense and communicate patient-related problems, and the team's reliance on the individual's competency and ability to plan and improvise when challenged by a problem or unforeseen situation during an operation. Safe work practices can be defined as the dynamic and continuous effort by each individual team member and the overall team to combine and draw upon explicit and tacit

knowledge repertoires to achieve a successful operation with minimal errors and complications. Safe work practices also can be viewed as the overall organization's ability to maintain inner and outer (system) conditions that are strong enough to support individual and team abilities to combine and draw upon knowledge repertoires.

This thesis' theoretical contribution to safety research lies in establishing a scientific model for exploring safe work practices in teamwork that is of broad enough design to include existing findings and concepts, as well as new findings. By applying the model as a frame for exploration during a qualitative study, this thesis also contributes to safety research by producing a broader understanding of how safe work practices are achieved in surgical teamwork. The main implication is that safety researchers should emphasize the design of broader models to facilitate systemizing existing findings. The thesis also suggests that a broader model increases the potential for generalizability and transferability of model aspects, implying that safety researchers should consider research quality during model development. These contributions and related implications answer the identified needs for explorations into the nature of teamwork and for developing models that can be applied to, and integrate findings from, such explorations.

Given the identified lack of explorations into the nature of teamwork within the health care sector, this thesis' practical contributions lie in the broad yet in-depth approach to safety in surgical teamwork. This is potentially relevant to policy-makers, managers, researchers, and practitioners. Implications include system conditions that should be established to facilitate safe work practices in surgical teamwork, such as buffers in terms of personnel, operating rooms, and equipment and forums/seminars for sharing knowledge. Systems should also be established to formalize different types of tacit knowledge, such as by incorporating questions into checklists that trigger sharp-end/local reflections. Establishing favorable system conditions, not only physically (buffers) but also in terms of knowledge-sharing and formalizing, can reduce the likelihood of adverse events and improve patient safety.

List of Articles

This thesis is based on the following articles:

I. Høyland, S., Aase, K. & Hollund, J. G. (2011). Exploring varieties of knowledge in safe work practices – An ethnographic study of surgical teams. *Patient Safety in Surgery*, *5*(21). doi:10.1186/1754-9493-5-21.

II. Høyland, S., Aase, K. & Hollund, J. G. (2011). Understanding the system in relation to safe medical work practices. *Safety Science Monitor*, *15*(1). ISSN 1443-8844.

III. Høyland, S. (2011). Exploring safe work practices in surgical operations – The role of time, patient, and operation. In S. Albolino et al. (Eds): *Healthcare Systems Ergonomics and Patient Safety 2011: Risks in OR, ICU and ER* (pp. 430–435). Leiden, The Netherlands: CRC Press/Balkema. ISBN 978-0-415-68413-2.

IV. Høyland, S. (2012). Developing and validating a scientific model for exploring safe work practices in interdisciplinary teams. *Safety Science*, *50*(2), 316–325. doi: 10.1016/j.ssci.2011.09.008.

Part I

1 Research Problem, Concepts, and Setting

This thesis begins by identifying a research question and related objectives to address two larger research calls in health research literature on quality and safety, followed by definitions of main concepts and an overview of the fieldwork setting, from the structure of the surgical unit to the layout of the typical operating room.

1.1 Identifying a research problem

Studies estimate that 3 percent to 17 percent of hospitalized patients worldwide suffer adverse events, and that 3 percent to 21 percent of adverse events lead to patient death (Baker, et al., 2004; Brennan, et al., 1991; Davis, et al., 2002; de Vries, et al., 2008; Schioler, et al., 2001; Soop, et al., 2009; Thomas, et al., 2000; Vincent, et al., 2001; Wilson, et al., 1995). Studies also suggest that approximately 50 percent[1] of all adverse events in hospitals occur in the operating room (Catchpole, et al., 2008; Leape, et al., 1991; Thomas, et al., 2000). These figures point to the operating room as a domain in urgent need of improved safety (van Beuzekom, et al., 2012). The figures also reflect the complexity of surgical operations, where anesthetists, nurses, and surgeons perform interdependent tasks and distribute patient care in complex arrangements (Healey, et al., 2006a), and where sequences of activities in the operating room often need to be changed or modified due to patient's condition, unanticipated technical challenges, or malfunctioning equipment (Leach, et al., 2009).

Sanchez and Barach (2012) captured this complexity: *"The surgical space, by its nature, is a high-risk environment where hazards lurk around every corner and for every patient. The patients who come to surgery are generally among the sickest and at more advanced stages of disease. The very act of treatment involves interventions that are often considerably invasive with vigorous and unpredictable physiologic responses. The level of complexity, both in task-oriented and cognitive demands, results in a dynamic, unforgiving*

[1] Zegers et al. (2011) identified an even higher number, at 65 percent.

environment that can magnify the consequences of even small lapses and errors" (p. 1).

One way of handling this complexity is the principle of team training, used in organizations with strong safety performance (such as firefighting teams and aircraft carriers). This has received increased recognition in health research literature on quality and safety (Burke, et al., 2004; Carne, et al., 2012; Gaba, 2000; Morey, et al., 2002; Riley, 2009; Salas, et al., 2009; Wilson, et al., 2005). Training in team skills,[2] within a simulated or clinical environment, is now commonly believed to improve these skills and elicit safer practices and overall higher levels of safety for health professionals and patients.

However, the claim regarding safety improvement remains to be documented. Specifically, the literature points to safety-related gaps in identifying, understanding, and training health care-specific team skills (Baker, et al., 2006; Lyndon, 2006; Peebles, et al., 2011; Reader, et al., 2006). There are also gaps in resources and time necessary to ensure team training (Burke, et al., 2004; Harris, 2006; Salas, et al., 2009); and in scientifically grounded models that can integrate existing findings (Manser, 2009) and be applied to explore and measure the behaviors and performance of interdisciplinary teams[3] (Baker, et al., 2006; Healey, et al., 2004, 2006b).

1.1.1 Relating the identified gaps to literature on safety in surgery

These gaps in explorations and model development are reflected in literature on safety in surgery. A main focus appears to be on training, performance, outcomes, assessments, and measures related to aspects of teamwork.[4] Russ (2013) described the development and content validation of a tool for measuring basic task completion during surgical procedures. Hull et al. (2012) identified limited research on the impact of other team members' (read: aside from the surgeons) team skills on technical outcomes of surgery. Gofton et al. (2012) applied an evaluation tool to assess surgical trainees' performance of

[2] Examples of team skills include leadership, problem-solving, communication, and decision-making (Catchpole, et al., 2008; Wallin, 2007; Østergaard, 2004).
[3] The typical team composition within health care is interdisciplinary. The team is composed of different professions and specializations, such as nurses, surgeons, and anesthesiologists (cf. Burke, et al., 2004).
[4] Teamwork is defined in Subchapter 1.2.2.

various surgical procedures. Arora et al. (2012) developed and validated a tool for assessing the quality of debriefings in surgery. Schraagen et al. (2010) assessed the role of intra-operative non-routine events (NREs) and team performance on pediatric cardiac surgery outcomes. Wolf et al. (2010) assessed the efficacy of medical team training. Neily et al. (2010) determined an association between a team training program and surgical outcomes (lower surgical mortality rates). Haynes et al. (2009) measured rate of complications and death associated with surgery after the introduction of a surgical checklist. Mazzocco et al. (2009) used a standardized instrument to determine the link between team behaviors and patient outcomes. Carney et al. (2010), Makary et al. (2006), Sexton et al. (2006), and Kaissi (2003) measured surgical team members' attitudes about safety and teamwork. Undre et al. (2006) developed an observational assessment of surgical teamwork, Allard et al. (2011) and Naveh et al. (2006) respectively measured safety climate in relation to exposure to pre-surgery briefings and personnel readiness to report treatment errors. Treasure et al. (2002) described issues related to measuring and monitoring surgical performance. Finally, de Leval et al. (2000) assessed the role of human factors (minor and major failures) on surgical outcomes. Further underscoring the focus on outcomes and assessments, a number of studies addressed the links between teamwork failures/disruptions and non-technical skills, and technical and surgical errors (Arora & Sevdalis, 2010; Catchpole, et al., 2008; ElBardissi, et al., 2008; McCulloch, et al., 2009; Mishra, et al., 2008; Mishra, et al., 2009; Wiegmann, et al., 2007).

While the above studies demonstrate a strong safety focus on team training, performance, outcomes, assessments and measures, recent exploratory attempts must also be noted. Larsson and Holmström (2013) described the behaviors of excellent anesthetists in the operating room. Rydenfalt et al. (2012) examined how social and organizational structures affect communication and common tasks in surgery. Minnick et al. (2012) focused on understanding conditions before and during operative procedures that increase the likelihood of NREs. Curry et al. (2011) attempted to identify and characterize exemplary behaviors in the operating room. Arakelian et al. (2011) identified seven ways of understanding operating room efficiency. Moulton et al. (2010) explored manifestations of how surgeons are able to transition to a more effortful state (such as stopping a procedure) when

required. Finn (2008) examined discursive practices that produce professional divisions in the operating room. Waring et al. (2007) investigated how rituals normalize risk within the operating room. Riley and Manias (2006) looked at governance and control in operating room nurses' clinical practice. Edmondson (2003) documented how leaders of action teams promote speaking up and other proactive coordination behaviors. Lingard et al. (2002) explored the nature of communications among team members. Graff et al. (1999) investigated the implementation of a differentiated practice model in the operating room. Hirschauer (1991) described making bodies operable, cooperating, and creating anatomical visibility. Katz (1981) looked at elaborate rituals and technical procedures of the operating room.

On a side note: Judging by the studies referred to so far, teamwork in surgery appears to encompass not only debriefings, checklists, safety attitudes and climate, task completion, efficacy, and performance but also social and organizational structures, conditions surrounding operations, human factors, states of transition, discursive and differentiated practices, and exemplary and ritualistic behaviors, and so forth. (This wider understanding of teamwork is applied to this thesis, as defined in Subchapter 1.2.2.)

1.1.2 Determining a research question and research objectives

Given the above descriptions, this thesis is concerned with how current literature appears to direct larger efforts to illuminate safety improvements through training, performance, outcomes, assessments, and measures of teamwork. This stands in contrast to the limited explorations of the nature of interdisciplinary teamwork in surgical operations. Flin and Mitchell (2009) emphasized: *"Given the importance of anaesthetic, theatre nursing and surgical tasks for patient safety during an operation, it is surprising how little scientific investigation of working life has taken place in this domain. There are very few reports of the culture and behaviour patterns in surgical and anaesthesia units"* (p. 1). Hindmarsh and Pilnick (2002) supported the lack of explorations into cultural and behavioral patterns in surgical operations: *"Despite the wealth of studies of health-care teams and medical practice, we are left with little understanding of the skills that enable medical staff to come together for the duration of an operation and coordinate their work such that they are seen as professionals; competent in the practices that form the*

foundation to this community" (p. 141). Greenberg et al. (2006) called for *"a fundamental understanding of safety in the operating room"* (p. 130), where terminologies, models, and methodologies are needed that *"fully describe the spectrum of events and factors that are encountered in the operating room"* (p. 135).

Limited research explorations sparked this thesis' interest in how safety is actually achieved through everyday interdisciplinary teamwork in surgical operations (safe work practices). More specifically, the basic building blocks of how safety is achieved need to be discovered first within health care, and then incorporated into current practices in different ways (including training efforts), rather than focusing on training to improve aspects of teamwork that are bottom-up and effective to achieve safety in other sectors. Thus, the research question becomes: How are safe work practices achieved in interdisciplinary surgical teamwork? This research question directs exploration into interdisciplinary teamwork, from which a scientific model can be developed to study safe work practices in interdisciplinary teamwork. The importance of the model development is evident from the identified gaps above. The nature of interdisciplinary teamwork has yet to be properly explored within the health care sector. There is a need for scientifically grounded models that can be applied to, and integrate findings from, explorations of teamwork. Consequently, the main research objectives of the thesis are as follows:

I. Objective I is to determine a conceptual orientation for exploring safe work practices in interdisciplinary surgical teamwork.
II. Objective II is to operationalize the identified concept(s) through a field research protocol and a semi-structured interview guide.
III. Objective III is to explore safe work practices in interdisciplinary surgical teamwork by means of a qualitative study.
IV. Objective IV is to develop and validate a model that can be used to explore safe work practices in interdisciplinary teamwork based on the qualitative exploration.

The understanding that comes from the exploration in Research Objective III answers the research question.

1.2 Main concepts of this thesis

The research question and title of this thesis contain several concepts: "safe work practices," "interdisciplinary surgical teamwork," "model," and "validity." These are frequently used throughout the thesis, and thus need proper clarifications. The first two concepts are addressed next, while the latter two are respectively defined in Subchapters 2.2.1 and 3.4.1.

1.2.1 Safe work practices

The concept of safe work practices consists of two basic components: "safety" and "practice." In the literature on safety in surgery (cf. Subchapter 1.1.1), a connection between safety and practice can be seen in the safety-oriented focus on outcomes, assessments, and measures to improve teamwork in surgical practice. Another connection between safety and practice appears in the concept of "Community of Practice" (CoP). A CoP is a network of people who share information, build on existing knowledge, and develop expertise to solve problems for a common purpose (Huckson & Davies, 2007; Wenger, et al., 2002). An example of a common CoP purpose is the pursuit of evidence to support current practices (Huckson & Davies, 2007), including improving teamwork, outcomes, and safety in surgical practice. Safe work practices, or a safe outcome for the individual, team, and patient in surgical operations, can be understood as the product of the particular safety-oriented efforts (CoP-initiated or otherwise) to improve teamwork in surgical practice.

While the above understanding is useful for providing insights into connections between safety and practice in literature, this thesis applies an inductive research strategy aimed at reducing preconceptions (cf. Subchapter 2.2). In this sense, the focus on specific improvements in the literature-based definition above is too predefined and restricts an open-minded approach to the field. From the outset, this thesis views safe work practices in the broadest manner as: How safety is actually achieved through everyday interdisciplinary teamwork in surgical operations (cf. Subchapter 1.1.2). The later model development brings system and knowledge dimensions to the understanding of safe work practices (cf. Subchapter 2.4), in line with the inductive approach of refining concepts as the research proceeds (cf. Subchapter 2.2). The broad nature of these dimensions ensures that the researcher will be looking at any

aspects related to system and knowledge during the fieldwork, thus securing open-mindedness in orientation to the field (cf. Subchapters 2.2 and 2.4.4).

1.2.2 Interdisciplinary surgical teams and teamwork

This thesis specifically looks at interdisciplinary teams in surgical operations. As will be described and illustrated in Subchapter 1.3 ("the setting"), an interdisciplinary surgical team is composed of a selection of specialized nurses (typically one to two nurse anesthetists and two operating room nurses), physicians (typically one anesthetist physician), and surgeons (typically one to two operators). These teams are typically put together ad-hoc. Team membership/assignments does not carry over from day to day (Morey, et al., 2002). The interdisciplinary surgical teams were the main focus throughout this project, not only during the review process aimed at identifying team-related aspects (cf. Subchapter 2.4) but also during the observations, conversations, and interviews conducted with team members to explore the nature of safe work practices in teamwork (cf. Subchapter 3.2.2).

In terms of what is meant by teamwork in health research literature on quality and safety, Salas et al. (1992) define a team (and, implicitly, teamwork) as *"a distinguishable set of two or more people who interact dynamically, interdependently, and adaptively toward a common and valued goal/objective/mission, who have each been assigned specific roles or functions to perform, and who have limited life span of membership"* (p. 4). In other words, performing dynamic and interdependent tasks, sharing and adapting to common goals, and carrying out specified roles and functions represent components of teamwork. The adaptation component is supported by Baker et al.'s (2006) emphasis on anticipation and adjustment: *"Teamwork depends on each team member being able to anticipate the needs of others; adjust to each other's actions, and have a shared understanding of how a procedure should happen"* (p. 1579). The shared understanding element also connects with common goals in Salas et al.'s (1992) definition. Another component of teamwork is the team skills referred to in Subchapter 1.1, namely leadership, problem solving, communication, and decision-making (Catchpole, et al., 2008; Wallin, 2007; Østergaard, 2004). Since team skills imply both interaction and adaptation, this component (interaction) corresponds to Salas et al.'s definition (1992). In support of the team skills

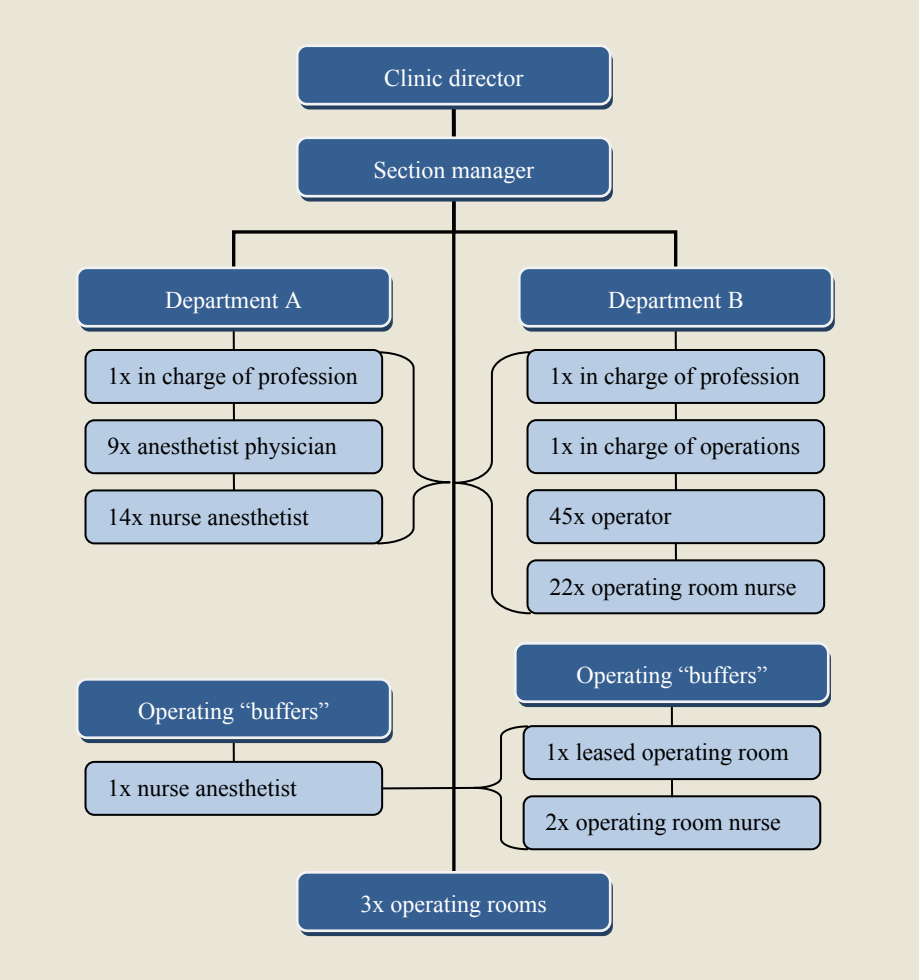
aspect of teamwork, Morey et al. (2002) stated: *"Teamwork is sustained by a shared set of teamwork skills"* (p. 1555).

This thesis aligns with the identified components of teamwork as follows: Through the research question aimed at understanding how safety is achieved in surgical operations, I recognize that team members share the common goal of ensuring a safe outcome for the patient. I recognize that surgical teams perform interdependent tasks (seen in team members' ability to anticipate future events through both explicit and tacit knowledge, cf. Subchapter 5.1.1). I recognize that team members hold specific roles and functions (seen in descriptions of the work zones, cf. Subchapter 1.3.3, and in the distribution of patient responsibility according to expertise, cf. Subchapter 5.1.1). I recognize the team-skills component by identifying such skills, namely communication, decision-making, experience and learning, in the scientific model development (cf. Subchapter 2.4.2), as well as in the findings (experience and learning constitute an expert, cf. Subchapter 5.1.1, while individuals' ability to handle multiple sources of information demonstrates aspects of communication and decision-making, cf. Subchapters 4.2.1 and 5.1.1). I recognize that surgical teamwork depends on team members' ability to adapt (seen in individuals' ability to handle unforeseen or unexpected situations, cf. Subchapters 4.2.1 and 5.1.1). Additionally, I view surgical teamwork as how teams interact, not only with each other, but also with the inner and outer parts of the system surrounding the surgical operations (cf. Subchapter 5.1.2). This broader understanding of teamwork aligns with the open-minded ("shaped through the fieldwork") approach to understanding safe work practices in this thesis (cf. Subchapter 1.2.1).

1.3 The setting

This section moves from a bird's eye view (the organizational structure of the surgical unit) to a fly-on-the-wall view that describes the logistics, layout, roles, and work zones associated with the operating room.

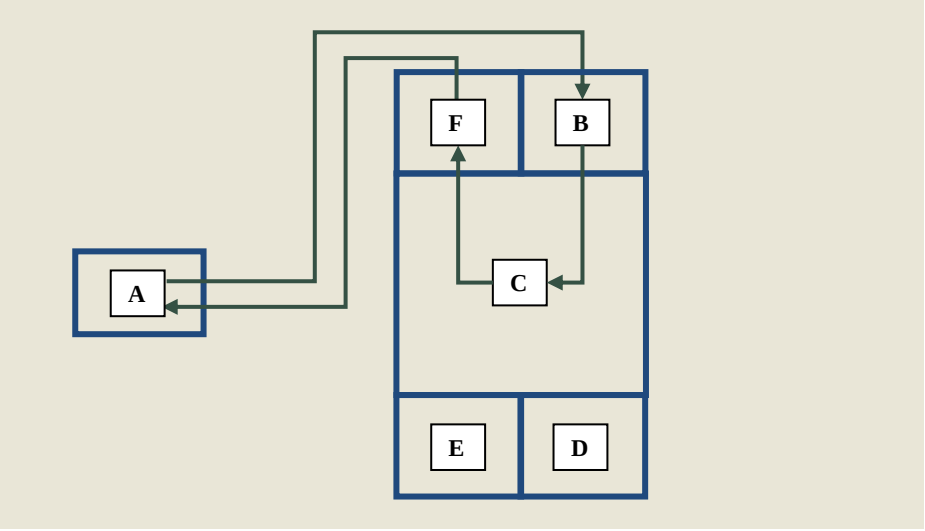
Figure 1: The structure of the surgical unit.



1.3.1 The organizational structure of the surgical unit

The clinic director is head of the unit and has overall administrative responsibility for the unit. This is followed by the section manager, who is responsible for everyday planning and coordination of the operating schedule and personnel. The unit is divided into two departments (A and B), each with a person in charge of a profession, who oversees their particular group. Within these two departments, the actual surgical team is drawn from a selection of specialized nurses (typically one to two nurse anesthetists and two operating room nurses), physicians (typically one anesthetist physician), and surgeons (typically one to two operators). The lower part of Figure 1 shows that these surgical teams work under buffered conditions. In other words, in addition to three operating rooms, the surgical unit also has access to extra resources (operating rooms and personnel) when the situation demands (such as emergency operations or a larger than usual patient queue).

Figure 2: Transporting the patient, and preparing the patient and the team.



1.3.2 Operating room logistics – patient and team interplay

The patient first arrives in the patient lock (A in Figure 2), where the ward nurse hands the patient and patient journal to one or more of the nurse anesthetists involved in the scheduled surgery. Assisted by an orderly, the nurse anesthetist(s) then transport(s) the patient through the corridors toward

the assigned operating room. They first reach the patient preparation room (B), where the nurse(s) present asks the patient for name, fast, history of allergies, and previous procedures. Depending on the particular procedure, the patient receives general or local anesthesia either in the preparation room (B) or in the operating room where the patient is next transported (C). In the operating room, the patient is moved from the ward bed to the operating bed, where they are properly positioned for the operation. Along with the orderly, the operating room nurses entering from the sorting room (D) and/or the material preparation room (E) often assist in positioning the patient. The operating room nurses also prepare the relevant instruments and equipment to be used during the operation, while the anesthesia personnel prepare syringes, medicaments, monitoring equipment, and so forth. The operator(s) usually enter(s) from the material preparation room during preparations and positioning of patient. They will gain an overview of the progress, confirm that the correct X-rays have been taken, and discuss aspects of the procedure. The operation begins following a timeout phase detailing the procedure, patient name, and risks. When general anesthesia is used and the operation is completed, the team waits for the patient to show responsiveness and then transports the patient via the extubation room (F) through the corridors to the assigned post-op ward. In case of local anesthesia, the patient is transported immediately via the extubation room once the operation is completed.

1.3.3 The operating room – layout, roles, and work zones

The operating room consists of two specific work zones. One is associated with operating personnel (dashed circle at the top of Figure 3), and the other is associated with anesthesia personnel (dashed circle at the bottom of Figure 3). The former is defined as the operating zone, and the latter as the anesthesia zone. A work zone is the general area for which the particular team member is responsible for and/or associated with from the beginning to the end of the operation.

The operating zone includes the operator(s) and operating room nurses (scrub nurse and circulating nurse). Specifically, a main operator is in charge of the procedure: Making the incision, operating, and closing the (marked) operating area of the patient. The main operator relies on the scrub nurse to provide the necessary equipment and instruments (which the nurse has prepared on the

instrument tables) and an assistant operator for input on progress and decisions to be made.

Figure 3: Layout of a typical operating room; zones, participants, and equipment.

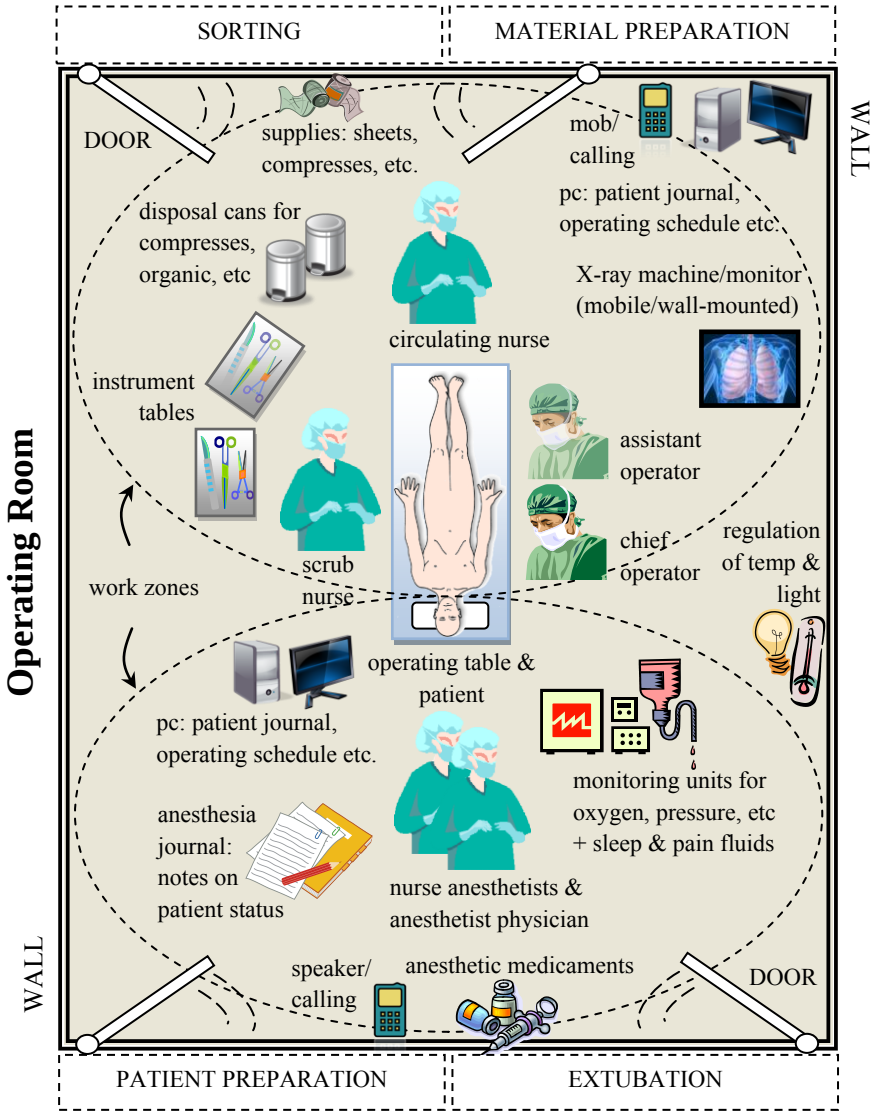


Figure 3 explanations:

- SORTING: In this room, operating room nurses prepare equipment and instruments for the particular operation.

- MATERIAL PREPARATION: In this room, the operators change into operating clothing before entering the operating room.
- PATIENT PREPARATION: Anesthesia personnel prepare for the operation, receive patient, and enter the operating room (with patient) from this room.
- EXTUBATION: Upon completion of the operation, the patient is transported out of the operating room via this room. In case of intubation, tubes are also removed in this room.

The main operator typically combines inputs both from colleagues and the X-rays (accessible from the wall monitor or mobile X-ray machine/monitor) to judge the procedure progress. The scrub nurse's job is to hand the main operator the necessary instruments, so rarely leaves the vicinity of the instrument tables. During certain procedures, the scrub nurse also assists the operator to maintain the patient in a steady position (for example, legs or arms) and helps the operator's access to the operating area. The circulating nurse keeps track of who is present during the operation (noting names and roles) and the upcoming operating schedule (planning and preparations) via the computer (upper right corner of Figure 3). The circulating nurse also observes and regulates who is allowed to enter and exit the operating room, maintaining sterile conditions as much as possible. In addition, the circulating nurse often obtains necessary supplies or equipment from the sorting room, other areas of the surgical unit, or even other areas of the hospital. However, both operating room nurses are responsible for managing equipment, instruments, and supplies in general, such as counting and sorting instruments before and after the operation.

The anesthesia zone (bottom section/dashed circle in Figure 3) is on the opposite side of the operating room. Within this zone, the anesthesia personnel administer general anesthesia, if needed, and also continuously monitor the patient's status. The monitoring is done visually/physically by looking at and touching the patient to determine if the patient reacts negatively (for example, gets cold or uneasy during general anesthesia) to different aspects/phases of the surgical procedure. Monitoring is also done electronically by observing the monitoring units (lower right corner of Figure 3). Combined, these efforts ensure that the correct dosages of sleep and pain-reducing medications are administered at any given time, and that oxygen, gases, and pressure levels are set correctly on the machines. Typically one to two nurse anesthetists take turns observing the vital data and writing it in the

anesthesia journal. The nurse anesthetist also keeps track of calls from outside, via the speaker/calling function, and keeps an eye on the upcoming operation via operating schedules on the computer (ensuring preparedness). Anesthetic medicaments are located directly behind the nurse anesthetist (illustrated in Figure 3), providing easy access, for example, to preparing and administering new sleep and pain dosages. The second member of the anesthesia zone is the anesthetist physician, who is responsible for carrying out the more skilled anesthetic procedures, such as insertion of an artery cannula for arterial blood pressure (BP). The anesthetist physician commonly stays directly outside the operating room, in the adjacent patient preparation room, where they monitor the patient's status from time to time, but also prepare for the next operation by reviewing the next patient's journal. However, the anesthetist physician is responsible for more than one operating room and often moves between several operating rooms, as needed.

In relation to the patient, the anesthesia zone is from the neck up because this zone focuses on respiratory functions. At this surgical unit, the operating zone is located from the neck down, focusing on back stabilizations, fractures, revisions, and extensions (cf. Table 2, Subchapter 3.1.4).

2 Conceptual Orientation and Model Development

To ensure overall consistency and transparency throughout the thesis, Chapter 2 describes the conceptual orientation and subsequent model development in this project. Specifically, the chapter begins with an account of the journey through a research process and the research strategy behind the project, followed by the theoretical reflections and the model development and validation process. Similarly, in Chapter 3 on methodology, the dimensions identified during model development are integrated into a field research protocol and a semi-structured interview guide (operationalization).

2.1 The journey through a research process

My journey began in 2004, when I was recruited to write my master's thesis on the project *Patient Safety – Managing Undesired Events in Health Care (2005–2007)*. At the time, my knowledge of patient safety research was nearly nonexistent and I was inexperienced in conducting literature reviews. Therefore, in building my master's thesis, I relied on literature with which I had become familiar during my master's coursework. Specifically, to fit both the overall patient safety orientation of the project and my existing knowledge level, I focused on error-management in the broadest sense (spanning from the department level to local/individual levels), and I applied theories on trust, resistance to change, and power structures. My master's thesis was entitled *Error Management in a Medical Clinic – A Product of Organizational Conditions* (Høyland, 2005).

Following this work, I continued my work on the patient safety project, as a research associate at the University of Stavanger. During this three-year period (2005–2008), my basic understanding of error reports/management evolved to include medication errors/handling and error-reporting systems (Aase, et al., 2008; Høyland & Aase, 2008b). Building on the growing migration of safety principles between sectors with strong safety records (so-called HROs) and the health care sector, I also began to investigate the concepts of interdisciplinary teamwork and safe work practices. As a first tangible effort, I compared the current status and challenges of transferring safety principles, such as communication, learning and simulation training,

from the civil aviation sector to the health care sector (Høyland, 2007). The general focus on safety principles was followed by a more specific focus on technical and nontechnical factors[5] relevant to interdisciplinary teamwork and simulation designs within health care (Høyland & Aase, 2008a). Along with these activities, I was involved in the project *Every Little Bit Helps? Risk Challenges and Parallel Change Processes Within the Norwegian Transportation Sector (2005–2007)*, in which my emphasis became change processes and complexity within civil aviation (Høyland & Aase, 2009).

Through these various projects, I discovered that complexity exists at different levels of a given system, such as the organization, and that structured and systematic approaches are required to represent the given complexity (Høyland & Aase, 2009). I also became aware that improvements in safety levels have been attempted via the between-sectors-transference of error-reporting practices, error-reporting systems, simulation designs and training, and the focus on nontechnical team skills (Aase, et al., 2008; Høyland, 2007; Høyland & Aase, 2008a, 2008b). However, these transferred ideals or principles for improving safety provided no concrete insight into how safety is achieved through the every-day work practices of interdisciplinary teams.[6]

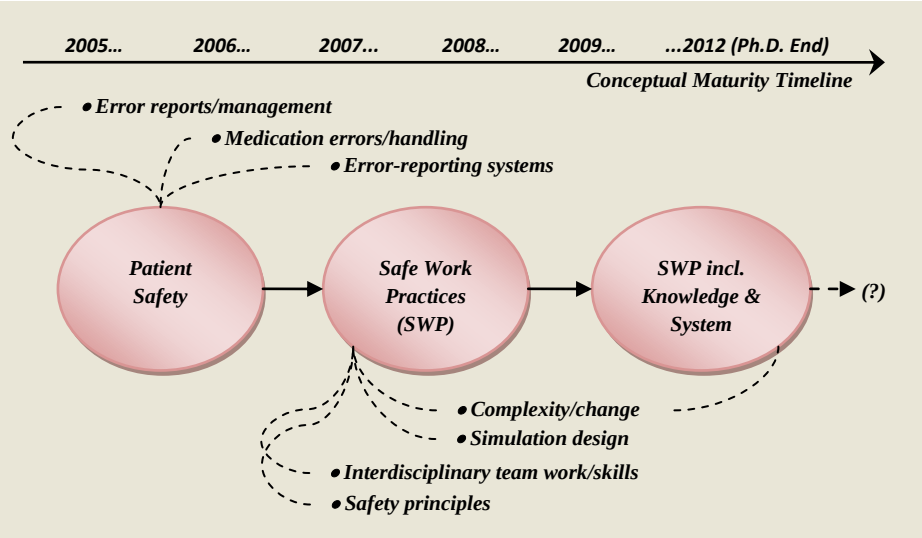
Thus, in January 2009, with my admission to the doctoral program in Risk Management and Societal Safety at the Faculty of Social Sciences, I decided to explore more thoroughly the nature of safe work practices in interdisciplinary teamwork. The understanding I gained through my previous projects and experiences, in terms of how to approach organizational complexity, supported a systematic approach to the exploration. This was developed in a paper I wrote in 2008, entitled *Reflections on Combining Research Approaches – Methodological Balancing Concerns.* Specifically, the paper focused on how to reach a balance between depth/details and transparency/structure in the later process of data analysis and presentation, based on the works by Miles and Huberman (1994) and Nielsen (1995, 2004). In the latter part of 2009, my momentum toward a systematic approach was

[5] Examples of technical factors include procedures and techniques, while nontechnical factors include planning, leadership, and communication.

[6] Mesman (2009) shares a similar view on safety, by promoting a need to define (patient) safety *"on the basis of what it is, instead of what it is not"* (p. 1705), or a need to recognize that safe work practices are about more than being error-free.

extended when I identified two broad concepts of knowledge and system that could be applied to explore safe work practices in interdisciplinary teamwork. More specifically, my previous experiences informed these concepts regarding the relevance of individual technical/nontechnical team skills and complexity and system in understanding the nature of teamwork. The concepts were also informed by electronic database literature searches (MedLine, ArticleFirst, ISI Web of Science, and ISI Cross Search). I used key words such as "teamwork," "nontechnical skills," "communication," "learning," "system," "complexity," and "ethnographic studies." In terms of conceptual development, the journey included theoretical reflections on knowledge and system concepts (cf. Subchapter 2.3), as well as a literature review process and a qualitative study to determine system and knowledge dimensions (cf. Subchapter 2.4).

Figure 4: The conceptualization of the journey.*



* Main concepts are in red bubbles. A bubble's width indicates the approximate time frame of the particular concept exploration. The bullet points next to the other concepts indicate the approximate time of these particular explorations.

Figure 4 summarizes the conceptual development during the journey, from the earlier phases and concepts examined during the first projects (2005–2007), to the later phases and concepts that are part of this project (2008–2012).

Furthermore, the journey involved operationalization of not only the identified knowledge and system dimensions, but also a balanced methodological approach for exploring safe work practices (cf. Subchapter 3.2). These operationalization efforts shaped a qualitative exploration of safe work practices in surgical operations (cf. Subchapters 3.1.3 and 3.2.2), which resulted in developing and validating a model for such explorations (cf. Subchapters 2.4, 3.3, and 3.4). The journey through the research process ended with the dissemination activities (cf. Chapter 4 and Part II of this thesis). Table 1 provides an overview of the complete journey in this project.

Table 1: An overview of the complete journey*

Time frame	Step in the journey	Addressed	Details and research objective
2008 – April 2010	*Conceptual orientation* toward the system and knowledge concepts	Subchapters 2.1 and 2.3	Orientation informed by previous experiences, literature searches, and theoretical reflections – corresponds to Research *Objective I*.
	Conceptual orientation toward the system and knowledge dimensions	Subchapter 2.4	Orientation informed by a three-phase literature review and a qualitative study – corresponds to Research *Objective I*.
January – April 2010	*Operationalization* of the dimensions (system and knowledge) and a balanced methodology	Subchapter 3.2	Operationalization of the dimensions and methodology through a field protocol and interview guide – corresponds to Research *Objective II*.
	Exploration of safe work practices in surgical teams**	Subchapters 3.1.3 and 3.2.2	A qualitative study of safe work practices in interdisciplinary surgical teamwork was undertaken – corresponds to Research *Objective III*.
January 2010 – Sept. 2011	*Development and validation* of scientific model for exploring safe work practices	Subchapters 2.4, 3.3, and 3.4	Based on a three-phase literature review and a qualitative study, the dimensions and aspects of the model were developed and validated – corresponds to Research *Objective IV*.
	Dissemination of findings through thesis Articles I-IV	Chapter 4 and Part II of the thesis	Findings from a qualitative study are described in Articles I-IV, while Article IV also addresses the model development and validation process

* The overlap between the time frames in the table illustrates the dynamic nature of this project, where conceptualization, operationalization, and model development and validation represented mutually influencing and continuously evolving processes.

** An experienced nurse anesthetist co-researcher was involved in the field work.

The following section describes the research strategy that supported the exploration and model development and validation efforts in this project.

2.2 The research strategy in this project

Several research strategies can be considered, given the desire to explore safe work practices in interdisciplinary surgical teamwork and develop and validate a scientific model for such explorations (cf. research objectives III and IV, respectively, in Subchapter 1.1.2). In the *deductive research strategy*, the researcher approaches from the top down with a general theory or model from which the specific hypotheses are derived and tested through observations to eventually confirm the original theory or model (Goetz & LeCompte, 1981; Pelto & Pelto, 1978; Trochim, 2001). By contrast, in the *inductive research strategy*, the researcher aims to reduce preconceptions (theories) by approaching from the bottom up to capture the true record of a phenomenon through observations and pattern recognitions, from which some general conclusions or theories are reached (Marcoulides, 1998; Medawar, 1969; Ridenour & Newman, 2008). In the *abductive research strategy*, the researcher aims to describe and understand social actors' motives and accounts through social discourse and, with no previous knowledge, conducts intellectual acts or mental leaps to discover new/unconventional ideas of how to combine and relate certain features (Blaikie, 2000; Levin-Rozalis, 2004; Peirce, 1955; Reichertz, 2010). The *retroductive research strategy* entails developing and testing hypothetical models that postulate underlying mechanisms behind empirical phenomena, where the researcher moves from observed empirical phenomena to their causes or mechanisms (Blaikie, 2000; Danermark, et al., 2002; Downward & Mearman, 2007; Sayer, 1992).

In choosing among these strategies for this project, my desire was to approach the field open-minded to allow empirical data to shape my understanding of safe work practices, including the model development. At the same time, I would bring with me a sense of (conceptual) direction to ensure a structure for the overall research process and model development. This approach aligns with the inductive notion that theories (and models) are reached through empirical pattern recognitions, but is less suited to the other strategies. Specifically, by starting out with a theory or model the deductive researcher seeks testing and confirmation rather than exploration. The abductive

researcher emphasizes mental leaps towards ideas that imply strong and risky interpretations. Finally, the retroductive researcher is committed to discovering the underlying mechanisms behind empirical phenomena, which also suggests a strong emphasis on interpretations. Thus, in securing an open-minded approach shaped by empirical findings rather than by leaps towards ideas or strong interpretations, the inductive strategy appeared most appropriate for this project and therefore was the one I selected.

2.2.1 Connecting the research strategy and model concept

The term "scientific model" is commonly used in literature (Ducheyne, 2008; Giere, 2010; Pluta, et al., 2011; Portides, 2005; Van Der Valk, et al., 2007), and signifies a model of scientific origin, rather than layman construction. In this thesis, "model" and "scientific model" have the same meaning and are used interchangeably. As for the compatibility between developing a scientific model and conducting inductive research in this project, Inkeles (1964) described a model as *"a rather general image of the main outline of some major phenomenon, including certain leading ideas about the nature of the units involved and the pattern of their relations"* (p. 28). Teller (2001) held an even broader view on what constitutes a model in science: *"In principle, anything can be a model, and that what makes the thing a model is the fact that it is regarded or used as a representation of something by the model users […] it would be a mistake for the general account of the use of models in science to specify more narrowly what can function as a model"* (p. 397). Similar to Teller, Giere (2010) suggested: *"Since just about anything can be used to represent anything else, there can be no unified [view on] models"* (p. 269).

From these definitions, as long as a scientific model attempts to create a representation of a phenomenon and the units involved, including their relations (cf. Inkeles above), model development is valid in any research tradition. Furthermore, since the definition of a concept is an abstract or general idea expressed in words or symbols (cf. Chapin, 1939, and philosopher John Locke), one could argue that the use of a model built around concepts conflicts with the concern for reducing preconceptions and allowing

data to speak for itself[7] in an inductive approach (Lincoln & Guba, 1985: p. 333).

However, by introducing concepts to explain egoistic suicide, Durkheim (1951) recognized that the researcher needs concepts at the outset to be able to make observations. As a result of Durkheim's work, the use of concepts became valid in an inductive research strategy, as Blaikie (2000) stated: *"Research within the inductive strategy involves collecting data by operationalizing concepts, and then searching for patterns in the data. Patterns become generalizations, and networks of generalizations become a theory"* (p. 178). Blaikie (2000) also explained the sensitizing tradition that can be part of an inductive research strategy: *"In the sensitizing tradition, the researcher sets out with one or a few rather general and vaguely defined concepts that are needed to provide an orientation to the research topic. Initially, this meaning will be established by exposition rather than definition. However, as the research proceeds, the meaning of the concepts will be refined to make them more relevant for their purpose"* (p. 137). Blumer (1954) first introduced the notion of sensitizing concepts by suggesting: *"Whereas definitive concepts provide prescriptions of what to see, sensitizing concepts merely suggest directions along which to look"* (p. 7).

In sum, concepts can be used at the outset of an inductive study to provide a rudimentary orientation (as in "directions along which to look"), such as during observations (The broad nature of the system and knowledge concepts identified in Chapter 2 qualifies for this criterion). The concepts can then be operationalized[8] (this project's operationalization process is described in Subchapter 3.2), adjusted and refined as the research process goes on and patterns emerge. (The concepts of this scientific model are validated through such a process; see Subchapter 2.4.) Finally, when enough patterns are

[7] My focus on reducing preconceptions and allowing data to speak for itself does not prevent any researcher brings preconceptions (such as previous research experience and knowledge of literature, theories, and methods) to the fieldwork (cf. my constructivist stance in Subchapters 3.1.1 and 3.2.3).

[8] Operationalization involves *"developing specific research procedures […] that will result in empirical observations of things that represent [certain] concepts in the real world"* (Rubin & Babbie, 2010: p. 165). Operationalization is applied in relation to the field research protocol and semi-structured interview guide (cf. Subchapter 3.2).

identified, the researcher can potentially generalize[9] (Subchapters 3.4.3, 6.1, and 6.3 suggest that aspects of the scientific model have generalizability for other interdisciplinary team settings).

Demonstrating inductive elements, the next section addresses the conceptual orientation process behind this project and the qualitative exploration, followed by descriptions of the model that emerged (Subchapter 2.4).

2.3 The theoretical reflections and considerations

In this section, I reflect on the considerations involved in determining the conceptual orientation for this project's focus on safe work practices in interdisciplinary teamwork.

2.3.1 Reflections on organizational safety concepts

Mindful of the knowledge and system concepts I identified in the journey through a research process (Subchapter 2.1), the inductive research strategy and positioning triggered theoretical reflections. As I concluded in Subchapter 2.2, the inductive research strategy allows the use of a model and related concepts as a rudimentary orientation to research. In other words, an inductive researcher can examine other theories and theoretical models to become better informed about concepts that might be useful to their particular exploration, as long as the concepts do not prevent the researcher from being open-minded about the field. The inductive research strategy, in turn, was informed by the broad-natured research question focused on how safe work practices are achieved in surgical teamwork (cf. Subchapter 1.1.2) and also by the broad-natured definition of safe work practices as how safety is achieved through surgical teamwork (cf. subchapter 1.2.1). Thus, in determining whether a particular concept reviewed in this theoretical reflection suited this project, it had to demonstrate a broad, open-minded focus on safe work practices in teamwork in line with both the research question and the inductive research strategy.

[9] I understand generalizability as the extent to which the scientific model established in this thesis can make sense in other (team) settings (cf. Huberman & Miles, 2002). Generalizability is discussed further in Subchapter 3.4.3.

The theories reviewed during this reflection were organizational safety theories with which I became acquainted through my master's study at the Centre for Risk Management and Societal Safety (SEROS), and explored through a conference paper (Høyland & Aase, 2009) and a doctoral course paper in 2009, entitled *Theoretical Reflections on Safety Management and the Implications to Understanding HTO-interfaces in Health Care*. I specifically reviewed safety theories in the works of Reason, Weick and Sutcliffe, Snook, and Vaughan.

Reason's (1997) Swiss cheese model has the premise that any organization consists of numerous levels/layers prone to both active failures and latent conditions. Active failures consist of sharp-end (operating end) errors and violations, such as a surgeon or nurse performing the wrong procedure on a patient. These failures are active because their occurrence and impact are immediate. The cause of active failures can be attributed to so-called latent conditions. These conditions lie outside individual psychology, and include gaps in supervision, training shortfalls in training, and inadequate tools and equipment. These latent conditions can be present in an organization for many years before interacting with active failures and local circumstances to penetrate several safety layers of the organization (the latent conditions and active failures thus become the holes in the Swiss cheese model).

Discussion: An examination of the nature of safe work practices in interdisciplinary teamwork is at the sharp end of the particular organization, making the concepts of active failures and latent conditions relevant, particularly given the number of adverse events that occur in surgical operations (cf. Subchapter 1.1). However, the difficulty in applying these concepts lies in the specific focus on failures (only one aspect of safe work practices) and on how these failures can be understood (connecting latent conditions to active failures and circumstances). The view that active failures and latent conditions interact over numerous organizational layers also makes the concepts very comprehensive for this thesis' focus on safe work practices in interdisciplinary teamwork. In sum, these concepts' specific and comprehensive nature did not appear to fit the broad and open-minded focus on safe work practices in teamwork, so was not included in the conceptual orientation. However, the fieldwork later revealed connections to Reason's

(1997) concepts, thus demonstrating the concepts' value in understanding safe work practices. These connections are discussed in subchapter 5.2.1.

I considered the mindfulness concept explored in previous research (a 2009 doctoral course paper). Specifically, Weick and Sutcliffe (2001) were concerned with a particular organizational vulnerability they called "dealing with the unexpected." These were events or problems at a strategic (decisional) or operational (practical) level that *"occur either when something that we expected to happen fails to happen or something that we did not expect to happen does happen"* (p. 2). To address the organizational vulnerability of unexpected events, they examined organizations that share a low rate of accidents, despite working under high pressure and trying conditions (so-called high reliability organizations [HROs]), and attempted to understand how these types of organizations are able to remain more resilient and reliable than non-HRO organizations. Weick and Sutcliffe (2001) identified one important organizational safety mechanism or principle that could account for the difference. This was the ability to be mindful, both at a managerial and operational level. At its core, mindfulness implies ways of thinking and organizing that have a higher likelihood of revealing unexpected events. One specific aspect of the concept is the preoccupation with even the smallest failure, where every signal or symptom of failure is treated as having potential severe or catastrophic (worst-case scenario) consequences for the system as a whole, such as when occurring with other failures. Another aspect of mindfulness is the "sensitivity to operations," or an awareness of the situation surrounding a particular operation or process that enables abnormalities to be recognized and addressed. As part of the situational awareness, relationships between one's own task and the related tasks of others are particularly important.

Discussion: Mindfulness is important not only to a team's ability to adjust to or anticipate events in surgical operations, but also to team members' interaction with each other and the environment (cf. the definition of teamwork in Subchapter 1.2.2). However, the concept represents only one aspect of safe work practices in interdisciplinary teamwork. The concept also has been highly refined through the focus on sensitivity to operations and preoccupation with failures. In short, applying this concept would cause this exploration to become highly focused, so appeared too restrictive to the broad

and open-minded focus on safe work practices in teamwork. Thus, the whole mindfulness concept was not included in the conceptual orientation. Despite this exclusion in the conceptual orientation, the fieldwork later revealed connections to Weick and Sutcliffe's (2001) concept, suggesting the concept's value in understanding safe work practices. These connections are discussed in Subchapter 5.2.1.

A third theory is Snook's (2000) causal map model. The essence of the author's theory and model is that the accidental downing of two Black Hawk helicopters by two F-15s over northern Iraq in 1994 was the result of a combination of individual and organizational factors. Specifically, because global procedures were perceived to be static and impractical, local adaptations of rules and procedures occurred both at an individual level (pilots of the Black Hawk helicopters and F-15s) and at an organizational level (practices within the control central). According to Snook, local practices gradually were detached from written procedures (the identified concept). Finally, the complex interactions among locally adapted practices of several actors, both at an individual and organizational level, contributed to the incident.

Discussion: The concept of local adaption and global detachment, in which local practices deviate from written procedures, is relevant to understanding the nature of safe work practices in interdisciplinary teamwork, particularly given that adaption constitutes a defining feature of teamwork (cf. the definition of teamwork in Subchapter 1.2.2). At the same time, the specific focus on deviations, as only one of many aspects relevant to understanding safe work practices, did not combine well with the broad and open-minded focus on safe work practices in teamwork. Thus, this concept was not included in the conceptual orientation. However, the fieldwork later revealed a connection to Snook's (2000) concept, thereby demonstrating the usefulness of aspects of this concept in understanding safe work practices. This connection is discussed in Subchapter 5.2.1.

Similar to Snook's (2000) concept, Vaughan (1996) viewed the Challenger Space Shuttle accident as a culmination of individual, organizational, political, and economic factors that shaped the NASA's practices over time. Specifically, NASA developed a tendency to normalize technical irregularities

and deviations (individual and organizational aspects). The organization also was affected by an institutional culture (structural secrecy) and a production-oriented culture that prioritized continued launching above thorough risk analyses (individual and organizational aspects). In addition, the organization struggled for continued support and resources from Congress and publicity (political and economical aspects). According to Vaughan (1996), the accident was a result of complex interactions among all these aspects.

Discussion: This theory contains an interesting concept of normalization and the complex interactions that foster it. The concept of normalization becomes particularly interesting when viewed in light of the inherent complexity of surgical operations (cf. Subchapter 1.1), which increases the risk of normalizing behaviors that include irregularities and deviations. However, the concept is centered on politics, economics, and the larger institution, making it too comprehensive/daunting for a qualitative study that explores the nature of safe work practices in interdisciplinary teamwork. The specific focus on irregularities and deviations also makes the concept too restrictive in understanding safe work practices (in other words, safety is about more than irregularities and deviations). Thus, the concept of normalization did not appear to fit the broad and open-minded focus on safe work practices in teamwork, so was not included in the conceptual orientation. The later fieldwork did not reveal any connections to Vaughan's (1996) concept.

A summary of the first reflections: During these reflections, I reviewed organizational safety concepts that could be applied to the exploration of safe work practices in interdisciplinary teamwork. However, I determined that the specific focuses and comprehensive scope of some of these concepts would be less suited to the broad and open-minded focus on safe work practices in teamwork derived from the research question and the inductive research strategy. Thus, at this stage in the conceptual orientation, I decided to rely on the concepts of knowledge and system identified in the journey through a research process (cf. Subchapter 2.1).

2.3.2 Reflections on team-oriented safety concepts

During a three-phase literature review begun in January 2010 (described in Subchapter 2.4), and as part of a journal manuscript preparation process,[10] several team-oriented safety concepts emerged for consideration in the conceptual orientation. The potential values of the concepts in ensuring a broad and open-minded focus on safe work practices in teamwork were evident. They all were developed to address aspects of teamwork specifically.

The first model was a version of the Non-Technical Skills (NOTECHS) scoring system, intended to measure team skills such as leadership, situation awareness, decision management, and so forth. Although the focus of this study is on exploration rather than measuring, the NOTECHS concept is still highly relevant, specifically, the operative NOTECHS measurement framework, as adapted by Catchpole et al. (2007) for use with operative teams. The adapted framework/concept includes "leadership and management," "teamwork and cooperation," "problem-solving and decision making," and "situation awareness." Each dimension is defined in great detail with observational markers to look for, such as the "notice" marker in situation awareness that includes "considers all elements," "asks for/shares information," "encourages vigilance," "request reports and updates." The overall aim of the adapted framework is to measure behaviors along a scale of 1 (below standard) to 4 (exceed). For example, a surgeon who ignores an appropriate suggestion by another team member is given a basic or below-standard score, on the "teamwork and cooperation" dimension, while team members who are aware of, and discuss, the progress of the operation and the patient's state are given a "standard or exceed" score on the "situation awareness" dimension. The focus of the NOTECHS concept in Catchpole et al. (2007) is on recording negative events, such as minor and major problems that can affect an operation and safety.

Discussion: Through the focus on leadership, cooperation, decision-making, and so forth, the adapted NOTECHS concept addresses the team skills component of teamwork identified in Subchapter 1.2.2. This makes the concept relevant to an exploration of safe work practices in interdisciplinary

[10] The work on, and revisions of, this manuscript led to the main article of my project, Høyland (2012), published in *Safety Science*.

teamwork. However, the concept has highly defined components and dimensions, such as the specified observational markers, which counteracts an open-minded inductive approach in this project. The concept is also specifically oriented towards deviant behaviors that constitute a risk to the operation. This is particularly seen in the emphasis on minor and major problems, which represents only one aspect of teamwork. Consequently, the NOTECHS concept did not appear to suit a broad and open-minded focus on safe work practices in teamwork, so was not included in the conceptual orientation. Despite this exclusion during the conceptual orientation, the fieldwork later revealed a connection to Catchpole et al.'s (2007) concept, suggesting the concept's value in understanding safe work practices. This connection is discussed in Subchapter 5.2.2.

The second model considered was the configurations of key support for team situation awareness (TSA), illustrated in Mackintosh et al. (2009). Specifically, the aim of the study was to describe the main mechanisms supporting TSA, and examine contrasting configurations of supports. The study applied an ethnographic approach of nonparticipant observations in delivery suites of four U.K. hospitals. The authors identified three particular configurations of supports that promoted or inhibited TSA from most ideal to least ideal: "strong and balanced supports," "diminished key supports," and "adaptive, but at risk." In "strong and balanced supports," the same methods were used across the team to gather and disseminate information, thereby facilitating work and team coordination. Only minor threats to TSA were present, resulting in a configuration of support that promoted high levels of TSA. The interplay between the different supports was central to achieving and sustaining TSA.

Discussion: The TSA concept is particularly interesting because it aims to capture the nature of teamwork in a medical setting and, importantly, it focuses on how safety is achieved and maintained. Compared to the concepts reviewed so far, TSA focuses on configurations that support, rather than represent threats (such as deviations and failures) to teamwork. However, TSA represents only one aspect of teamwork, which leads to a highly specific focus that appeared to be unsuited to the broad and open-minded focus on safe work practices in teamwork. Consequently, it was not included in the conceptual orientation. However, the fieldwork later revealed connections to

Mackintosh et al.'s (2009) concept, thereby demonstrating usefulness in understanding safe work practices. These connections are discussed in Subchapter 5.2.2.

The third model was a sociotechnical view of influences on surgical team performance and surgical outcomes in Leach et al. (2009). The model is a result of the authors' exploration of contributing factors to surgical outcomes through their observations and interviews at a university medical center. Specifically, Leach et al. (2009) found that surgical outcomes are influenced by individual experience and competence, and collective knowledge and experience, which inform and shape role expectations and performance. At the same time, they found that the work environment, managerial systems, and organizational processes influence these roles and individual capabilities. The findings were represented in their sociotechnical model as "system influences" ("equipment," "scheduling," "room setup," "supplies," and "training") on the one side, and "outcomes" ("patient," "individual," "team," and "organizational") on the other. Roles of the various team members were in the center, with individual and collective experience and competence surrounding this center.

Discussion: The concept of sociotechnical influences (influences from system, processes, and experiences) is highly relevant to the exploration of teamwork. Specifically, I previously defined a component of teamwork to be how teams interact with the inner and outer parts of the system surrounding surgical operations (cf. Subchapter 1.2.2), aligning with the sociotechnical concept. However, the primary and specific focus on input → performance → surgical outcomes addresses but one aspect (measurement) of teamwork, which limits an exploration of safe work practices. The concept also adds to my criticism of the existing studies for the strong emphasis on training, outcomes, performance, assessments, and measures compared to the few explorations of teamwork (cf. Subchapter 1.1). Thus, the whole concept did not fit well with the broad and open-minded focus on safe work practices in teamwork, and as a result was not included in the conceptual orientation. The fieldwork later revealed connections to Leach et al.'s (2009) concept, demonstrating usefulness in understanding safe work practices. These connections are discussed in Subchapter 5.2.2.

A summary of the second reflections: These particular team-oriented safety models were not included in the conceptual orientation and model development, mainly because each has a focus that is too specific and thus restrictive to the broad and open-minded focus on safe work practices in teamwork derived from the research question and the inductive research strategy. Consequently, I decided to rely on the system and knowledge concepts identified in the journey through a research process (cf. Subchapter 2.1). It must be emphasized that while neither the organizational nor team-oriented safety concepts were included as a conceptual orientation during the fieldwork and the model development in this project, the fieldwork did trigger an awareness of connections between my findings and these concepts. These connections were briefly mentioned throughout this subchapter and are thoroughly addressed in Subchapter 5.2.

Descriptions next of the development and validation of a scientific model for exploring safe work practices, concludes Chapter 2.

2.4 Development and validation of a scientific model

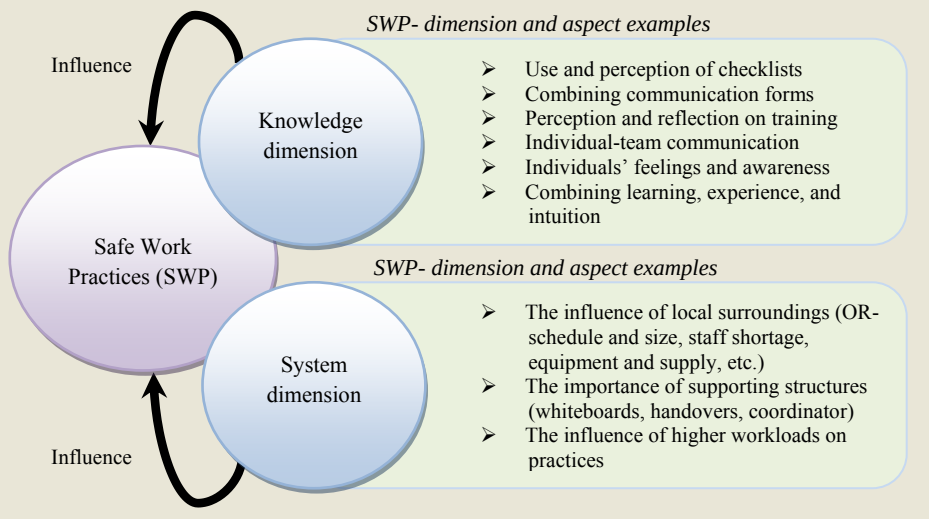
A three-phase literature review was conducted, aimed at refining the conceptual orientation towards the system and knowledge concepts (cf. Subchapters 2.1 and 2.3). This was done parallel to a qualitative study of a surgical unit. This review process represented the first steps in developing a scientific model for exploring safe work practices. Specifically, online searches were combined with searches within a local EndNote database to identify and determine team-related aspects and dimensions of a frame for exploration.[11] Empirically based, original articles and findings were specifically identified during the review, as a response to Manser's (2009) identification of the need for a scientifically grounded model that can integrate existing findings. The first phase of the review consisted of identifying team-related aspects commonly addressed in original health research literature on quality and safety. Electronic online databases (PubMed, Web of Science, and Academic Search Elite) were searched for the key words: "team," "health care," "result," or "finding." The search was narrowed to original articles, where the actual hits in the online databases varied between 100 and 400 articles. Of the hits that primarily focused on team, such as in relation to a particular profession, primary care or surgery, the following recurrent aspects were identified (closely related aspects are grouped): "communication," "training or performance," "experience or learning," "management or organization," and "complex or context" (cf. Høyland, 2012).

[11] Høyland (2012) and this Subchapter (2.4) describe this model's two main functions: to serve as frame for exploration during the field work, and to represent and adjust the understanding of safe work practices throughout the field work. This signals a model that evolved continuously rather than one that was "fixed." Accordingly, in this thesis the first installments of the model (cf. Figures 5 and 6) have been labeled a "framework" or a "frame for exploration." As for using literature reviews to inform the conceptual orientation, this finds support in McGhee et al.'s (2007) perception of reviews as beneficial in providing an "open minded but not empty headed" field approach (p. 336), and Owens and Hekman's (2012) inductive account of conceptualizing leader humility through several reviews, followed by concept operationalization through an interview protocol (a process similar to this project).

2.4.1 An initial understanding of the system dimension

In the second review phase, the aspects identified above were systemized according to specific dimensions that could fit a framework for exploring safe work practices.[12] System became a natural category for including aspects such as "management or organization" and "complex or context." As for support, there was health research literature specifically on quality and safety. Catchpole et al. (2006) explored the systemic aspects affecting pediatric cardiac surgery, described as patient threats (related to anatomy and physiology) and environmental threats (related to equipment, workspace, and external resources). Infante (2006) argued for a systems model that made the broader system dimension explicit, including environment, organizational factors, structural factors, system design, adaptation, and policy (p. 520). General support exists for the view that health care is a complex and adaptive system in which people can act in unpredictable ways, and patient, clinicians, and technology actions are interconnected in so-called clinical microsystems (Barach & Johnson, 2006; Donaldson & Mohr, 2000; Mohr, 2000; Mohr, et al., 2003; Mohr, 2004; Quinn, 1992).

Figure 5: The frame for exploration – first step toward a model.*



[12] The understandings of the dimensions and safe work practices in Subchapters 2.4.1 to 2.4.3 are provided "as is," in that they represent the literature stage of the model development process, including weaknesses that can be identified retrospectively.

* The framework as per February 2010. The emphasis on "influence" is removed in the improved version of the framework (cf. Figures 6) because of the implicit determinism that is unsuited to inductive research (in other words, research would examine aspects of the dimensions as "influences" on safe work practices).

In sum, a broad range of perspectives point to the relevance of viewing the system in relation to safety and safe work practices. Thus, the system became a dimension of the framework. Given that the literature I had reviewed did not provide a clear distinction between the identified aspects of the system dimension (Høyland, 2012), my particular understanding of the system dimension includes "inner structures," defined as the team-related aspects within the operating room (such as equipment and supply), and "outer structures," defined as external factors related to the operating room, anchored to structures and management (such as policies, workload, and operating room size) (cf. Figures 5 and 6 and also Høyland, et al., 2011b).

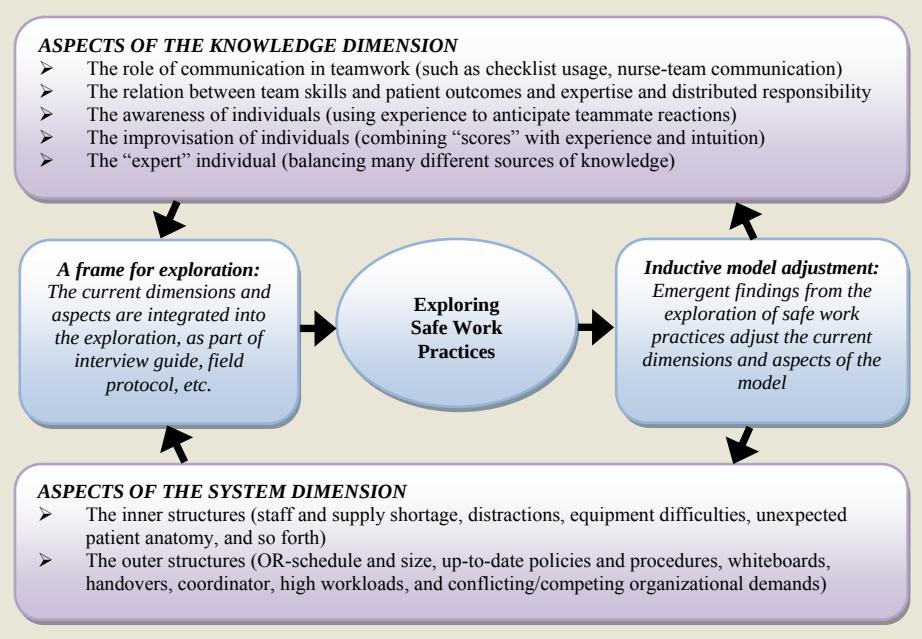
2.4.2 An initial understanding of the knowledge dimension

The common factor of the remaining aspects identified in the first review phase ("communication," "training or performance," and "experience or learning") is their basic anchor to knowledge. From the perspective of evidence-based medicine (EBM), knowledge rests on a technical rationality model, where an individual problem-solves according to established scientific theories and techniques (Schön, 1991, p. 21). The technical rationality model represents "proven and explicit knowledge repertoire" on which operating room personnel rely, comprising procedures, protocols, routines, and so on. However, critiques of the technical rationality view argue that one must account for the kinds of knowledge health care personnel actually use in practice. Not only explicit, but also tacit elements of knowledge, such as clinical judgment and expertise, come into play (Braude, 2009; Haynes, 2002; Henry, 2006; Polyani, 1966).

With this understanding, the connection between knowledge and the remaining identified aspects can be made. Specifically, the communication aspect has explicit knowledge elements, expressed as protocols or routines that over time have proven to be "the right way of doing things." For example, checklists are typically used as cognitive aids during task completion (Hales, et al., 2008) and are important for information exchange and team cohesion in

the operating room (Lee, 2010; Lingard, et al., 2005). Other ways of communicating occur through body language and listening (Friedman & Bernell, 2006), as well as through the selective use and control of information flow (Riley & Manias, 2009). These last examples illustrate the less visible sides of communication; the tacit knowledge elements. Similarly, performance will be shaped by the explicit knowledge elements developed through training, such as economy of hand motion to measure technical competence (Grober, et al., 2010) or formal instruction for more advanced technical skills (Benson, et al., 2010). However, skilled judgment based on personal experience also influences performance (Thornton, 2006), enhancing the ability to handle patients and recognize the limits of safe practice (Smith, et al., 2006). These are tacit knowledge elements.

Figure 6: The improved frame for exploration – second step toward a model.*



* The framework as it appeared in the manuscript submitted to *Safety Science*, June 2011 (cf. Høyland, 2012). The content of the two dimensions are derived from the three-phase literature review. Descriptions of the framework's logic and dynamic ("how it works") are provided in Subchapter 2.4.3, along with clarifications of how the concept of safe work practices relates to aspects and dynamics of the framework.

In sum, the described links between different types of knowledge and the remaining aspects identified from the literature review suggested that knowledge represents a second dimension of the framework. Specifically, knowledge comprises explicit/encoded aspects shaped by textbook understandings of various procedures and tacit aspects shaped through experience and exposure to various clinical situations (cf. Figures 5 and 6 and also Høyland, et al., 2011a).

Following the online databases review (first phase) and the systemization of the identified aspects (second phase), the final stage of the three-phase review consisted of determining additional support for, and validity of, the identified system and knowledge dimensions (cf. Figures 5 and 6). In this effort, a local EndNote database on health research literature was used. The database contained about 500 scientific references to publications in the area of health research on quality and safety. The database mainly featured articles addressing a wide range of health care safety topics from training and simulation to culture and risk governance. The database references originated from searches conducted between 2005 and 2010, mainly via electronic online databases such as ArticleFirst, Medline/PubMed, Web of Science, ISI Web of Knowledge, and Academic Search Elite.

To obtain an overview of relevant publications in this database, combinations of key words and search phrases were used from the first review phase in relation to the identified dimensions and aspects. Specifically, the knowledge dimension was searched using "team" and "finding" or "result" in combination with "communication" (55 hits), "training" or "performance" (73 hits), and "experience" or "learning" (50 hits). The system dimension was searched using "team" and "finding" or "result" in combination with "management" or "organization" (94 hits), and "context" or "complex" (45 hits). Judging from the number of hits, both the knowledge and system dimensions had support in health research literature on quality and safety. The hits were then reviewed to identify articles that demonstrated both original findings and a high relevance to the identified team-related aspects and dimensions. The original findings identified from this review (cf. Tables 1 and 2 in Høyland, 2012) were compared and combined into aspects of the two dimensions, as shown in Figure 6.

2.4.3 An initial understanding of safe work practices

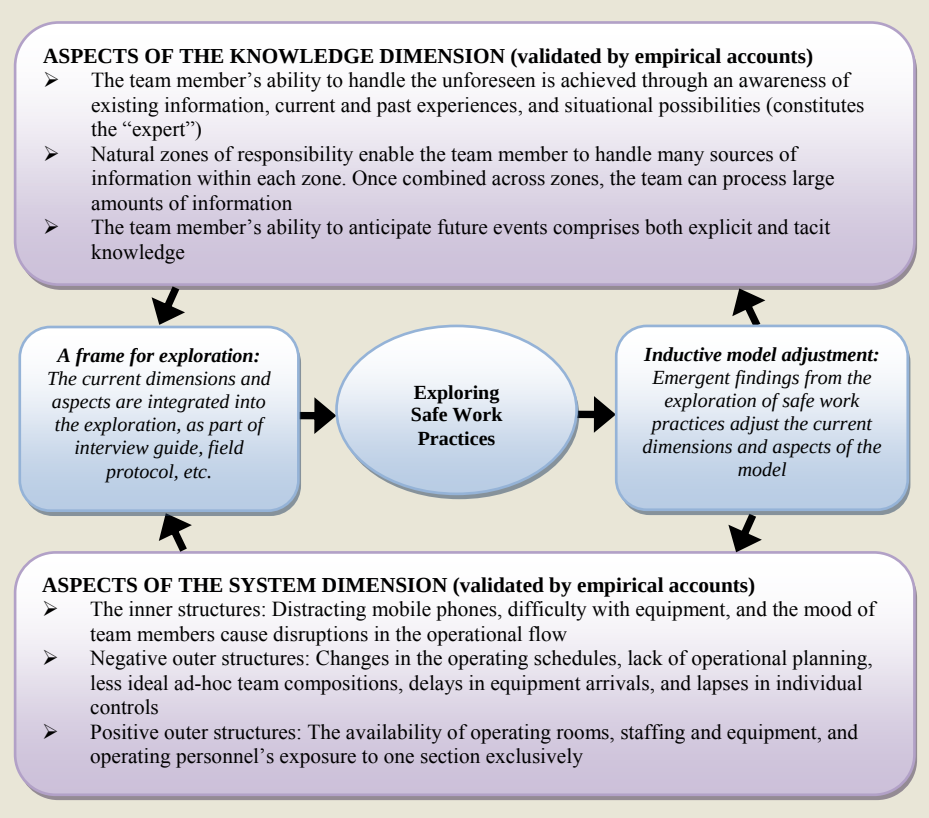
Subchapter 1.2.1 viewed safe work practices in the broadest manner as how safety is actually achieved through everyday interdisciplinary teamwork in surgical operations. This corresponds with the inductive research strategy that aims at adjusting and refining the understanding of concepts in the fieldwork (cf. Subchapter 2.2). Consequently, model development evolves. Supportive of this strategy, the framework (cf. Figures 5 and 6) suggests that safe work practices comprise two broad dimensions (knowledge and system) that were refined throughout the inductive research process (cf. "inductive model adjustment" in Figure 6). Compared to the classic deductive model that seeks testing and confirmation of a theory and related hypotheses, the framework provides only a rudimentary orientation for exploring safe work practices in the field (cf. "a frame for exploration" in Figure 6). Thus, fieldwork shapes the understanding of safe work practices as a concept, in line with the inductive research strategy.

The overall logic and dynamic of the framework are as follows: Literature reviews inform the knowledge and system dimensions in Figures 5 and 6. The resulting understandings of the two dimensions are then integrated into the exploration (the qualitative study) as part of the field protocol and interview guide. This is indicated by the arrows pointing towards the left and middle rectangle in Figure 6. As suggested by the arrow pointing towards the circle of the framework, the operationalization of the dimensions into a field protocol and interview guide (cf. Subchapter 3.2) provides a rudimentary orientation for the researcher's fieldwork (cf. "a frame for exploration"). In this project, the orientation is toward exploring safe work practices. Once the researcher conducts fieldwork, the emergent findings refine the existing understanding of the knowledge and system dimensions, as indicated by the arrow from the circle towards the right middle rectangle and by the arrows pointing to the upper and lower rectangles (cf. "inductive model adjustment"). This refined understanding then adjusts the current knowledge and system dimensions, which again adjusts the field protocol (what to look for during observations) and interview guide (what to ask about). This dynamic process then repeats, until the researcher concludes the fieldwork.

2.4.4 Validation of a scientific model

The system and knowledge dimensions were validated through a qualitative study (cf. Subchapter 3.2.2), concurrent with the three-phase review process. Specifically, data collected through the qualitative study[13] were used to inform the understanding of dimensions and aspects of the model shown in Figure 7 (This validation process is described in Subchapters 3.2.2–3.2.4 and 3.3.)

Figure 7: The "empirically validated" scientific model.*



* The model as it appeared in the manuscript submitted to *Safety Science* (cf. Høyland, 2012). The content of the two dimensions comprise empirical findings from the qualitative study that support the existing dimensions and improve understandings of the dimensions and safe work practices.

[13] See Chapter 4 for details on the empirical findings.

The emergent findings from the qualitative study provided insights into safe work practices (see the empirical understandings later), which also supported the existing dimensions of system and knowledge (cf. Figures 5-7). The fit of data to the model (validity) suggests that the dimensions have generalizability to future research within medical/team settings (cf. Subchapter 3.4.3). As for potential weaknesses of the model, the broad/inclusive dimensions could be viewed as a concern. However, experiences from the qualitative study suggested that the broadness should be viewed as an advantage. Specifically, the broad nature of the model provided a relatively open-minded approach to the fieldwork, in contrast to a highly specific model focusing exclusively on communication, expertise or similar, which would narrow the researcher's disposition and vision. In support of this, Subchapter 3.2 describes how the knowledge and system dimensions were integrated into a field protocol (operationalization approach) as a basic checklist of what to look for during the fieldwork – an approach neither too specific nor too broad (as in an "all-encompassing checklist") that also reduced feelings of being overwhelmed by many field impressions, particularly in the initial phase of the fieldwork. In addition, the checklist provided a basic foundation for organizing the findings at an early stage of the fieldwork. As part of the qualitative study, a semi-structured interview guide was created, incorporating the knowledge and system dimensions (operationalization approach) on the one hand and adjusting to particular findings in the fieldwork on the other (cf. Subchapter 3.2). This demonstrates the benefits of a broad-natured design.

2.4.5 Empirically informed understandings

The empirical findings (Figure 7) elicit empirically informed understandings of how the knowledge and system dimensions relate to safe work practices, supporting the bottom-up approach of the inductive research strategy (cf. Subchapter 2.2). Specifically, observations of surgical operations revealed the team's focus on a minimum of errors and complications as an important aspect of the individuals' and team's work philosophy. As Figure 7 suggests, individuals and the team drew upon, and combined, various aspects of both explicit and tacit knowledge to achieve safe work practices. The emergent findings also suggest that safe work practices resulted from the individuals' and team's continuous efforts to adjust to and compensate for vulnerabilities and disruptions during the operation, as well as the ability to utilize accessible

resources. From this understanding, safe work practices can be defined as the dynamic and continuous effort by each individual team member and the overall team to combine and draw upon explicit and tacit knowledge repertoires to achieve a successful operation with minimal errors and complications. Safe work practices also can be viewed as the overall organization's ability to maintain inner and outer (system) conditions that are strong enough to support individual and team abilities to combine and draw upon knowledge repertoires.

Chapter 3 provides insight into the methodology that supported the exploration, model-development and validation efforts, including the integration of the knowledge and system dimensions into a field research protocol and a semi-structured interview guide (operationalization).

3 Positioning, Operationalization, and Quality

Chapter 3 begins with descriptions of my position as a researcher and the nature of the exploratory approach in this project. This is followed by descriptions of how the identified knowledge and system dimensions were operationalized with the creation of a research protocol and a semi-structured interview guide. The chapter continues with descriptions of the data collection and analysis processes, and the efforts in validating the scientific model and determining the quality of the project. Chapter 3 concludes with reflections on ethical considerations and methodological strengths and limitations.

3.1 Positioning as a qualitative researcher

My recent exploration of changes in the civil aviation system (Høyland & Aase, 2009) and experiences from the doctoral course *Reflections on Combining Research Approaches: Methodological Balancing Concerns,* promoted a tantalizing idea. Balanced representations of data could be achieved by combining transparent/structured overviews (Miles & Huberman, 1994) with in-depth/detailed textual descriptions (Nielsen, 1995, 2004).

3.1.1 A balanced methodological approach

Miles and Huberman (1994) are representative of a minimalist research vein, concerned with representing data in a structured, standardized, and accessible way via matrices. They believed that methods of analysis should be practical, communicable, not self-deluding, and that the lack of *"a bank of explicit methods to draw on"* (p. 2) remains an obstacle to tackling qualitative research. They suggested that researchers need to share their craft, specifically *"the explicit, systematic methods we use to draw conclusions and test them carefully"* (Miles & Huberman, 1994: p. 3). They also suggested that the highest priority for researchers should be *"the creation, testing and revision of simple, practical, and effective analysis methods"* (p. 3). They placed their line of thinking in a realism and transcendental realism doctrine or vein within naturalistic research. Transcendental realism implies the belief *"that social phenomena exists not only in the mind but also in the objective world – and that some lawful and reasonable stable relationships are to be found among*

them" (Miles & Huberman, 1994: p. 4). In other words, they believe that a reality exists independent of the researcher, which the researcher's accounts can capture (ontological perspective; Burrell & Morgan, 1979). The focus on seeing the observer and observed as separate entities implies that the transcendental realism approach can be associated with the positivist paradigm,[14] and is typically applied by the researcher who believes it is possible *"to discover and represent faithfully the true nature of social phenomena"* (Hammersley, 2002: p. 66). Miles and Huberman's positivist line of thinking suggests that methods for analysis and representation should be kept minimalistic (relying on categorization and matrices), practical, simple, explicit, and, thus, easy to communicate to the reader. In short, the particular method(s) should be transparent in nature.

At the other end of the spectrum, Nielsen's (1995) "up with the text" approach focuses on textual richness. Nielsen's perspective is characteristic of the social anthropologist who seeks to describe the world views and interpretations of individuals, through extensive contact with a given community. While this approach lacks the structure and transparency of Miles and Huberman (1994), the strength lies in the dense and thorough textual descriptions that capture the uniqueness of the phenomenon under study, which is a "maximalist" research approach. Although Miles and Huberman's realism view has been applied in qualitative research, the qualitative researcher is increasingly concerned with reality as a construct of people's interpretations and related actions (ontological perspective; Hammersley, 2002).[15] Wadel (1990) also emphasized that reality is a social product constructed by humans *"involving every part of the reality that concerns relations between humans […] upon this reality formed by social processes and the society, social scientists have constructed a social scientific reality"* (p. 121).[16] Consequently, whether viewed as constructed or independent (positivist vein) of the researcher, a minimalist approach of categorization will

[14] A paradigm *"rests upon distinctive foundations and applies a specific approach to researching the social world"* (Barron, 2006: p. 212), such as the positivist paradigm that emphasizes measurements in the collection and analysis of data.
[15] An ontology defines *"what is real in the world, whether physical or abstract structures"* (Schuh & Barab, 2008: p. 70), seen in this case in the view of reality as independent of the researcher (foundation of the positivist paradigm).
[16] Paraphrases translated from Norwegian.

capture the more general trends or patterns that emerge from the processes, interpretations, and actions that individuals convey to the researcher through observations, interviews, and so forth. However, the complex and social nature of these processes, interpretations, and actions require the deeper descriptions of observations, interviews, and so forth, in line with a maximalist approach.

Overall, the coursework provided the necessary components of a balanced methodological approach for exploring safe work practices. Specifically, the approaches are complementary, rather than contradictory, and could be combined between the emphasis on depth (detailed insights and descriptions) in the maximalist approach and the emphasis on structure and transparency (practical, explicit, conveyable) in the minimalist approach. This combined "minimalist and maximalist methodological approach" takes into account the complexity of the constructed reality and, at the same time, the need to communicate this reality in a structured and transparent way that signals not only a concern for the reader's accessibility to research, but also for sharing one's craft and thus making qualitative research methods explicit (as called for by Miles and Huberman). This approach became the methodological balancing strategy, later transferred to a practical field research protocol and interview guide (see Subchapter 3.2.1).

3.1.2 Recognizing the positioning alternatives

In terms of methodological positioning, the fundamental question had to be decided; whether to investigate the phenomenon safe work practices by means of numeric data and statistical methods (Best & Khan, 1989; Blaxter, et al., 1996; Little, 1991), by non-numeric data and exploratory/qualitative research methods (Denzin & Lincoln, 2005; Marshall & Rossman, 1998; Silverman, 2004), or by combining both types of methods (Brewer & Hunter, 1989; Creswell, 2003; Newman & Benz, 1998). This was not a hard choice to make, judging by the limited explorations of teamwork in surgical operations (cf. Subchapter 1.1.2): *"Despite the wealth of studies of health-care teams and medical practice, we are left with little understanding of the skills that enable medical staff to come together for the duration of an operation and coordinate their work such that they are seen as professionals; competent in the practices that form the foundation to this community"* (Hindmarsh &

Pilnick, 2002: p. 141); *"There are very few reports of the culture and behavior patterns in surgical and anaesthesia units, apart from some accounts from sociologists, journalists, and personal recollections from surgeons"* (Flin & Mitchell, 2009: p. 1); *"The empirical evidence on the role of the OR environment in the safety and quality of surgical care […] is almost non-existent"* (Sevdalis, et al., 2009: p. 405).

The challenge lies in changing the view of "system" as something that is taken for granted and typically seen as the "whole" (Infante, 2006). Thus, the nature of interdisciplinary teamwork in surgical operations, including the system conditions that surround these practices, has yet to be properly explored. Consequently, until a basic understanding of safe work practices has been achieved through qualitative exploration, no sound variables are available to be explored quantitatively through correlations and relationships. This line of argument represents the rationale for selecting an exploratory approach to the study of safe work practices. In terms of positioning within the exploratory approach, I view reality as complex and socially constructed (cf. Subchapter 3.1.1), in line with the constructivist idea that the observer and the observed, or "knower and know" in Guba and Lincoln's (1985) terminology, are interactive and, therefore, inseparable entities (p. 37).

Related to key features of qualitative research, the specific nature of this exploratory approach is discussed next.

3.1.3 An exploratory approach to the study of safe work practices

According to Denzin and Lincoln (2005), *"Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self"* (p. 3). In terms of the interpretive element in Denzin and Lincoln's definition, qualitative research is based upon the belief that the social world is comprised of subjective experiences and understandings of reality that can change over time and social contexts (cf. Dew, 2007, and the constructivist view in Subchapter 3.1.1). Given this multi-faceted social world, the researcher should seek to describe, interpret, and understand the meanings that people attribute to their existence and world (Cutcliffe &

McKenna, 1999). This exploratory "feature" of qualitative research is supported by de Ruyter and Scholl (1998) and Kapoulas and Mitic (2012), who suggest that qualitative research is essentially of a "diagnostic exploratory nature," so is suited to the study of new or emerging phenomena, such as safe work practices in surgical settings. This makes qualitative/exploratory research important for the development of new conceptualizations in evolving disciplines (Kapoulas & Mitic, 2012), such as safety research in surgical settings. Finally, the "situated activity" and "practices that transform the world" elements in Denzin and Lincoln's definition can be connected to Miles and Huberman (1994). Specifically, in understanding the nature of qualitative data, Miles and Huberman suggest that data collection activities are carried out in close proximity to a local setting for a sustained period of time (situated activity), where data is not immediately accessible for analysis but requires some processing (read: practices that transform the world) (p. 9).

In summary, qualitative/exploratory research comprises situated methods and data collection that are carried out for a sustained period of time; a view that the social world is multi-faceted and thus requires a certain degree of interpretation; and an inherent exploratory nature suited to the study and conceptualization of new or emerging phenomena. In terms of how the qualitative study conducted in this project relates to these features, a combination of non-participant observations, semi-structured interviews, and informal conversations[17] was situated and carried out in a surgical setting for a sustained period of time. The investigated phenomenon (safe work practices) is viewed as complex and constructed (cf. Subchapter 3.1.1). A conceptually oriented approach (cf. Subchapters 2.1 and 2.3) is applied to an area (surgical setting) of limited exploration (cf. Subchapter 1.1.1).

The next section addresses the selections, and provides an overview of the data collection methods in the qualitative study.

3.1.4 Selections and an overview of data collection methods

As this study aimed to explore safe work practices in interdisciplinary teamwork within a medical setting, a hospital organization became the natural

[17] The application of these methods is discussed in Subchapter 3.2.2.

choice for conducting the research. A research group of which I was part had established a recent partnership with another research group at a regional hospital, which became a logical place to locate the research. As a further narrowing, a specific surgical unit was involved in the research these partners conducted, implying obvious benefits of conducting this research at the same unit. Thus, the interdisciplinary surgical teams at that unit were selected as the main research unit. Next, the actual compositions of the surgical teams to be studied were determined, with an eye to representativeness of the data. As a means to this end, interviews and observations were sampled to cover variety across different types of professions. Variety was also achieved through age groups (33–54 years, 43.9 years on average), gender (five females, 10 males), and levels of experience as a specialist (2–36 years, 12.6 years on average). Variety of observations was achieved by selecting two main categories of surgeries – elective (planned) and immediate (within 72 hours) – and including different types of operations within the main categories (cf. Table 2). The observations were conducted during day surgery (7:30AM–3:00PM), and excluded weekends. In sum, the fieldwork consisted of approximately 60 hours of observations of surgical procedures, 15 interviews, and 35 informal conversations over a period of four months in 2010.

Table 2: An overview of the data collection

Time frame	Methods	Article	My actions
January – April 2010	Observations	Articles I, II, IV	15 elective and 12 immediate surgical operations were observed, including variants of fractures, revisions, extensions, and back stabilizations
	Conversations	Articles I, II, IV	35 informal conversations with team members were conducted
	Interviews	Articles I-IV	15 interviews were conducted, spread across groups (anesthetist physicians, nurse anesthetists, operating room nurses, operators, and managers)

The next section describes how the idea of a balanced methodology that combined depth (the maximalist approach) with structure (the minimalist approach), as well as the two dimensions of the framework (cf. Subchapter 2.4), were operationalized, followed by descriptions of how the balancing was achieved during data collection and analysis in the qualitative study.

3.2 Operationalization of the dimensions and methodology

With the choice of a balanced methodology, the practical approach had to allow for in-depth explorations that could capture the complexity of the investigated reality, yet at the same time account for the structure and transparency needed to analyze and communicate this reality. The practical methodology also had to incorporate the system and knowledge dimensions (cf. Subchapter 2.4). This was achieved by means of operationalization, as described next.

3.2.1 Transforming the dimensions and methodology into practice

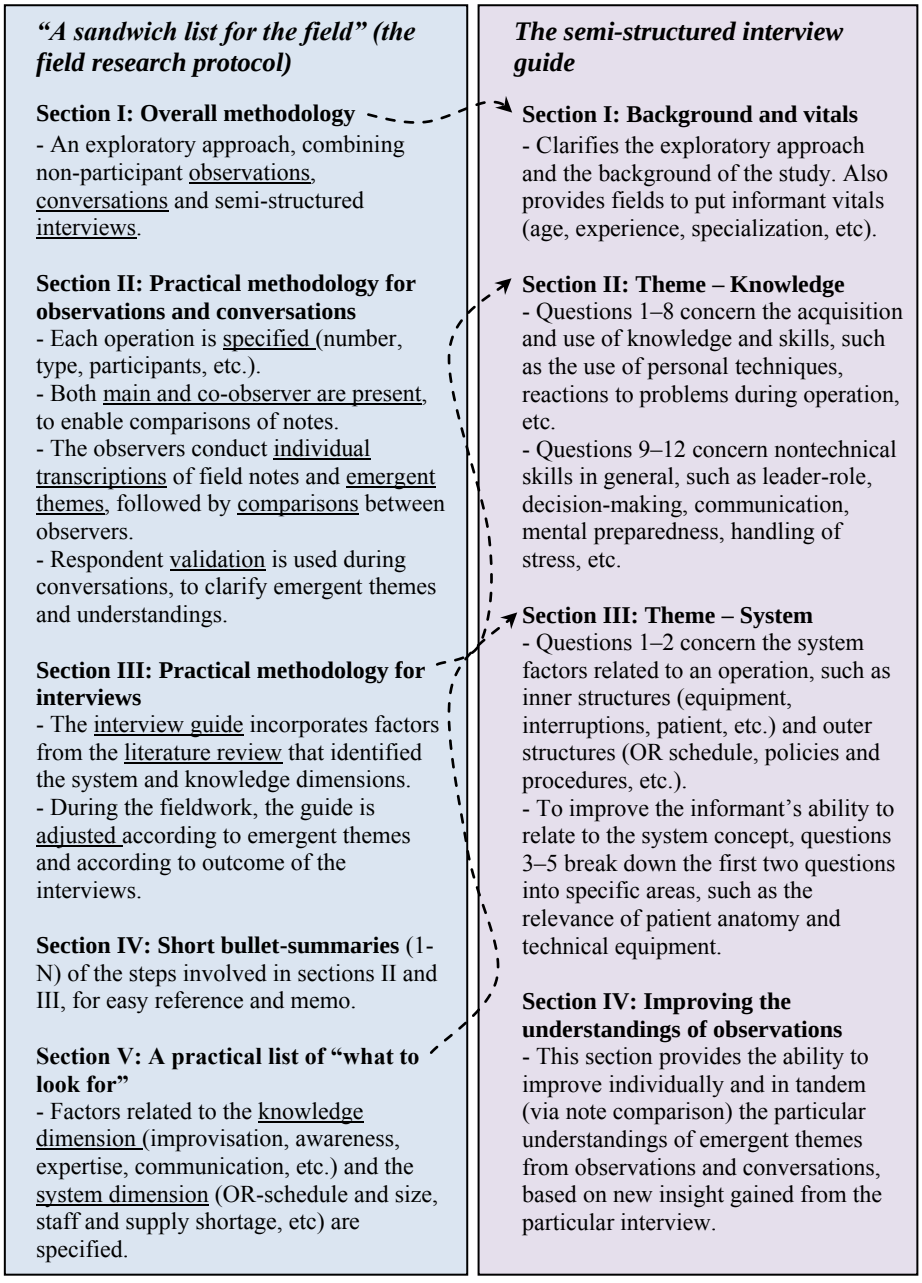
Operationalization of the balanced methodology was achieved by creating a field research protocol that by definition implied a certain degree of structure and transparency.[18] To gain an overview of relevant protocol elements, a review in a local EndNote database was conducted, counting about 500 scientific references within health research literature on quality and safety. The key words "qualitative," "ethnography,"[19] and "protocol" were used to narrow down the search scope, resulting in 109 hits. Among these, one article stood out (Smith, et al., 2003). It combined a strong methodological structure (describing the specific steps of the methodology in detail) with an ethnographic approach (their classification). Elements found in this article were used as a guide to shape the various sections of the field research protocol for this study, from the overall methodology to the specific practical steps to be taken during observations and interviews, as illustrated in Figure 8. The balance between structure/transparency and depth/details was achieved by structuring data according to categories (emergent themes and episodes[20]), and gaining insights through exploratory approaches (observations, conversations, and interviews) (cf. Figure 8, left side, Sections I-III).

[18] *"A protocol is a document that explicitly states the reasoning behind and structure of a research project"* (O'Brien & Wright, 2002: p. 58), in this case the field stage.

[19] The exploratory study in this project applied *"a combination of detailed non-participant observations, conversations and a series of semi-structured interviews"* (Høyland, 2012: p. 318), which is typical to ethnographic approaches. This was the rationale for including "ethnography" as a key search word.

[20] In this thesis, an emergent theme is defined as *"a clear 'red line' that runs through more than one episode,"* whereas an episode is understood *"as a series of related events that form a "bigger story"* (Høyland, et al., 2011a: p. 3).

Figure 8: The field protocol and interview guide.*



* The dashed arrows represent "carry-over" effects. The exploratory approach in the field protocol informs the interview guide (upper arrow), while the dimensions emphasized in the protocol inform the knowledge and system themes in the guide (middle and lower arrows). For the complete protocol and guide, see Appendices.

The system and knowledge dimensions were operationalized through both the field research protocol and the semi-structured interview guide. For example, the field research protocol focused on the general knowledge and system factors to keep in mind during fieldwork (Figure 8, left side, Section V). The semi-structured interview guide included two main sections: knowledge and system (Figure 8, right side, Sections II and III), derived from the field research protocol (left side, Sections III and V), which again originated from the model development process that produced the knowledge and system dimensions (cf. Subchapter 2.4). Thus, consistency is maintained from model development to practical methodology, which supports the emphasis on overall consistency in the thesis.

3.2.2 The qualitative data collection process and balancing

In terms of how the data collection process relates to the balanced methodology outlined above and in Subchapter 3.1.1, the focus on gaining detailed insights and identifying emergent themes reflect the balancing between depth/details and structure/transparency of the operationalized field protocol and interview guide (cf. Figure 8). This balancing is seen below in the descriptions of the three methods, which also highlight the inductive elements of this project.

The non-participant observations[21]: My co-researcher[22] and I conducted a total of 62 hours of observations across both elective (planned) and immediate (within 72 hours) surgical operations, in the period of four months of fieldwork (cf. Table 2). Before we began the observations, we agreed to the following key element in how we would conduct the observations: The field

[21] See clarification of this method later in this subchapter.

[22] The co-researcher was an experienced nurse anesthetist who provided in-depth technical understanding of the operating room (procedures, terminology, etc.). The co-researcher's experience, in combination with that of the principal researcher in conducting safety-oriented projects, created a "health worker–safety researcher duality" that strengthened validity.

protocol would be used as a broad-natured orientation toward the knowledge and system dimensions (cf. Appendix I): "Generally, the idea is to map aspects [related to knowledge and system] that can influence the ability to create and maintain safe work practices in a team." This approach reflected the broad-natured research question and inductive strategy of this thesis, aimed at understanding how safe work practices are achieved in interdisciplinary surgical teamwork (cf. Subchapter 1.1.2).

The process of taking down notes during observations varied between observers. Specifically, my co-researcher's nursing background enabled him to capture a degree of details that I did not. In return, my background as a safety researcher enabled me to notice safety-related aspects in the operation that my co-researcher did not. Thus, when we compared our notes, both during and after an operation, this improved both our understandings of the particular operation and observations.

Transcribing the observations was conducted individually and focused on identifying emergent themes. Given that my co-researcher and I were present in the operating room mostly the entire days (at regular work hours, 7:30AM–3:00PM) to follow as many operations as possible, the field notes were transcribed in the afternoons and evenings. These transcriptions are reflective summaries that elaborate, for example, on how the surgical team performed their roles and functions (such as how the surgeon planned and conducted the procedure), how the team interacted with each other (such as the operating room nurse giving the surgeon instruments) and their environment (such as equipment and interruptions), and how anesthesia personnel monitored the patient and prepared medicaments.

Subchapter 1.3 reflects aspects of these notes. The emergent themes we identified through these transcriptions were then compared between researchers to improve understanding of common emergent themes, and to ensure an awareness of emergent themes across researchers (in case one researcher missed themes the other did not). Such comparisons occurred both within and outside the operating room (outside = in breaks and lunches, during travel, by phone, or back at the office). Through the observations that followed, we sought further insight into the particular identified themes, and at the same time paid attention to new ones that could emerge. Later in the

fieldwork, a systematic off-site (back at the office) analytical triangulation was conducted that improved the understanding of emergent themes further (see descriptions in Subchapter 3.2.4).

During the non-participant observations, the balanced methodology can be seen in how the focus on identifying emergent themes (structure/transparency) was combined with the focus on improving insights (depth/details) into the particular theme.

The informal conversations: A total of 35 informal conversations were conducted in the four-month period (cf. Table 2). The primary function of the conversations was to gain a deeper understanding of the particular emergent themes my co-researcher and I had identified during the non-participant observations (cf. the descriptions above), and alternatively to adjust (in cases where we realized what we had observed did not reflect what was actually going on, cf. example in Subchapter 3.2.3) our understandings of themes. The nature of the field notes, transcriptions, and comparisons that occurred during conversations is identical to the descriptions of "the non-participant observations" above. It should be noted that the conversations took place both within and outside the operating room, as mentioned below in "this study's application of non-participant observation." It should also be noted that while numerous conversations occurred during the study, only conversations that pertained to our observations, or clarified aspects of the operating room activities, were included in the 35 counted conversations.

To summarize, the focus on improving insights into emergent themes (depth/details) and adjusting existing themes (structure/transparency) during the conversations reflects the methodological balancing strategy.

The semi-structured interviews[23]: My co-researcher and I conducted a total of 15 semi-structured interviews with a variety of team members (cf. Table 2). The interviews held three particular functions in this qualitative study. First,

[23] A semi-structured interview is flexible. It allows for the grouping of topics and questions that can be asked in different ways for different participants, and it has an open-ended nature that allows for new questions to be brought up, resulting in spontaneous and in-depth responses (Lindlof & Taylor, 2002; Ryan, et al., 2009). The process of using semi-structured interviews involves the development of an interview guide (Rubin & Rubin, 2005).

through the broadness of the dimensions (system and knowledge) and related questions included in the interview guide (cf. Appendix II), the interviews provided only a rudimentary orientation towards the field in terms of understanding safe work practices (cf. Appendix II: "The particular question is intended to trigger the respondent's reflection process; that is, the respondent will interpret and steer the interview towards relevant aspects and explanations"). This aligns with the inductive research strategy of approaching the field in an open-minded fashion. Second, the semi-structured interviews functioned as a stepping stone, not only in gaining a deeper understanding of the emergent themes identified through observations and conversations with team members, but also in improving the understanding of themes gained through other interviews (cf. Appendix II: "The above questions are adjusted according to emergent themes identified during preliminary analysis of observations, and also based on insights gained through interviews"). During the interviews, we introduced (as questions) themes preliminarily identified through observations and conversations (cf. descriptions earlier) to gain the perspective of the particular team member we interviewed. This understanding was then further improved by introducing the particular theme in another interview. This process of triangulation of observations, conversations, and interviews is described in detail in Subchapters 3.2.3 and 3.2.4. The final function of the interviews was to "inform us of themes or aspects in need of further exploration during our observations" (cf. Appendix I), meaning that the interviews initiated another round of triangulation focused on this particular theme through observations and conversations. The example described in connection with the triangulation process (cf. Subchapter 3.2.3) illustrates this function.

Similar to the observations and conversations, the semi-structured interviews provided further insights into emergent themes (depth/details) and the possibility of introducing new or adjusting existing themes identified by observations and conversations (structure/transparency), corresponding to the methodological balancing strategy.

This study's application of non-participant observation[24]: In this study, the observations my co-researcher and I conducted are defined as non-participant in the sense that we did not take the roles of team members.[25] Specifically, while my co-researcher's background as a nurse anesthetist made him qualified to become a member of the surgical team, my own lack of medical or nursing education, and the highly specialized nature of surgical operations, made such participation impossible. Thus, in order to function as a team of observers following the same approach, non-participant observations became necessary. In all other senses of the word, we participated, by being part of the setting in which the team functioned and engaging in conversations with team members to get to know their perspective on what they were doing and what my co-researcher and I observed (the "immersion" element in Emerson, et al., 1995). Time in the field was also spent outside the operating room, in "patient preparation" (cf. Figure 3), where we gained insight into how the surgical unit functioned through conversations with, and observations of, team members (increasing immersion). This insight (taken down as field notes) was translated into the descriptions provided in Subchapter 1.3, by creating elaborate, reflective field summaries as described above.

3.2.3 Clarifying the concept of triangulation

The upcoming subchapter (3.2.4) deals with this study's analysis process in which the concept of triangulation represents an important element. Before moving on to this chapter, this study's application of the triangulation concept needs to be clarified, given the "controversy" surrounding the concept in qualitative literature.

Specifically, there are two distinct perspectives on triangulation in literature that I will discuss. The first, initial, perspective referred to triangulation as *"the claim that comparing findings from two or more different research methods enables the researcher to conclude whether an aspect of a*

[24] Pettigrew (1999), Smith et al. (2003), and Mackintosh et al. (2009) are examples of studies that apply non-participant observations to health research.

[25] The strict term for the type of observations we conducted is "passive participation," since we observed activities in the setting (operating room) but without participating in activities (Kawulich, 2005; Spradley, 1980). Thus, "non-participant" in our application, and also as applied in other health-related studies (Mackintosh, et al., 2009; Smith, et al., 2003), must be viewed as synonymous with passive participation.

phenomenon has been accurately measured" (Moran-Ellis, et al., 2006: p. 47). In other words, triangulation increases validity, which is a view mirrored by Creswell and Miller's (2000) definition of triangulation as *"a validity procedure where researchers search for convergence among multiple and different sources of information to form themes or categories in a study"* (p. 126). A similar emphasis on validity is seen in Thurmond's (2001) suggestion that *"triangulation might enhance the completeness and confirmation of data in research findings of qualitative research"* (p. 257). In the same vein, Fielding and Fielding (1986) state *"The important feature of triangulation is not the simple combination of different kinds of data, but the attempt to relate them so as to counteract the threats to validity identified in each"* (p. 31). In short, this particular perspective on triangulation suggests that the concept serves to strengthen validity through convergence and confirmation of data.

Related to projects mixing qualitative and quantitative methods, the second and more contemporary view on triangulation criticizes the initial perspective for not considering how differences between positivist and interpretivist[26] accounts of the nature of social reality contradict the claim to being able to converge methods and strengthen measurement validity[27] (Denzin, 2009; Moran-Ellis, et al., 2006; Sale, et al., 2002). Specifically, I discussed earlier (cf. Subchapter 3.1.1) how positivists view reality as independent of the researcher, in contrast to constructivists, who view reality as a product of social interactions (including between the observer and the observed). The account that is produced (epistemological aspect[28]) in the former view/paradigm reflects that the "truth is out there," as captured by the researcher, while the account in the latter view/paradigm would claim that this is one of many possible insights into our complex world. In other words, the two paradigms appear to be contradictory, in terms of the epistemological claims that their "world-view stances" imply (Blaikie, 2007). Consequently, advocates of the contemporary perspective suggest that triangulation, while

[26] Interpretivists view the world as constructed, and filled with interpretations before the researcher arrives in the field (cf. Blaikie, 2007).
[27] Measurement validity determines whether observations meaningfully captures the ideas contained in concepts (Adcock & Collier, 2001).
[28] Epistemology is the philosophy of knowledge, or how we come to know (Trochim, 2001), such as the view that knowledge is a multidimensional, dynamic construct (Sturmberg & Martin, 2008), or a constructivist perspective.

not suited to validate measurements, can deepen and widen a researcher's understanding of a phenomenon (Olsen, 2004) and enrich understandings of the multi-faceted, complex nature of the social world (Moran-Ellis, et al., 2006).

I can now clarify how the concept of triangulation is situated in this thesis. By combining qualitative methods that are based on the same paradigm, or by using a constructivist view (cf. Subchapters 3.1.1–3.1.3), I avoid the epistemological dilemma described above. The concept of validity can be used. At the same time, the contemporary view on triangulation as an effort to deepen and enrich the understanding of a phenomenon aligns with my constructivist stance. Thus, this thesis applies triangulation as the act of combining different types of data to reach a deeper understanding of a phenomenon (contemporary perspective), where the refined understanding is seen as a validation effort. This is illustrated through the process of identifying one of the themes in the qualitative study. When my co-researcher and I first observed the surgeons at work in the operating room, we categorized their discussions with colleagues and the use of X-ray monitors as "control checks" to ensure a safe procedure. However, conversations and interviews revealed later in the fieldwork that what we had perceived as control checks actually had to do with the individual's handling of multiple sources of information before reaching a decision. The example highlights how my co-researcher and I combined multiple sources of data (observations, conversations, and interviews) to reach a deeper understanding and thus validate an observation. Again, I emphasize that a focus on combining data to improve validity does not dismiss that multiple "truths" exists. This is evident in how my co-researcher and I combined our interpretations (observers) with that of the subjects (observed) to enable a more refined, or informed, understanding of a given observation. In other words, the thesis adheres to the epistemological view that knowledge in qualitative research is acquired through sensory experiences, colored by subjective interpretations (Walliman, 2006) as well as the interactive and inseparable nature of observer and observed (cf. the constructivist view in Subchapters 3.1.1–3.1.3).

To conclude, the discussion above points to several benefits in applying triangulation, assuming that the particular method(s) employed rely on the same paradigm. Triangulation can achieve a depth to results by combining

multiple and different sources of information that increase confidence in the research data (Denzin, 1970; Thurmond, 2001) and strengthen the credibility/validity of the research. This benefit is not reaped through the single method/strategy. Another benefit is that triangulation aligns directly with this thesis' inductive research strategy of refining understandings, including concepts, as the data-gathering and research process goes on (cf. Subchapter 2.2). Specifically, the application of several different types of triangulation in this project, as discussed in the next subchapter, strengthened the validity of the scientific model established in this thesis (cf. Subchapters 2.4 and 3.3).

3.2.4 Methodological balancing during the analysis process

The analysis process consisted of triangulation during different stages of the fieldwork, as a part of a yo-yo system (Wulf, 2002), or on-site and off-site field methodology. The intention is to achieve a distance to the field that can reduce the proneness to "field blindness" and stimulate more "sober" reflections (Fangen, 2005). Specifically, in the first stage of the analysis, the co-researcher and I conducted on-site and off-site data and analytical triangulation of field notes and transcripts from observations, conversations, and interviews. Whereas data triangulation entails several data sources (see example on theme identification in Subchapter 3.2.3), analytical triangulation means that multiple researchers conduct observations and analyze findings (Denzin, 1978; Patton, 1990). For this study, analytical triangulation meant observations were conducted in tandem, and the field notes and transcripts were subsequently reviewed, compared, and preliminarily analyzed to improve our understandings of emergent findings. This triangulation was an on-the-fly process in the field, meaning that it occurred through continuous dialogue between researchers, both inside and outside of the operating room, through conversations with the particular team members in the operating room to clarify the observations, and through the interviews with team members to improve our understandings of observations and conversations (Subchapter 3.2.3 provided an example of this triangulation process). Outside the field setting (surgical unit), a more traditional analytical triangulation was conducted, in the sense that field notes were individually transcribed and reviewed, and subsequently compared in tandem to improve the particular understandings of emergent findings. Furthermore, as described above,

respondent validation was conducted through both conversations and interviews – a cross-checking method whereby the respondent is confronted with the researcher's account of what was observed to determine the level of correspondence between the two interpretations (Barbour, 2001; Mays & Pope, 2000).

Taken together, the data and analytical triangulation (including respondent validation), conducted during the first stage of the analysis, produced an initial understanding of what was going on in the operating room, and the themes that emerged. Retrospectively, the first stage was the most influential to the qualitative study as a whole because the themes that emerged from these weeks, while refined, remained intact throughout the fieldwork, including the second stage of the analysis.

The second stage included the systematic off-site analytical triangulation that followed the first four weeks of operating room observations. Specifically, the principal researcher, co-researcher, and research supervisor repeatedly read the raw observational and conversational data to look for potential relationships among the events that occurred during the particular operation. These events created an episode, or a series of related events that form a "bigger story." Next, the researchers read and compared the episodes repeatedly, individually and in tandem, until a particular emergent theme became visible. A theme constitutes a clear pattern or "red line" that runs through more than one episode. In cases where observational data did not provide a particular theme, we relied on patterns identified in the conversational and interview data.

In sum, the strategies for identifying episodes and themes during the on-site and off-site analytical triangulation processes are complementary and support the overall emphasis on a balanced methodology. Specifically, detailed insights (including episodes) is supported by Nielsen's (2004) story-telling approach, providing an in-depth and unique picture of findings. The focus on episodes and themes represent categorizations (cf. Miles & Huberman, 1994), providing a structured and transparent picture of findings.

Furthermore, in the second stage of analysis, the principle researcher could have been more thorough in maintaining the strategy. In particular, while all

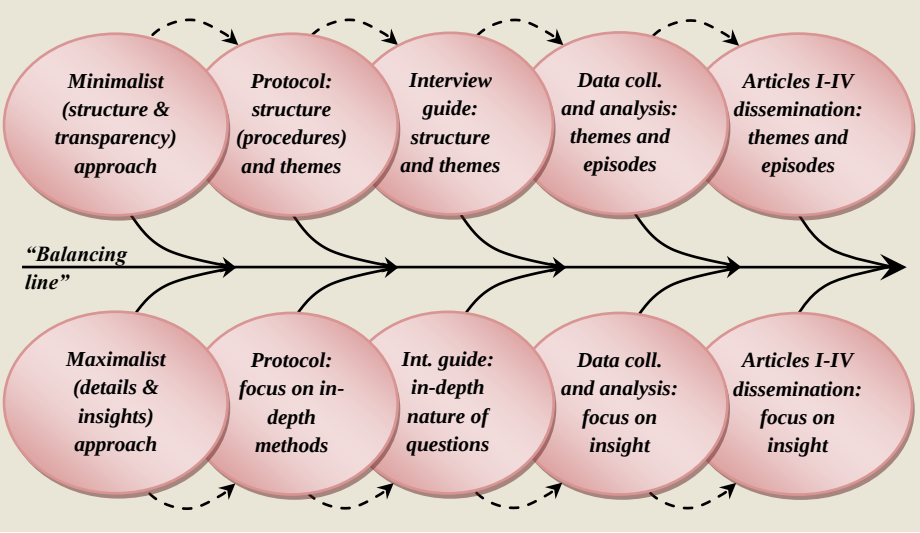
three researchers involved in this stage did read through all the transcribed data material to identify episodes and themes, each prepared the material differently. Specifically, the transcribed material consisted of two large word-processing documents: The principal researcher's and co-researcher's transcribed field notes, which were explicitly systemized into sections of episodes and themes by the principal researcher; and the co-researcher's transcribed field notes, which were less systemized (not organized into explicit sections of episodes and themes). The research supervisor read through both documents in the latter, less-systematic vein. In short, the categorization, while consistent in terms of identifying episodes and themes, varied in terms of thoroughness, and thus was not as stringent as originally anticipated. At the same time, the "loose" nature of this process actually benefited the inductive approach because each researcher analyzed the data material and identified the emergent themes more open-mindedly. The outcome also supports this analysis stage as an "overall good process." The major identified themes remained consistent, despite minor variations in the researchers' interpretations, which can be attributed to individual differences. Finally, the systematic off-site analytical triangulation was conducted only once. While new episodes and resulting insights into the existing themes were gained, no new themes emerged during the subsequent field stays. Data collection ceased by the end of April, when no more new data or insights seemed possible. Data saturation had been determined.[29]

While strong emphasis was placed on data and analytical triangulation during the different stages of the fieldwork, equal efforts were applied to adjusting the current dimensions and aspects of the scientific model in accordance with the three-phase literature review and emergent findings (cf. Subchapter 2.4). Particularly useful were the off-site periods that occurred during, between, and after the fieldwork stages. These periods provided distance to the field

[29] By applying triangulation and validation approaches extensively during this study (see also Subchapter 3.3), I perceive the point of saturation as reasonably informed. Thus, this study satisfies the "good practice norm" put forth by Bowen (2008): *"Claims of saturation should always be supported by an explanation of how saturation was achieved and substantiated by clear evidence of its occurrence"* (p. 150). However, I did not challenge myself to question why I observed the same things repeatedly, as Åkerström et al. (2004) did in their study of the Swedish deaf world. It would be interesting for me to do so in future research.

that allowed emergent findings to be processed more clearly or soberly, in relation to the model, as Fangen (2005) suggested. Consequently, before returning to the field, the interview guide could be adjusted (questions added, revised, or dismissed) and the field protocol revised ("what to look for"), according to emergent findings and refinement of the model (cf. Subchapter 3.2.1 and Appendices).

Figure 9: A methodological balancing strategy.*



* The dashed arrows indicate the researcher's "movement" from design (protocol and guide) to data collection/analysis and dissemination, while the merging/solid arrows (middle of figure) represent the researcher's attempt to combine minimalist (upper part of the figure) with maximalist elements (lower part of the figure) during this movement.

Figure 9 depicts how the operationalization of the overall balancing strategy, emphasizing both structure/transparency and in-depth descriptions, runs through the overall methodology. Specifically, the "balancing line" in the figure suggests that the researcher attempts to balance the focus on structure/transparency in the upper part of the figure (the five bubbles) with the attention to details/insights in the lower part (the five bubbles). This "balancing act" is maintained from methodological design (field protocol and interview guide) to data gathering/analysis and dissemination. Thus, a main

rationale for focusing on balancing becomes the need to account throughout one's research from design to dissemination for the complexity of the constructed reality, and still communicate this reality in a structured and transparent way (improving the reader's accessibility to the research) (cf. Subchapter 3.1.1). Besides the "balancing steps" in Figure 9, the choice of using a yo-yo system (Wulf, 2002) also represents a balance between gaining insight/presence (in the field) and reflection/distance (outside the field), which aided model development. The approaches to validating the model (cf. Subchapter 2.4) are discussed next.

3.3 Validating the scientific model

This thesis began by identifying a need for explorations into the nature of interdisciplinary teamwork within the health care sector, and a related need for scientifically grounded models that can be applied to, and integrate findings from, such explorations (cf. Subchapter 1.1). Corresponding to these needs, Research Objective III is aimed at exploring safe work practices in surgical teamwork by means of a qualitative study, followed by Research Objective IV, which is aimed at developing and validating a scientific model based on the qualitative study (cf. Subchapter 1.1.2). Addressing Objective IV, this subchapter describes the specific approaches in validating the model.

Literature-based validation: The first structured validation occurred through the three-phase review process (cf. Subchapter 2.4), in which dimensions and related aspects were identified and incorporated into a framework for exploring safe work practices in interdisciplinary teamwork (cf. Figure 6). Specifically, the following validation strategies were applied during the review process (cf. Høyland, 2012: p. 318):

- Several electronic data sources online and a local source (EndNote database) were triangulated (data triangulation).[30]
- With no predefined theory and a general openness to perspectives, emergent team-related aspects were sought to develop a framework (theory triangulation).
- The literature review combined online and local searches via electronic databases, in addition to a three-phase process of

[30] See Subchapter 3.2.3 for a clarification of the triangulation concept.

determining the particular dimensions and aspects of the framework (methodological triangulation).

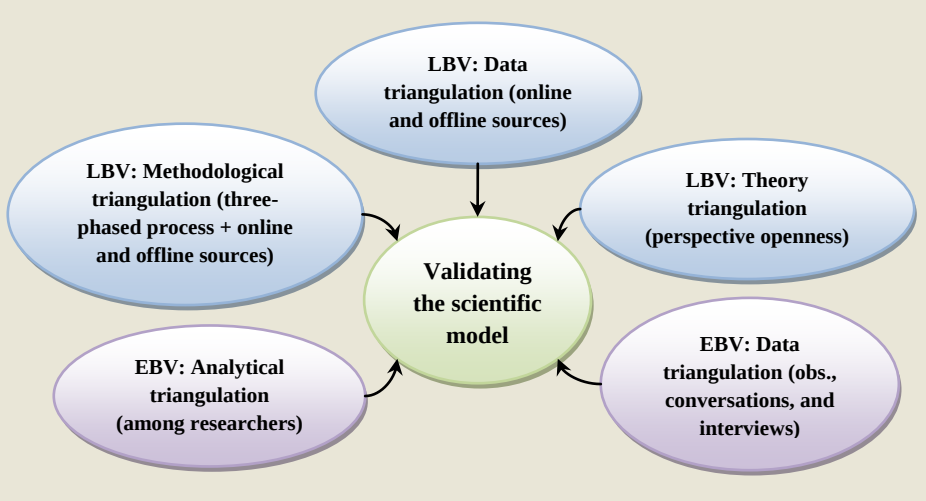
Empirical-based validation: The second structured validation occurred through the qualitative study in 2010 and was conducted in parallel to the literature-based validation. The techniques of analytical and data triangulation were applied (cf. Subchapters 3.2.2 and 3.2.4 and Høyland, 2012). These validation techniques helped determine the strength of the existing dimensions and aspects of the proposed framework (Cook & Campbell, 1979; Lincoln & Guba, 1985), resulting in the validation of a scientific model (cf. Figure 7 in Subchapter 2.4).

Specifically in the analytical triangulation, a research protocol was constructed that incorporated the two dimensions and aspects of the framework as a basic checklist of "what to look for" during the observations (cf. Figure 8). Applied to the fieldwork, the researchers regularly compared the identified emergent findings against the checklist in the protocol. The emergent empirical findings fit the two main dimensions of the framework. Specifically, the findings supported the existing framework dimensions, whether they aligned directly with, adjusted, or suggested new aspects to the dimensions. As described in Subchapter 3.2.4, comparison between the two observers and a third researcher revealed variations in each researcher's findings during a later off-site triangulation analysis. However, the main findings remained constant, demonstrating only minor variations among researchers. The main findings also supported the existing framework dimensions.

In the data triangulation, the dimensions and aspects of the framework were replicated as sections in a semi-structured interview guide (cf. Figure 8). For example, the main theme of "system" consisted of the sub-themes of "inner" and "outer" structures (see definition in Subchapter 2.4.1), with associated questions. Respondents were able to identify with the dimensions and questions, even though minor, clarifying adjustments were made. The open nature of the semi-structured interview guide also enabled the researchers to introduce and compare their observational findings and understandings against the respondents' interpretation of the findings (respondent validation). Overall, the data-triangulation process helped refine and improve

understanding of the existing dimensions and aspects of the framework, as well as the emergent findings from the exploratory study.

Figure 10: Complementary strategies in validating the scientific model*



* LBV = Literature-based validation (during the three-phase review process), EBV = Empirical-based validation (during the qualitative study). Throughout the field work (January to April 2010), the review process and qualitative study employed different triangulation strategies aimed at validating the dimensions and model. Given that these strategies also provided different types of insights, such as literature-based findings from the review process and empirical findings from the qualitative study, the strategies became complementary in validating the model.

The complementary nature of the validation strategies applied during the review process and the qualitative study (cf. Figure 10), supported and added validity to the knowledge and system dimensions (cf. Figures 5-7 & Høyland, 2012). In addition to validating the scientific model, the quality of the overall project was also determined, as described next.

3.4 Assessing the quality of this research project

Compared to the greater agreement on quality criteria in quantitative research, particularly in terms of validity and reliability (Bryman, et al., 2008), qualitative research has often been criticized for having no clearly defined set of quality criteria for judging it.[31] Smith and Deemer (2000) defended this state of affairs in qualitative research and suggest that any criterion for qualitative research can never be fully explicit, should take into account local circumstances, and always be open to revision. In short, the multi-faceted, and thus contextual nature of qualitative/exploratory research, becomes a hindering factor in establishing common quality criteria (cf. Subchapter 3.1.3). However, as Hammersley (2007) argues, despite this difficulty, it is still desirable to establish certain guidelines or criteria for how to judge the quality of qualitative research accounts. Following Hammersley's suggestion, the next sections describe how this project applied validation techniques and considered criteria of reliability, generalizability, and transferability in establishing the quality of the research that was carried out. The Hawthorne Effect is also addressed as part of the discussion concerning validity.

3.4.1 Validity

Within qualitative research, validity has traditionally been defined as the researcher's efforts to determine the degree of correspondence between claims about knowledge and the reality being investigated (Eisner & Peshkin, 1990). This definition is comparable to how quantitative research applies internal validity. This is understood as a criterion to determine whether observations and measurements truly captures what these approaches intended to capture, such as safe work practices (LeCompte & Goetz, 1982). In more recent times, the concept of validity in qualitative research has evolved to an approach Cho and Trent (2006) label transactional validity, which *"assumes that qualitative research can be more credible as long as certain techniques, methods, and/or strategies are employed during the conduct of the inquiry"* (p. 322). The transactional approach is applied to this project, where specifically credibility,

[31] While useful in creating a distinction between research traditions in this case, the reader should be aware that the criticism could be a myth, given that many qualitative researchers (myself included) start by outlining conceptions of validity and reliability, based on the quantitative tradition, before discussing the (lack of) relevance of these concepts (Seale, 2002).

and thus validity, is established by employing the following techniques or strategies[32] during the project design, and data collection and analysis phases, including model development:

- **Prolonged engagement**: Entails investing enough time to understand the culture, establish trust with study participants, and check for distortions such as priori values and constructions (Lincoln & Guba, 1985). The four-month fieldwork established both an understanding of the surgical setting (see Subchapters 1.3 and 3.2.2), and trust with participants. The check for priori values and constructions was emphasized in the design phase of the project, when selecting an open-minded approach and inductive research strategy (cf. Subchapter 2.2). This emphasis carried over to model development and validation (cf. Subchapter 2.4), as well as operationalization and triangulation (cf. Subchapter 3.2).

- **Persistent observations**: Aims to identify the characteristics and elements in a situation that are most relevant to the phenomena under investigation, and focus on them extensively to achieve depth (Lincoln & Guba, 1985). Related to this project, understanding emergent themes improved throughout the qualitative study, facilitated by techniques of data and analytical triangulation conducted both inside and outside the field setting (cf. Subchapters 3.2.2–3.2.4). Thus, this project applied an extensive focus on characteristics (emergent themes) to achieve depth.

- **Triangulation**: Involves combining multiple and different sources of information to deepen and widen understanding of the multi-faceted, complex nature of the social world and phenomena (Moran-Ellis, et al., 2006; Olsen, 2004). Triangulation reduces the possibility of chance associations and prevalent, systematic biases, thereby increasing confidence in the research data and interpretations (Denzin, 1970; Fielding & Fielding, 1986; Maxwell, 1992; Thurmond, 2001). Triangulation represented the main validation technique in this project, applied throughout the data collection and

[32] For an overview of these techniques, see Onwuegbuzie and Leech (2007).

> analysis processes to validate not only the emergent findings but also the scientific model (cf. Subchapters 3.2.2–3.2.4 and Subchapter 3.3). These efforts increase confidence in this project's research data and interpretations.

By clarifying these techniques for determining credibility and validity in this project, I follow up on Whittemore et al.'s (2001) suggestion that findings *"need to be presented with an explicit articulation of the validity criteria of emphasis and the specific techniques employed, so that consumers of research can critique findings in a meaningful way"* (p. 533).

The Hawthorne Effect: The Hawthorne Effect comes to mind when determining correspondence between claims of knowledge and the reality being investigated (validity). Specifically, in the words of Mangione-Smith et al. (2002), *"The Hawthorne effect refers to a phenomenon where a study subject's behavior and/or study outcomes are altered as a result of the subject's awareness of being under observation*" (p. 1604). While such a reflection on one's research may seem straightforward, it must be noted that the value of considering the Hawthorne Effect has been viewed with skepticism. For example, Olson et al. (2004) stated, *"Using the phrase 'Hawthorne Effect' to describe reactivity or confounding variables in an experiment is probably unnecessary and may perpetuate other difficulties due to interpretive problems"* (p. 35). This is supported by Chiesa and Hobbs (2008), who suggested that it is *"inappropriate for authors to employ the term in interpreting their own results since, given its multiple meanings, it provides no useful information for readers in terms of evaluating specific controlling effects"* (p. 73). It follows that I do not need to, (or perhaps should not), consider the Hawthorne Effect. Nevertheless, I find a reflection interesting. Specifically, when my co-researcher and I arrived at the surgical unit, a certain style of dressing was required to enter the surgical unit and the operating room, which helped us "blend in" naturally. This "researcher camouflage" was strengthened by the number of people that entered and left the operating room (such as students, representatives from equipment and instrument producers, and other medical personnel), meaning that the surgical team soon forgot about us, even when informed of our presence. Granted, we did engage in conversations with team members, and some members also noticed us throughout the study and asked questions. However, these were

only brief "encounters" that did not appear to affect the rest of a team that was highly task-occupied. In short, we were soon forgotten in the team's busy and highly focused work-schedule.

In sum, I determine that the Hawthorne Effect, as far as it can be said to be a valid indicator of research quality (cf. the above discussion), had only a minor influence on this project. Furthermore, in terms of considering the validity of the effect on this project, a constructivist would claim that the Hawthorne Effect is only "natural" given that the observer and the observed, or "knower and know" (Lincoln & Guba, 1985: p. 37), are interactive and therefore inseparable entities. Thus, an assessment of research quality should not be determined by this effect.

To conclude this subchapter, I will argue that this project holds validity by satisfying the credibility-seeking techniques of prolonged engagement, persistent observations, and triangulation. Also strengthening the validity, I believe the Hawthorne Effect influenced this project only to a minor degree. There is also an external element to validity, which is discussed in Subchapter 3.4.3 on generalizability. First, the issue of reliability is addressed.

3.4.2 Reliability

From a quantitative research perspective, the concept of reliability implies "dependability, stability, consistency, predictability, accuracy" (Kerlinger, 1973: p. 422), and is considered a precondition for validity. More specifically, Kirk and Miller (1986, pp. 41–42) identified three types of reliability: The degree to which a measurement, given repeatedly, remains the same; the stability of a measurement over time; and the similarity of measurements within a given time period. Careful considerations of measurements are imperative in quantitative research.

The quantitative researcher's focus on measurements and stability does not align well with the qualitative researcher's view on the social world as multi-faceted and constructed (cf. Subchapters 3.1.2 and 3.1.3). Thus, an alternative perspective in qualitative research suggests that reliability can be reached through systematic operation at the level of the research design (methods and techniques, interview protocol, and so forth) (de Ruyter & Scholl, 1998: p. 13), implying keeping *"detailed account of the research steps undertaken"*

(Kapoulas & Mitic, 2012: p. 361). A desire to provide a detailed research account, and thus demonstrate a systematic research design, resonates with this project's thorough descriptions from conceptualization to model development and methodology. This includes the systematic steps taken toward the development of the scientific model.

Specifically, the project was initiated by several rounds of conceptual orientation, which identified the knowledge and system concepts (cf. Subchapters 2.1 and 2.3). These concepts were refined through a three-phase review process that identified the knowledge and system dimensions (cf. Subchapter 2.4). The dimensions, as well as a balanced methodology, were then operationalized through a field protocol and interview guide (cf. Subchapter 3.2). Finally, the protocol and guide were applied in a qualitative study comprising several triangulation efforts (cf. Subchapters 3.2.2–3.2.4), which eventually lead to the validation of a scientific model for exploring safe work practices (cf. Subchapter 3.3).

To conclude, the thorough descriptions of processes of conceptualization, operationalization, and model development and validation throughout this thesis demonstrate a systematic research design that strengthens the accuracy and reliability of this project. This suggests that the research design could be replicated by other researchers in other contexts.

3.4.3 Generalizability and transferability

Polit and Beck (2010) suggest that *"Generalization is an act of reasoning that involves drawing broad conclusions from particular instances – that is, making an inference about the unobserved based on the observed"* (p. 1451). The term "external validity" is often associated, and also used interchangeably, with generalizability (Ferguson, 2004).[33] This can be seen in Cook and Campbell's (1979) understanding that *"External validity refers to the approximate validity with which we infer that the presumed causal relationship can be generalized to and cross alternate measures of the cause and effect and across different types of persons, settings, and times"* (p. 37). Similar to the topic of triangulation (cf. Subchapter 3.2.3), generalizability is

[33] External validity is viewed as synonymous with generalization in this thesis.

considered a controversial subject within qualitative research, with both proponents and opponents (Polit & Beck, 2010).

Specifically, generalizability implies that a researcher's observations in one instance, such as with specific settings, times and people, can also be found in other instances, such as across settings, times, and people. Some qualitative researchers agree with this view, in terms of how the in-depth and insightful nature of qualitative research can reveal higher-level concepts and theories that are also applicable to other settings and participants (Glaser, 2002; Misco, 2007; Morse, 2004).

In this project, I believe the triangulation[34] aimed at validating the scientific model produced higher-level concepts that could have generalizability. Specifically, the empirical findings identified in this qualitative study fit the knowledge and system dimensions of the model (cf. Subchapter 2.4.4), which were informed by existing team-related studies conducted within the health care sector and across different contexts, times, and individuals (cf. Subchapters 2.4.1–2.4.3 and Tables 1 and 2 in Høyland, 2012). Thus, it can be concluded that the dimensions relate not only to a particular phenomenon (safe work practices) but possibly also to research findings more broadly (team-related health care research). This suggests that the dimensions constitute higher-level concepts of potential generalizability across contexts, times, and individuals within the health care sector. I also believe the system and knowledge dimensions are broad enough to include findings across contexts, times, and individuals in other sectors, which suggests cross-sector generalizability. Furthermore, representative samples and events strengthen the generalizability of the dimensions (Maxwell, 1992; Miles & Huberman, 1994).

This project emphasized representativeness of the data during selections (cf. Subchapter 3.1.4), and applied extensive triangulation efforts to identify emergent themes (representative events) and validate the scientific model (cf. Subchapters 3.2.2–3.2.4 and Subchapter 3.3). To improve generalizability further, the dimensions should be tested in other contexts, both within and outside the health care sector and surgical setting.

[34] Mayring (2007) suggests triangulation as one pathway to generalization.

In contrast, other qualitative researchers question generalizability of any type of findings. In their view, findings are always embedded within a context, making it problematic to extrapolate "the particular" (Erlandson, et al., 1993; Lincoln & Guba, 1985). I acknowledge the challenge of generalizing from the particular. In addition to the suggested generalizability of the model dimensions, I considered an alternate approach of transferability in relation to the particular findings (themes and insights into safe work practices) identified in this project (cf. Subchapters 2.4 and 4.2). Transferability, or the case-to-case translation model in Firestone (1993),[35] assumes that it is the researcher's job to provide descriptions of the time and context in which the particular findings were found to hold true, whereas it is the reader's job to determine the extent to which the findings apply in another context (Polit & Beck, 2010). It follows that the degree of transferability between two given contexts depends on the thoroughness of the researcher's contextual descriptions so that other researchers can determine the applicability of the findings (Lincoln & Guba, 1985). Correspondingly, Subchapter 1.3 provided detailed descriptions and illustrations of the organizational structure of the surgical unit as well as the logistics, layout, roles, and work zones associated with the operating room. This should enable other researchers to assert the contextual applicability of my findings.

In summary, I suggest generalizability of the dimensions of the model and transferability potential of the particular findings (themes and insights) for this project. This nuanced view on generalization finds support in Larsson's (2009) suggestion *"that in some cases several lines of reasoning on generalization can be applicable to different parts of the same work"* (p. 33). Ethical considerations involved in this project are discussed next.

3.5 Ethical considerations

In my understanding, ethics pertain to rules of conduct. They involve the researcher maintaining the highest standards of work, protecting information given in confidence, faithfully reporting procedures and results, appropriately crediting co-authors, acknowledging other writers and materials, accurately presenting qualifications, and acknowledging sources of financial support

[35] Note that transferability, or the case-to-case translation model, represents a variant of generalization (Firestone, 1993; Polit & Beck, 2010).

(Comitas, 2000; Hobbs, 1968). A thorough reflection on ethics is seen in van Deventer's (2009) discussion of issues the researcher should consider in connection with the design, implementation, analysis, and dissemination of research. These considerations will next be related to this project.

The design phase: van Deventer (2009) suggests that the researcher should reflect on how choices of methodological approaches can affect the research environment, such as the decision to choose an overt rather than a covert research design. In the former design, participants are aware of the researcher's presence and that a research process is ongoing. It is the researcher's obligation to provide participants with all relevant information associated with the research process. The participants must also acknowledge this information and their voluntary participation (informed consent). In the covert design, the intention is to not alert subjects of the researcher's presence to achieve data collection of behavior unaffected by the awareness of a researcher/research process. A certain degree of deception is thus applied to achieve this goal. By its nature, a covert design does not allow for information and consent efforts. Instead, it relies on the researcher's judgment of gains versus risks in conducting the particular research. Such a design should also prompt the researcher to apply specific ethical guidelines and seek institutional approval.

An overt research design was applied to this project, which comprised an exploratory approach and methods that required information- and consent-seeking activities. In advance of the fieldwork, the potential ethical implications of this research were presented to the Regional Ethics Committee for Medical and Health Research (REK). The REK concluded this study did not require its approval, given the quality-assuring nature of the project (focused on improving practices among health care personnel). However, approval of the Norwegian Social Science Data Services (NSD) was necessary because the researchers would be exposed to personal information during the study. As a result, the NSD required that all potential participants of the study be informed prior to data gathering.

The implementation phase: van Deventer (2009) states *"An ethical design with an unethical implementation is equal to an unethical research process"* (p. 50). Thus, in implementing the particular design for this project's overt

nature, the ethical implications to the particular environment (the surgical setting in this case) must be considered. This phase should emphasize two particular components: The information part and the "upholding" part.

The information part concerns the researcher informing potential participants of the research design, the type of processes and procedures (such as methods) being carried out, the right to withdraw at any time, the right to privacy in terms of anonymity and confidentiality, and potential harms that can occur during the research process. The first four information efforts were accomplished in this project by customized presentations for surgeons and nurses. Specifically, the presentation for the surgeons emphasized study background, theory, methodology, and examples of team aspects. The nurse presentation dealt with operationalization issues, such as how observations would be conducted, who to interview, and the approximate time the interviews would require. Participants were given written information during the presentations (based on a template from REK) that explained the aim of the study and anonymity issues. A field for signing informed consent (voluntary/withdrawal possible at any time) was included. Information on harms did not apply to this project, given its quality-assuring, rather than experimental, nature.

The "upholding part" of a particular research project concerns the researcher's efforts to ensure that the elements of the research process of which participants were informed during the meetings above is upheld and that participants are kept from harm. My project accomplished this by conducting observations only when every member of the operating team had agreed to be observed. In situations where information had not been given and/or consent was not obtained beforehand, the required consent was obtained before the particular operation began. As a digression, maintaining this ethical concern was often a lot less straightforward than it sounds. In the initial phase of the qualitative study only eight of the 45 surgeons signed the consent form, and it became necessary to seek permission from each individual surgeon to gain access to the operating room. This experience is similar to Groger et al.'s (1999) account of the difficulty in gaining the consent of individuals who exert a high degree of control to access certain people and/or areas of an organization.

The analysis phase: van Deventer (2009) suggests that the researcher should describe during analysis how personal perceptions affected data, and demonstrate how they strove to avoid interpreting data in desirable directions (what the researcher believes or feels data should indicate). For this project, such descriptions have been provided (while strictly not part of analysis), related to the open-minded inductive field approach aimed at reducing personal perceptions/preconceptions (cf. Subchapter 2.2), and to the triangulation processes (cf. Subchapters 3.2.2–3.2.4). The latter technique of triangulation not only improves the depth of a researcher's understanding of results, but also reduces the influence of preconceptions on interpretations. Triangulation connects with another analytical issue upon which van Deventer touches: The thorough documentation of a given research technique, which improves reliability and validity of the particular results and increases a reader's confidence that data was not distorted or manipulated.

The dissemination phase: According to van Deventer (2009), two main issues relate to the dissemination of research: Protection of privacy/anonymity and research reviewing. In terms of the former issue, the researcher should seek to honor their agreement with participants (as formulated in an information and consent form, for instance) and remove specific data from analysis and dissemination if the participants so desire. Applied to this project, the participants did not raise concerns related to dissemination, as long as the researchers attempted to remove any identifiable aspects (names, personal details, characteristic behaviors), as declared in the information and consent form. However, the anonymization efforts were not entirely successful. Specifically, later presentations to the participants revealed that some could identify one surgeon's described "agitated behavior" (cf. the episode: "Lack of equipment, inexperience… and mobile phones" in Høyland, et al., 2011b: p. 5). While it is doubtful that this individual will be identified by other than those working at the particular surgical section, this still represents an "ethical lesson" for future work and an even higher level of vigilance.

The latter dissemination issue of research reviewing concerns the use of other researchers to ensure that analytical conclusions are fair and unbiased and to identify potential problems that the researcher may have overlooked. This strengthens confidence in results. In this project, processes of triangulation

conducted during data collection and analysis (cf. Subchapters 3.2.2–3.2.4) reduced the possibility of chance associations and prevalent, systematic biases, thereby increasing confidence in the research data and interpretations. Before journal publication, results of the exploration in this project were also presented at conferences to gain feedback from which papers in progress could be improved, further strengthening the credibility of interpretations.

In conclusion, ethics relate to every phase of a research project, from design to dissemination, and therefore need to be taken into equal consideration. The reflections above suggest that this was achieved in the research project, and that ethics thus have been taken into sufficient consideration. A discussion of methodological strengths and limitations in this project completes Chapter 3.

3.6 Methodological strengths and limitations

This subchapter addresses methodological strengths and limitations of this project, including the model development and validation process.

Strengths: Earlier in this thesis, I described how the concepts identified and developed in this project adhered to an inductive research strategy and sensitizing tradition (cf. Subchapter 2.2), meaning that the concepts were not prescriptions of what to see but rather acted as *"a general sense of reference and guidance in approaching empirical instances"* (Blumer, 1954: p. 7). More specifically, *"Sensitizing concepts offer ways of seeing, organizing, and understanding experience"* (Charmaz, 2003: p. 259). This sensitizing notion of incorporating concepts as references and guidance and as ways of seeing, organizing, and understanding, represented a main methodological strength in this project. This strength is evident in the connections between the conceptual orientation, operationalization, and field work. Specifically, the broad, open-minded nature of the dimensions identified during the orientation phase translated to an equally broad, open-minded operationalization and subsequent field approach. This avoided the specific focuses of existing theories and models (as identified during the theoretical reflections, cf. Subchapter 2.3). At the same time, the dimensions provided a sense of direction that ensured a structure to the field work (cf. operationalization in Subchapter 3.2). Thus, the simultaneous openness and structure/direction constitutes a methodological strength of this project.

Another methodological strength lies in making the research process structured and transparent, and thus easier to replicate in future (cf. Miles and Huberman's call for researchers to share their craft, Subchapter 3.1.1). Applied to this project, structure and transparency was attempted through descriptions and reflections on research strategy, conceptual orientation, model development and validation, methodological positioning, balanced methodology, operationalization, triangulation, and research quality. Moreover, by demonstrating transparency across several elements of the research process, this project aligns directly with Auberbach and Silverstein's (2003) category of "transparency," which measures how well a researcher, through descriptions of interpretation processes, research and protocol design, epistemological viewpoint, and so forth, informs the reader how they arrived at the particular interpretations. The structured, transparent approach also corresponds with Pawson et al.'s (2003) suggestion that *"The process of knowledge generation should be open to outside scrutiny"* (p. 38). Finally, this project attempted transparency via the active use of illustrations (such as figures and tables) throughout this thesis. These were intended to improve the reader's overview and access to the particular research element.

Furthermore, this project gained access to a setting (surgical operations) in which individuals (primarily surgeons) exert a high degree of control (Groger, et al., 1999). Limited explorations of this setting have been undertaken (cf. Subchapter 1.1.1). Thus, a methodological strength of this project lies in the type of data and setting accessed. A related strength is seen in the complementary nature of the perspectives applied to interpret and analyze data gathered as a result of this access, such as combining the nurse anesthetist's insights into the surgical setting with the safety angle of the principal researcher. In sum, both the access to, and the interpretation of, data from a surgical setting are strengths in this project.

Limitations: In terms of the overall research design, Toledo-Pereyra (2012) suggests that *"When the research question and hypothesis are clear and well defined, the research design becomes more evident and readily introduced in the overall planning of the study"* (p. 279). Correspondingly, the research question in this project was derived from an assessment of limited explorations of interdisciplinary teamwork within the health care sector (cf. Subchapter 1.1). This inspired an exploratory research design that comprised a

combination of observations, interviews, and conversations (cf. Subchapter 3.1.3).

Alternatively, and potentially strengthening to the project, the research design could have combined qualitative and/or quantitative methods (mixed-methods design) within or across one or more stages of the research (Leech & Onwuegbuzie, 2009). Specifically, O'Cathain et al. (2008) and Kettles et al. (2011) suggest that the value of a mixed-methods design depends on the particular situation. For example, it is possible that a second source of quantitative (statistical) data could have enhanced the descriptions of empirical results in this project (cf. Table 2 in Kettles, et al., 2011). However, a mixed-methods design (based on different paradigms) raises the dilemma of epistemological claims, as discussed in relation to triangulation (cf. Subchapter 3.2.3). Consequently, in selecting a mixed-methods approach, I would have to consider sacrificing triangulation as a validation approach, which could potentially weaken research quality (given that triangulation represented a key element in strengthening validity and generalizability in this project, cf. Subchapters 3.4.1 and 3.4.3).

A possible limitation also relates to the time span of this qualitative study. Compared with Smith et al. (2003), this project's fieldwork relied on fewer interviews (15 vs. 21 in Smith et al.) and fewer hours of observation (62 hours vs. 133 hours in Smith et al.), but Smith et al.'s fieldwork spanned an entire year, compared to a condensed four-month period (January to April 2010) for this research. Time span in itself is not an indication of quality (Album, 2008), particularly if close attention is paid to recognizing the point where no more themes emerge and data collection can cease (saturation). This study did just that through extensive triangulation and validation efforts (cf. Subchapters 3.2.2–3.2.4 and 3.3). This is supported by Wolcott (1987), who states *"Based on any one researcher's skill, sensitivity, problem, and setting, optimum periods of fieldwork may vary as much as the circumstances for pursuing it"* (p. 38). Yet, with a year time span, and by attending different types of operations (such as brain or heart surgery, and so forth), as well as operations in the evening and at night (in addition to regular work hours), the scientific model could potentially capture other aspects of the studied work practices and changes in the organization.

Another potential limitation relates to the application of non-participant observations in this qualitative study. This was a necessary choice, given my lack of specialized medical or nursing background. Specifically, non-participant observations meant my co-researcher and I were positioned at varying distances (1 to 4 meters) from the surgical team. This sometimes made it challenging to capture every detail of the team dialogs. While I believe this limitation was compensated for by extensive triangulation efforts, participant observations (in activities) could potentially have avoided this limitation. However, participation would require not only that both researchers have specialized nursing or medical background, but also concentration on the task at hand. This would have sacrificed the overview a distanced/non-participant perspective provides. Video recording, given the potential increase in precision, could also have improved our insights, but would introduce a new set of methodological challenges. Mackenzie et al. (2004) suggest that video analysis is tedious and time consuming, a microphone system will not pick up all utterances, and events occurring outside of the field of view are not recorded. Additionally, the researcher loses the opportunity of follow-up conversations with respondents to clarify or deepen understanding of an observation. Thus, even direct recording methods do not capture the empirical world authentically and have other shortcomings. This leads to the conclusion that pros and cons need to be carefully weighed, according to the goals of the particular research. For this project, the possibility of triangulating data on the fly to clarify and deepen understanding outweighed a lack of (potential) increase in accuracy or insights gained by video recording and participant observations.

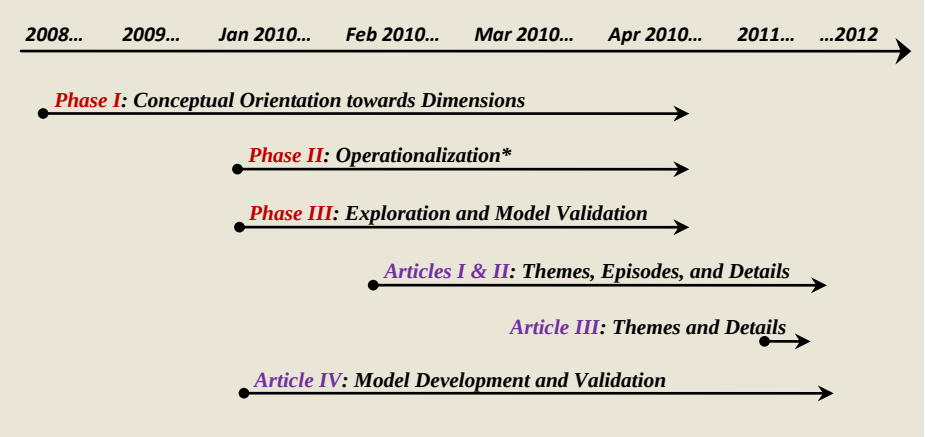
4 Research Phases, Article Connections, and Findings

This chapter describes the particular phases of the research project and their parallel and connected nature. The chapter describes how the researcher's articles connect to each of these phases through their aims and findings. Descriptions of each article's main findings are included to address the research question raised in Chapter 1: *How are safe work practices achieved in interdisciplinary surgical teamwork?* The findings are discussed more thoroughly in Chapter 5, in relation to existing findings and concepts.

4.1 Connections between the research phases and articles

This project's research process comprised parallel, closely connected research phases and articles, as illustrated in Figure 11. Specifically, the system and knowledge dimensions were identified during conceptual orientation ("Phase I") and subsequently integrated into a research protocol and a semi-structured interview guide, thus gradually operationalizing the dimensions ("Phase II"); see Subchapters 2.4 and 3.2. A balanced methodology (combining structure/transparency and depth/details) was used throughout in support of the field work and model development ("Phase II"); see Subchapters 3.1.1 and 3.2. Finally, the field protocol and interview guide were applied in the qualitative study, in which the findings validated the scientific model ("Phase III"); see Subchapters 3.2 and 3.3. The articles reflected these phases. Specifically, Articles I and II addressed the themes that emerged from exploring the knowledge and system dimensions in the qualitative study, corresponding to conceptual orientation ("Phase I"), operationalization ("Phase II"), and exploration and validation ("Phase III"). Article III focused on identifying the most frequently occurring "operating room themes" in the transcribed interview data and related to safe work practices (corresponding to operationalization in "Phase II" and exploration in "Phase III"). Finally, Article IV addressed not only the themes that emerged from exploring the knowledge and system dimensions, but also the model development and validation process corresponding to all three phases.

Figure 11: The timeline and parallel/connected nature of this research process.



* Operationalization of the balanced methodology and dimensions.

4.2 Aims, connections, and findings across articles

An overview of the articles follows, with an emphasis on aims, findings, and connections across articles, which reflects the project's overall research consistency.

4.2.1 Article I

Høyland, S., Aase, K., & Hollund, J. G. (2011). Exploring varieties of knowledge in safe work practices – An ethnographic study of surgical teams. (*Patient Safety in Surgery*).

Aim and article connections: Article I explored the varieties of ways in which knowledge is expressed during interdisciplinary surgical operations (corresponding to Research Objective III), where the findings validated the proposed model in Article IV.

Findings and article connections: Article I identified three particular themes in how operating room personnel express knowledge. The first theme was the ability and variety individuals demonstrated in handling multiple sources of information before reaching a particular decision. Team members displayed this theme in the ways they gathered information from multiple sources, both technological (monitors, computers) and human (colleagues). This enabled the

individuals and team to reach a particular decision when confronted with uncertainty. The second theme emerged in the variety of ways awareness or anticipation of future events was expressed. Typically, actions among team members were triggered by procedures (preparing equipment, preventing damage) and/or experience (continuous focus on preventing injury, checking urine, preparing gloves and syringe, calling early on the patient). This demonstrated that the ability to plan ahead depends on a combination of both explicit and tacit knowledge elements. The third theme comprised the different ways sudden and unexpected situations were handled by the individual team members. An example occurred during preparations for an operation when the team suddenly was informed that a dental hygienist was to conduct a parallel procedure to remove tartar, something for which the team had not planned. However, the team demonstrated two specific tacit knowledge elements that facilitated handling this unforeseen situation: the ability to remain calm, and the ability to assist each other in the completion of individual tasks ("lending a hand").

In conclusion, these particular findings on varieties of expressed knowledge contributed to validating the knowledge dimension of the scientific model presented in Article IV (corresponding to Research Objective IV). The focus on themes and episodes (structures/transparency) and details (in-depth descriptions) in Article I also reflected the operationalization of the balanced methodology (corresponding to Research Objective II). Finally, Article I provided insight into how surgical teams conduct safe work practices, thus addressing not only the research question in this thesis but also the limited explorations of the nature of interdisciplinary teamwork within the health care sector (cf. Subchapter 1.1).

4.2.2 Article II

Høyland, S., Aase, K., & Hollund, J. G. (2011). Understanding the system in relation to safe medical work practices. (*Safety Science Monitor*).

Aim and article connections: Article II explored how system factors influence interdisciplinary surgical operations and safe work practices (corresponding to Research Objective III), where the findings validated the proposed model in Article IV.

Findings and article connections: Article II identified two particular themes that stood out from the data material. Theme 1 was demonstrated in how various combinations of system factors contributed to disrupt the operational flow, although the particular operation continued and was completed as normal. Specifically, for an operation to become vulnerable and experience disruptions in the normal flow, a combination of local and external system factors typically needed to be simultaneously triggered. Outer structural factors (outside the operating room) included changes in the operating schedules, lack of planning in preparing operational equipment, less than ideal ad-hoc team compositions (such as inexperience under immediate and/or demanding surgery), delays in equipment arrivals (once requested), and lapses in individual control checks at several organizational levels. Inner structural factors (within the operating room) included the team members' moods, mobile phone disruptions, equipment failure and lack of control, and lack of equipment in the operating room. Once the negative outer and inner structural factors interacted in some way, operations became vulnerable. However, various system factors appeared to compensate for the vulnerabilities and disruptions because the observed operations proceeded despite interruptions (that is, the focus was on "the job" and safety). This pattern was identified as Theme 2 in the data material. Specifically, buffers (staffing, equipment, and operating rooms) constituted the outer structural factors of the system (cf. thesis Figure 7) and part of the compensating ability during operations. An anesthetist physician suggested that these buffers can reduce the individual work load, and thereby strengthen the working environment. Overall, the buffers helped to explain why the operations continued as normal, despite disruptions, such as less than ideal ad-hoc team compositions under demanding surgery interacting with team members' moods, for instance. Another compensating system factor was that operating personnel were exposed to only one section, which over time boosted specialized knowledge, confidence levels, and the ability to become proficient with the equipment and select the right equipment at the right time.

In conclusion, the particular findings on disrupting and compensating mechanisms validated the system dimension of the scientific model presented in Article IV (corresponding to Research Objective IV). The focus on themes and episodes (structure/transparency) and details (in-depth descriptions) in

Article II also reflects the operationalization of the balanced methodology (corresponding to Research Objective II). Finally, Article II provided insight into how surgical teams conduct safe work practices, thus addressing not only the research question but also the limited explorations of the nature of interdisciplinary teamwork within the health care sector (cf. Subchapter 1.1).

4.2.3 Article III

Høyland, S. (2011). Exploring safe work practices in surgical operations – The role of time, patient, and operation. (CRC Press/Balkema).

Aim and article connections: Article III focused on identifying elements of individual and team abilities to conduct and complete operations with a minimum of complications, defined as safe work practices. In Article III, the focus was not on validating the model in Article IV, but rather on gaining an overview of the most frequently occurring themes in the data material to achieve further insights into interdisciplinary surgical operations and safe work practices (corresponding to Research Objective III).

Findings and article connections: Article III identified three distinct patterns, or themes, in the interdisciplinary surgical team's ability to achieve safe work practices. Theme 1 ("time") was demonstrated in the individual's ability to disregard stress/pressure and apply the necessary time and considerations to do the job properly. This ability included the decision to involve a second person/opinion during a procedure and/or the ability to think ahead by calling for assistance to save precious time in a critical situation. Theme 2 ("patient") consisted of the individual's ability to sense and communicate patient-related problems, enhanced by the specialized patient focus. Specifically, the team member's specialized focus (anesthesia or operating-related tasks, cf. thesis Figure 3) enabled the team, as a whole, to remain focused and in control of both the surgical procedure and the patient's respiratory/vital functions. A specialized focus improved the team's ability to sense and communicate patient-related problems and/or judge the criticality of the patient's situation. Theme 3 ("operation") was represented by the team's reliance on individuals' competency and ability to plan and improvise when challenged by a problem or an unforeseen situation during an operation. Specifically, the reliance on the particular team member depended on (trust in) the competency levels of the individual/specialization. This meant that a

nurse anesthetist's medical judgment was heard during the operation and could result in suspension of an operation.

In conclusion, findings in Article III provided insights into how safe work practices in surgical teams relate to the themes of time, patient, and operation, thus contributing to answering the research question in Subchapter 1.1.2. Although not aimed for, insights into various "individual and team abilities" demonstrated tacit aspects of knowledge that validated the knowledge dimension of the scientific model in Article IV (corresponding to Research Objective IV). Finally, the focus on details (in-depth descriptions) and themes (structure/transparency) in Article III reflected the operationalization of the balanced methodology strategy (corresponding to Research Objective II).

4.2.4 Article IV

Høyland, S. (2012). Developing and validating a scientific model for exploring safe work practices in interdisciplinary teams. (*Safety Science*).

Aim and article connections: Corresponding to the need for scientifically grounded models that can be applied to, and integrate findings from, explorations of teamwork (cf. Subchapter 1.1.), the aim of the article was to present the development and validation of a model for exploring safe work practices in interdisciplinary teams (cf. Research Objective IV). A synthesis of findings, presented in Articles I and II, was used to validate the model.

Findings and article connections: In terms of the system dimension, two specific patterns in the data material were identified. One pattern emerged in the ways various combinations of system factors in the inner and outer structures interacted to disrupt the normal flow of activities conducted in the operating room. These factors included distracting mobile phones, difficulty with equipment, and team members' moods (typically an agitated surgeon interacting with an inexperienced operating room nurse). Another pattern emerged in how other system factors appeared to compensate for disruptive influences on team behavior. These factors included the availability of operating rooms, staffing and equipment, as well as the operating personnel's exclusive exposure to one surgical unit. This exposure boosted specialized knowledge, confidence levels, and the ability to become proficient with the equipment and to use the right equipment at the right time.

In terms of the knowledge dimension, three specific patterns were identified. The first pattern was displayed through the different ways individual team members handled sudden and unexpected situations. For example, the anesthetist physician handled the unforeseen (the patient had not received pain-relieving medicaments) by building on existing information (a challenging patient type and difficulties in entering the veins), being aware of the current situation and equipment (he decided to move into a less crowded room, and used ultrasound equipment to locate an area of good veins), and considering the future consequences of his actions (he rejected insertion into the groin due to the unclean state of this area, which risked infection). The second pattern was seen in the various abilities individuals demonstrated in handling multiple sources of information before reaching a particular decision. For example, the surgeon combined information from X-rays, colleagues, and his own experience to conclude how to proceed with the particular operation and procedure. The third pattern emerged in the variety of ways awareness or anticipation of future events was expressed. Specifically, the team member's ability to anticipate future events comprised both explicit knowledge, such as procedural elements (related to injury prevention, equipment preparation, and patient positioning), and tacit knowledge (healthy skepticism, handling of instruments, and continuous checking on patient).

In sum, safe work practices can be viewed as a product of individual and team abilities to draw on, and combine, explicit and tacit knowledge repertoires (cf. findings in Article I), which again is a product of the particular inner and outer structural conditions of a system (cf. findings in Article II). These insights into safe work practices validated both dimensions of the scientific model (corresponding to Research Objective IV). The focus on patterns (structures/transparency) and details (in-depth descriptions) in Article IV also reflects the operationalization of the balanced methodology strategy (corresponding to Research Objective II). In terms of answering the research question (cf. Subchapter 1.1.2), Article IV provided insight into how surgical teams conduct safe work practices and addressed the limited explorations of the nature of interdisciplinary teamwork within the health care sector.

5 Discussion on Findings and Model

This chapter begins by discussing the empirical findings of the qualitative study in connection with team-related findings in health research on quality and safety, and then connects the scientific model established in this project to existing concepts identified in Subchapter 2.3.

5.1 Connecting the study findings to existing findings

The discussions of this section are organized according to the particular dimension of the model, beginning with the knowledge dimension (comprising findings presented in Articles I, III, and IV) and followed by the system dimension (comprising findings presented in Articles II and IV).

5.1.1 Findings on the knowledge dimension

In terms of the knowledge dimension, a comparison can be made to the understanding of an expert within anesthesia, as described in Smith et al. (2003). In their view, an expert is characterized by the ability to simultaneously combine many different sources of knowledge, such as past learning (formal and experienced) and an understanding of the dynamic situation (patient and equipment signals). In this study, the "combination of sources" is exemplified in the ability an anesthetist physician demonstrated in handling an unforeseen situation (patient had not received pain-relieving medicaments) by building on existing information (a challenging patient type and the difficulties he experienced in entering the veins), being aware of the current situation and equipment (he decided to move into a less crowded room, and used ultrasound equipment to locate an area of good veins), and considering the future consequences of his actions (he rejected insertion into the groin due to the unclean state of this area, which risked infection). In other words, the team member's handling of the unforeseen through awareness of existing information, current and past experiences, and situational possibilities becomes an expression of what constitutes an expert. This supports Smith et al.'s (2003) findings.

In another study, Patel et al. (2000) identify the ability a primary care team demonstrates according to expertise in distributing responsibility for a

particular patient problem. This ability allows the team to process large amounts of patient information, thereby reducing the load on the single individual. Patel et al.'s (2000) findings can be compared to observations in this study of how different individuals demonstrated different ways of handling multiple sources of information before reaching a particular decision. For example, a surgeon handled information from multiple sources during his decision-making process (x-rays, colleagues, and his own experience), but the information was clearly defined within his "zone of responsibility" (how to proceed with the operation and procedure). In another situation, the nurse anesthetist handled information from a number of sources (patient, father, ward nurse) as part of her defined role and responsibility in preparing the patient for the operation. In both examples, it is clear that information is processed based on a natural zone of responsibility. Many sources of information can be combined within each zone that, when put together, enables the team to process large amounts of information. The finding supports Patel et al.'s (2000) understanding of distributed responsibility.

Another comparison can be made to what Friedman and Bernell (2006) identify as an ability to anticipate another team member's actions due to shared experiences. While this study does not bring additional clarity to understanding "shared experience," it supports that the ability to anticipate future events (such as the operator's instrument needs and possible pressure injuries to patient) comprises both explicit knowledge, such as procedural elements (related to equipment preparation, injury prevention, and patient positioning), and tacit knowledge (instrument preparation ahead of the operator's request, healthy skepticism, and continuous checking on patient). Friedman and Bernell's (2006) and this study's findings demonstrate different aspects of the team member's ability to anticipate future events.

Further supporting the knowledge dimension, this study highlights the themes of time, patient, and operation. In terms of time, this study identifies the individual's ability to disregard stress/pressure and apply the time and considerations necessary to the job properly, thus taking time becomes a positive element that enables safe work practices. This stands in contrast to Carl et al. (2010), who look at complications associated with peri-operative

issues and find that operating room time could derail a surgical outcome, even with an otherwise uneventful surgical technique.

In terms of the patient theme, this study finds that safe work practices are aided by the individual's ability to sense and communicate patient-related problems, enhanced by the specialized patient focus. Linked to existing literature, the specialized patient focus can be viewed as a property of how a team delegates tasks to those most skilled (distributed responsibility). This enables the team to process large amounts of information (cf. Patel, et al., 2000). The sensing and communicating aspects are similar to Catchpole et al.'s (2008) finding that a low rate of errors in surgical technique can be associated with higher situational awareness among surgeons, in terms of the ability to notice what is happening, understanding the implications, and thinking ahead.

Finally, in terms of the operation theme, this study suggests that safe work practices comprised team reliance on the individual's competency and ability to both plan and improvise when challenged during an operation. The reliance on an individual's competency is comparable to Patel et al.'s (2000) finding that tasks are delegated to those most skilled.

5.1.2 Findings on the system dimension

In terms of the system dimension, Catchpole et al. (2007) attempt to identify system factors that can be improved. They find that complications during operations resulted from an escalation of smaller problems, caused by the context in which the operation took place. This includes unnecessary distractions (telephones, pagers), difficulties with equipment (availability and function), unexpected problems with patient anatomy, and conflicting demands on team members from other parts of the hospital system. Supporting these findings, this study identified that inner structural factors, such as distracting mobile phones and difficulty with equipment, disrupt operational flow. In addition, this study suggests that team members' mood plays a role (such as an agitated surgeon interacting with an inexperienced operating room nurse). However, in terms of outer structural factors, this study does not support the relevance of conflicting demands on team members from others parts of the hospital, as Catchpole et al. (2007) found. Instead, relevant outer system factors in this study include: Changes in the operating

schedules, lack of planning in preparing operational equipment, less than ideal ad-hoc team compositions, and delays in equipment arrivals. Leach et al. (2009) focus on understanding the nature of surgical teams and their performance. They describe problems associated with operating schedules, the availability to operating rooms, and a shortage of staff, equipment and supply. However, this study found that the availability of operating rooms, staffing and equipment represents the main strengths of the surgical unit and the teams studied. This is an important finding, suggesting that the conditions for conducting operations might differ significantly from one setting to another, as well as the ability to ensure safe work practices. Besides this reversed "similarity" between the findings, this study determined a relevant system factor to be the operating personnel's exclusive exposure to one surgical unit, boosting specialized knowledge and confidence levels and the ability to become proficient with the equipment and use the right equipment at the right time.

In conclusion, findings in this qualitative study support existing findings on aspects of teamwork in health research literature on quality and safety. The findings also provide a nuanced and partially contrasting (Carl, et al., 2010; Catchpole, et al., 2007; Leach, et al., 2009) understanding of existing findings. In addition, a broader understanding of safe work practices is achieved by combining all findings (cf. Subchapter 2.4.5). This broader understanding contrasts with the specific approaches in the studies above, such as Smith et al.'s (2003) focus on what constitutes an expert, Friedman and Bernell's (2006) concern with how aspects of tacit knowledge influence performance, Catchpole et al.'s (2007) focus on identifying latent failures to improve performance, and Leach et al.'s (2009) emphasis on the link between coordination and performance.

5.2 Connecting the model to existing concepts

In terms of connecting the model to existing concepts, I assessed that existing concepts restricted an open-minded and inductive research approach, and thus excluded these concepts in the conceptual orientation (cf. Subchapter 2.3). However, reflections during the fieldwork revealed connections between aspects of the model and the existing concepts. The organizational safety concepts are addressed first, followed by the team-oriented safety concepts.

5.2.1 The organizational safety concepts

Reason's (1997) Swiss cheese model is concerned with the existence of latent conditions in a system that could potentially lead to active failures. This can be seen in this study's finding on how "various combinations of system factors, such as operating schedules, lack of planning, less than ideal ad-hoc team compositions, mobile phone interruptions, and equipment failure, contribute to disrupt the operational flow" (aspect of the system dimension), and also the finding on "the team's ability to compensate, through buffers (staffing, equipment, operating rooms) and experience from exclusive exposure to one section, for the vulnerabilities and disruptions that arise during operations" (aspect of the system dimension). Specifically, the latter finding of this study suggests that active failures are prevented through the compensating ability of surgical teams.

Another connection can be made to Weick and Sutcliffe's (2001) concept of mindfulness in handling unexpected situations or problems at an operational level. More precisely, the "sensitivity to operations" element in their concept is similar to this study's findings on "the different ways individual team members handle sudden and unexpected situations" (aspect of the knowledge dimension), "the variety of ways awareness or anticipation of future events is expressed" (aspect of the knowledge dimension), and "the team's reliance on individuals' competency and ability to plan and improvise when challenged by a problem or an unforeseen situation during an operation" (aspect of the knowledge dimension). Finally, a more indirect connection can be made to Snook's (2000) understanding of "local adaption and global detachment," in the sense that the team members in this study demonstrated an ability to combine various elements of tacit and explicit knowledge that were not part of written procedures or the "textbook" (aspect of the knowledge dimension, cf. Subchapter 4.2.1). This ability could be viewed as a way of coping with static and impractical procedures.

5.2.2 The team-oriented safety concepts

In terms of the connections to team-oriented safety concepts, the (teamwork) dimensions of "problem solving and decision making" and "situation awareness" in Catchpole et al.'s (2007) adapted NOTECHS concept, are both clearly reflected in this study's finding on "the ability and variety individuals

demonstrate in handling multiple sources of information before reaching a particular decision" (aspect of the knowledge dimension). The related observational markers Catchpole et al. (2007) define, such as "considers all elements" and "asks for/shares information," also support this connection. Mackintosh et al.'s (2009) concept of team situation awareness (TSA) implies the understanding that whiteboard, coordinator, and handover ("supporting structures") across a team improves information handling and dissemination, so facilitates work and overall team situation awareness. This scientific model and the TSA concept connects to my finding on "the ability and variety individuals demonstrate in handling multiple sources of information before reaching a particular decision" (aspect of the knowledge dimension), and in the finding on "the team's ability to compensate, through buffers (staffing, equipment, operating rooms) and experience from exclusive exposure to one section, for the vulnerabilities and disruptions that arise during operations" (aspect of the system dimension). Specifically, the findings imply that various sources of information (electronic and human) and buffers (staffing, equipment, and operating rooms) become the supporting structures. Furthermore, Leach et al.'s (2009) concept of "sociotechnical influences" are clearly reflected in the connection between "system influences" (equipment, scheduling, supplies, and so forth) and this study's findings on how "various combinations of system factors, such as operating schedules, lack of planning, less than ideal ad-hoc team compositions, mobile phone interruptions, and equipment failure, contribute to disrupt the operational flow" (aspect of the system dimension). Also the components of "individual experience" and "individual competence" in Leach et al. (2009) are seen in this study's finding on "the ability and variety individuals demonstrate in handling multiple sources of information before reaching a particular decision" (aspect of the knowledge dimension) and in the finding on "the team's reliance on individuals' competency and ability to plan and improvise when challenged by a problem or an unforeseen situation during an operation" (aspect of the knowledge dimension).

Finally, connections can be made to models (in health research literature on quality and safety) that were not revealed in the second theoretical reflections in this project (cf. Subchapter 2.3.2), and thus not included during model development. One example is Lingard et al.'s (2006) model of "utility." This

model, while never represented explicitly (visually), comprises two elements, "informational utility" and "functional utility," aimed at understanding communication aspects of teamwork. Specifically, the former element is defined as the impact of information exchange (typically during briefings) on knowledge or awareness of the team, while the latter is understood as the precipitated effect on teamwork. Lingard et al.'s (2006) two concepts of information and functional utility can first and foremost be seen in this study's finding on "the ability and variety individuals demonstrate in handling multiple sources of information before reaching a particular decision" (aspect of the knowledge dimension). More precisely, information gathering and exchange affect team members' awareness and action (decision to take). Another example of models not revealed during the theoretical reflections is Gillespie et al.'s (2010) "fish-bone schema" of cause-and-effect influences of organizational and individual factors on teamwork in surgery. This model comprises two concepts: "interdisciplinary diversity in teams contributes to complex interpersonal relations," and "the pervasive influence of the organization on interdisciplinary team cohesion." The main connection between Gillespie et al.'s (2010) model and this scientific model is seen in the latter concept, which includes "finite resources" as derived from Gillespie et al.'s (2010) finding on how limited resources resulted in a "skeleton staff." This scientific model includes the exact reversed finding on system aspects. Buffers (staffing, equipment, and operating rooms) enabled the team to compensate for vulnerabilities and disruptions during operations (aspect of the system dimension).

In conclusion, the reflections above provide insights into how the model developed in this project captures a number of facets of existing theories and models, thus demonstrating the benefits of a broader model design (cf. Subchapter 2.4.4). The broader, inclusive design is also reflected in the model's ability to incorporate a number of existing findings from health research literature on quality and safety (cf. Tables 1 and 2 in Høyland, 2012).

6 Thesis Contributions and Implications

This concluding chapter focuses on the contributions and implications of this thesis, as well as suggestions for further research. The contributions and implications are two-fold. There are theoretical contributions and implications to safety research, and there are practical contributions and implications for policy-makers, managers, researchers, and practitioners. Related to the theoretical contributions, the section on further research provides suggestions on possible follow-up approaches to the scientific model and findings.

6.1 Theoretical contributions and implications

This thesis contributes to safety research by establishing a scientific model for exploring safe work practices in teamwork that is of broad enough design to include existing findings and concepts, as well as new findings (cf. Research Objective IV in Subchapter 1.1.2). Specifically, related to health research literature on quality and safety, this thesis began by outlining gaps in scientifically grounded models that can integrate existing findings (Manser, 2009) and be applied to explore and measure the behaviors and performance of interdisciplinary teams (Baker, et al., 2006; Healey, et al., 2004, 2006b). These gaps could be explained by the specific focuses of existing concepts in safety research (cf. Subchapter 2.3), limiting to researchers' ability to integrate and systemize a wider specter of existing team-related findings. This project addressed this concern by focusing on a model of broader design, comprised of broad dimensions and dynamic mechanisms[36] that allowed for continual adjustment of these dimensions (cf. Subchapter 2.4.3). As a result, the model was able to incorporate existing findings and concepts (from the literature review process and discussion), as well as new findings from the qualitative study (cf. Subchapters 2.4 and 5.2).

By applying the model as a frame for exploration during the qualitative study (cf. Subchapters 2.4 and 3.2), this thesis also contributes to safety research by

[36] These dynamic mechanisms, in conjunction with the dimensions, enabled the model to integrate existing team-related findings from different contexts, and thus suggested transferability of the mechanisms to other contexts involving teamwork.

creating a broader understanding of how safe work practices are achieved in interdisciplinary surgical teamwork (cf. Research Question and Objective III): *"Safe work practices can be defined as the dynamic and continuous effort by each individual team member and the overall team to combine and draw upon explicit and tacit knowledge repertoires to achieve a successful operation with minimal errors and complications. Safe work practices also can be viewed as the overall organization's ability to maintain inner and outer (system) conditions that are strong enough to support individual and team abilities to combine and draw upon knowledge repertoires"* (Subchapter 2.4.5, p. 41). This broad understanding of safe work practices contrasts with the specific focuses and insights found in existing health research on quality and safety (cf. Subchapters 1.1.1 and 5.1.2), such as communication (Lingard, et al., 2002; Rydenfalt, et al., 2012), conditions and non-routine events (Minnick, et al., 2012), exemplary behaviors (Curry, et al., 2011), efficiency (Arakelian, et al., 2011), coordination and performance (Leach, et al., 2009), discursive practices (Finn, 2008), latent failures and performance (Catchpole, et al., 2007), ritualistic behaviors (Waring, et al., 2007), governance and control (Riley & Manias, 2006), and expertise (Smith, et al., 2003).

Based on the assumption that the specific focuses of existing safety research concepts (cf. Subchapter 2.3) explain a lack of continuation and systemizing of existing team-related findings (Høyland, 2012; Manser, 2009), the main implication is that safety researchers should emphasize the design of scientific models, including dynamic mechanisms, that are broad and inclusive enough to integrate existing findings and concepts, as well as new findings. The potential for generalizability and transferability of model aspects, as demonstrated in this project, underscores the value of a broader model design. Thus, another implication for safety researchers is to consider research quality in connection with model development.

The theoretical contributions and related implications answer the identified needs in health research literature on quality and safety for exploring the nature of teamwork and developing models that can be applied to, and integrate findings from, such explorations (cf. Subchapter 1.1).

6.2 Practical contributions and implications

Given an identified lack of explorations into the nature of teamwork and surgical operations within the health care sector (cf. Subchapter 1.1), this thesis' practical contributions lie in the broad yet in-depth approach to safety in surgical teamwork. This is of potential interest and relevance to: Policy-makers who decide on financing for specialist health services and related research (interest trigger: the need for further explorations into surgical operations), managers at different levels of the hospital system who seek to improve surgical operations (interest trigger: system buffers that facilitate safe work practices), researchers within and outside the health care sector who are interested in approaches to safety and related results (interest trigger: a broader approach to safety), and practitioners who wish to gain insight into their own environment and practices (interest trigger: a broader safety perspective on surgical operations).

Related to this, in terms of practical implications for improving safety in surgical operations, managers at different levels should establish system conditions to facilitate a team's ability to draw on explicit and tacit knowledge repertoires. Examples of such system conditions include buffers in operating rooms, equipment and personnel (Høyland, et al., 2011b), and different forums (weekly/monthly seminars and/or meetings) for sharing insight on knowledge and system aspects among operating personnel (Høyland, et al., 2011a). Practitioners share equal responsibility for the latter approach of sharing insight, in that they actively attend and benefit from the seminar/meeting discussions. Consequently, establishing favorable system conditions, not only physically (buffers) but also in terms of knowledge-sharing and formalizing, can reduce the likelihood of adverse events and improve patient safety (cf. Subchapter 1.1).

Another implication is for researchers to establish ways of formalizing different types of tacit knowledge. One feasible approach could be to include questions that trigger sharp-end/local reflections in the design of checklists, such as the World Health Organization (WHO) Surgical Safety Checklist (Fourcade, et al., 2012; Høyland, et al., 2011a). Specifically, the "time-out" phase of the checklist, conducted immediately prior to the incision, includes reflections on the planned procedure, incision, risk factors, infection concerns,

and so forth. These reflections could extend to, and benefit from tacit knowledge. For example, reflections could be initiated by: Are there experiences, insights, and/or techniques that could aid work practices and the operation? This way of integrating sharp-end/local knowledge could improve the fit between checklists and clinical practice. This would enable practitioners to more easily relate to surgical checklists, which in turn could potentially overcome *"The traditional culture of surgery [that] is rigid and resists changes to convention, including the introduction of checklists, which are not part of its traditional practice pattern"* (Weiser, et al., 2010: p. 369). In other words, incorporating sharp-end/local knowledge into checklists can account for aspects of surgical operations not yet formalized or systemized, which can in turn improve patient safety by reducing the likelihood of adverse events.

6.3 Further research

The theoretical implications focused on the need for models of a broader and more inclusive design. Related to this scientific model, further research into the model should seek to test and improve generalizability of the knowledge and system dimensions. The research should not be limited to the surgical context and specialist health services, but also gradually extend beyond the health care sector (cf. Subchapter 3.4.3). Furthermore, the research should place particular emphasis on the system dimension, given the partial contrast between this study's findings on the system dimension and existing findings (cf. Subchapter 5.1.2), and the lack of distinction and categorization of system aspects in existing literature (cf. subchapter 2.4.1 and Høyland, 2012). Finally, the research can determine the transferability of the model's dynamic mechanisms to other contexts (cf. Subchapter 6.1).

Another route for further research is to develop methods aimed at improving safe work practices, based on the findings in this project. Specifically, one suggested approach is designing checklists to integrate this project's findings (cf. Subchapter 6.2), while another approach could be to incorporate the findings in the design of simulation training programs applied during health professional education (cf. Kyrkjebø, 2006; Østergaard, 2004).

References

Aase, K., Høyland, S., Olsen, E., et al. (2008). Patient safety challenges in a case study hospital – Of relevance for transfusion processes? *Transfusion and Apheresis Science, 39*(2), 167–172.

Adcock, R., & Collier, D. (2001). Measurement validity: A shared standard for qualitative and quantitative research. *The American Political Science Review, 95*(3), 529–546.

Album, D. (2008). [Completely ordinary patients]. In A. Tjora (Ed.), *[The Modern Patient]*. Oslo: Gyldendal Akademisk.

Allard, J., Bleakley, A., Hobbs, A., et al. (2011). Pre-surgery briefings and safety climate in the operating theatre. *BMJ Quality & Safety, 20*(8), 711–717.

Arakelian, E., Gunningberg, L., & Larsson, J. (2011). How operating room efficiency is understood in a surgical team: A qualitative study. *International Journal for Quality in Health Care, 23*(1), 100–106.

Arora, S., Ahmed, M., Paige, J., et al. (2012). Objective structured assessment of debriefing: Bringing science to the art of debriefing in surgery. *Annals of Surgery, 256*(6), 982–988.

Arora, S., & Sevdalis, N. (2010). Surgical flow disruptions: Measurement and impact of stressful events in the operating room. *World Journal of Surgery, 34*(9), 2247–2248.

Auberbach, C. F., & Silverstein, L. B. (2003). *Qualitative Data: An Introduction to Coding and Analysis*. New York: New York University Press.

Baker, D. P., Day, R., & Salas, E. (2006). Teamwork as an essential component of high-reliability organizations. *Health Services Research, 41*(4, Pt 2), 1576–1598.

Baker, G. R., Norton, P. G., Flintoft, V., et al. (2004). The Canadian Adverse Events Study: The incidence of adverse events among hospital patients in Canada. *Canadian Medical Association Journal, 170*(11), 1678–1686.

Barach, P., & Johnson, J. K. (2006). Understanding the complexity of redesigning care around the clinical microsystem. *Quality & Safety in Health Care, 15*(Supplement 1), I10–I16.

Barbour, R. S. (2001). Checklists for improving rigour in qualitative research: A case of the tail wagging the dog? *BMJ, 322*(7294), 1115–1117.

Barron, L. (2006). Ontology. In V. Jupp (Ed.), *The Sage Dictionary of Social Research Methods*. London: Sage Publications.

Benson, A. D., Kramer, B. A., Boehler, M., et al. (2010). Robot-assisted laparoscopic skills development: Formal versus informal training. *Journal of Endourology, 24*(8), 1351–1355.

Best, J., & Khan, J. (1989). *Research in Education*. Englewood Cliffs, NJ: Prentice Hall.

Blaikie, N. (2000). *Designing Social Research*. Cambridge, UK: Polity Press.

Blaikie, N. (2007). *Approaches to Social Enquiry (2nd ed.)*. Cambridge, UK: Polity Press.

Blaxter, L., Hughes, C., & Tight, M. (1996). *How to Research*. Buckingham, UK: Open University Press.

Blumer, H. (1954). What is wrong with social theory. *American Sociological Review, 19*, 3–10.

Bowen, G. A. (2008). Naturalistic inquiry and the saturation concept: A research note. *Qualitative Research, 8*(1), 137–152.

Braude, H. D. (2009). Clinical intuition versus statistics: Different modes of tacit knowledge in clinical epidemiology and evidence-based medicine. *Theoretical Medicine and Bioethics, 30*(3), 181–198.

Brennan, T. A., Leape, L. L., Laird, N. M., et al. (1991). Incidence of adverse events and negligence in hospitalized patients. Results of the Harvard Medical Practice Study I. *New England Journal of Medicine, 324*(6), 370–376.

Brewer, J., & Hunter, A. (1989). *Multimethod research: A synthesis of styles*. Newbury Park, CA: Sage.

Bryman, A., Becker, S., & Sempik, J. (2008). Quality criteria for quantitative, qualitative and mixed methods research: A view from social policy. *International Journal of Social Research Methodology, 11*(4), 261–276.

Burke, C. S., Salas, E., Wilson-Donnelly, K., et al. (2004). How to turn a team of experts into an expert medical team: Guidance from the aviation and military communities. *Quality & Safety in Health Care, 13*(Suppl I), i96–i104.

Burrell, G., & Morgan, G. (1979). *Sociological Paradigms and Organisational Analysis*. Aldershot, UK: Gower.

Carl, A., Kaufman, E., & Lawrence, J. (2010). Complications in spinal deformity surgery: Issues unrelated directly to intraoperative technical skills. *Spine (Phila Pa 1976), 35*(25), 2215–2223.

Carne, B., Kennedy, M., & Gray, T. (2012). Review article: Crisis resource management in emergency medicine. *Emergency Medicine Australasias, 24*(1), 7–13.

Carney, B. T., West, P., Neily, J., et al. (2010). Differences in nurse and surgeon perceptions of teamwork: Implications for use of a briefing checklist in the OR. *AORN Journal, 91*(6), 722–729.

Catchpole, K., Mishra, A., Handa, A., et al. (2008). Teamwork and error in the operating room – Analysis of skills and roles. *Annals of Surgery, 247*(4), 699–706.

Catchpole, K. R., Giddings, A. E. B., De Leval, M. R., et al. (2006). Identification of systems failures in successful paediatric cardiac surgery. *Ergonomics, 49*(5–6), 567–588.

Catchpole, K. R., Giddings, A. E. B., Wilkinson, M., et al. (2007). Improving patient safety by identifying latent failures in successful operations. *Surgery, 142*(1), 102–110.

Chapin, F. S. (1939). Definition of definitions of concepts. *Social Forces, 18*(2), 153-160.

Charmaz, K. (2003). Grounded theory: Objectivist and constructivist methods. In N. K. Denzin & Y. S. Lincoln (Eds.), *Strategies for Qualitative Inquiry (2nd ed.)* (pp. 249–291). Thousand Oaks, CA: Sage.

Chiesa, M., & Hobbs, S. (2008). Making sense of social research: How useful is the Hawthorne Effect? *European Journal of Social Psychology, 38*, 67–74.

Cho, J., & Trent, A. (2006). Validity in qualitative research revisited. *Qualitative Research, 6*(3), 319–340.

Comitas, L. (2000). Ethics in anthropology: Dilemmas and conundrums. *Annals New York Academy of Sciences, 925*, 196–210.

Cook, T. D., & Campbell, D. T. (1979). *Quasi-experimentation: Design and Analysis for Field Settings*. Chicago: Rand McNally.

Creswell, J. W. (2003). *Research Design: Qualitative, Quantitative, and Mixed Approaches*. Thousand Oaks, CA: Sage.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory Into Practice, 39*(3), 124-131.

Curry, S. E., Cortland, C. I., & Graham, M. J. (2011). Role-modelling in the operating room: Medical student observations of exemplary behaviour. *Medical Education, 45*(9), 946–957.

Cutcliffe, J. R., & McKenna, H. P. (1999). Establishing the credibility of qualitative research findings: The plot thickens. *Journal of Advanced Nursing, 30*(2), 374–380.

Danermark, B., Ekstrom, M., Jakobsen, L., et al. (2002). *Explaining Society: Critical Realism in the Social Sciences*. London: Routledge.

Davis, P., Lay-Yee, R., Briant, R., et al. (2002). Adverse events in New Zealand public hospitals I: Occurrence and impact. *New Zealand Medical Journal, 115*(1167), U271.

de Leval, M. R., Carthey, J., Wright, D. J., et al. (2000). Human factors and cardiac surgery: A multicenter study. *Journal of Thoracic and Cardiovascular Surgery, 119*(4 Pt 1), 661–672.

de Ruyter, K., & Scholl, N. (1998). Positioning qualitative market research: Reflections from theory and practice. *Qualitative Market Research, 1*(1), 7–14.

de Vries, E. N., Ramrattan, M. A., Smorenburg, S. M., et al. (2008). The incidence and nature of in-hospital adverse events: A systematic review. *Quality & Safety in Health Care, 17*(3), 216–223.

Denzin, N. K. (1970). *The Research Act: A Theoretical Introduction to Sociological Methods*. Chicago: Aldine.

Denzin, N. K. (1978). *Sociological Methods*. New York: McGraw-Hill.

Denzin, N. K. (2009). The elephant in the living room: Or extending the conversation about the politics of evidence. *Qualitative Research, 9*(1), 139–160.

Denzin, N. K., & Lincoln, Y. S. (2005). *The Sage Handbook of Qualitative Research (3rd ed.)*. Thousand Oaks, CA: Sage.

Dew, K. (2007). A health researcher's guide to qualitative methodologies. *Australian and New Zealand Journal Of Public Health, 31*(5), 433–437.

Donaldson, M. S., & Mohr, J. J. (2000). Improvement and innovation in health care microsystems. A technical report for the Institute of Medicine Committee on the Quality of Health Care in America. Robert Wood Johnson Foundation.

Downward, P., & Mearman, A. (2007). Retroduction as mixed-methods triangulation in economic research: Reorienting economics into social science. *Cambridge Journal of Economics, 31*, 77–99.

Ducheyne, S. (2008). Towards an ontology of scientific models. *International Journal for Ontology and Metaphysics, 9*, 119–127.

Durkeim, E. (1951). *Suicide*. New York: Free Press.

Edmondson, A. C. (2003). Speaking up in the operating room: How team leaders promote learning in interdisciplinary action teams. *Journal of Management Studies, 40*(6), 1419–1452.

Eisner, E., & Peshkin, A. (1990). *Qualitative Inquiry in Education: The Continuing Debate*. New York: Teachers College Press.

ElBardissi, A. W., Wiegmann, D. A., Henrickson, S., et al. (2008). Identifying methods to improve heart surgery: An operative approach and

strategy for implementation on an organizational level. *European Journal of Cardio-thorac Surgery, 34*(5), 1027–1033.
Emerson, R. M., Fretz, R. I., & Shaw, L. L. (1995). *Writing Ethnographic Field Notes*. Chicago: The University of Chicago Press.
Erlandson, D., Harris, E., Skipper, B., et al. (1993). *Doing Naturalistic Inquiry: A Guide to Methods.* Thousand Oaks, CA: Sage.
Fangen, K. (2005). *[Participant Observation]*. Stockholm: Lieber Forlag.
Ferguson, L. (2004). External validity, generalizability, and knowledge utilization. *Journal of Nursing Scholarship, 36*(1), 16–22.
Fielding, N. G., & Fielding, J. L. (1986). *Linking Data*. Beverly Hills, CA.: Sage
Finn, R. (2008). The language of teamwork: Reproducing professional divisions in the operating theatre. *Human Relations, 61*(1), 103–130.
Firestone, W. A. (1993). Alternative arguments for generalizing from data as applied to qualitative research. *Educational Researcher, 22*(4), 16–23.
Flin, R., & Mitchell, L. (Eds.). (2009). *Safer surgery – Analysing behaviour in the operating theatre*. Farnham, UK: Ashgate Publishing Limited.
Fourcade, A., Blache, J. L., Grenier, C., et al. (2012). Barriers to staff adoption of a surgical safety checklist. *BMJ Quality & Safety, 21*(3), 191–197.
Friedman, L. H., & Bernell, S. L. (2006). The importance of team level tacit knowledge and related characteristics of high-performing health care teams. *Health Care Management Review, 31*(3), 223–230.
Gaba, D. M. (2000). Structural and organizational issues in patient safety: A comparison of health care to other high-hazard industries. *California Management Review, 43*(1), 83–102.
Giere, R. N. (2010). An agent-based conception of models and scientific representation. *Synthese, 172*(2), 269–281.
Gillespie, B. M., Chaboyer, W., Longbottom, P., et al. (2010). The impact of organisational and individual factors on team communication in surgery: A qualitative study. *International Journal of Nursing Studies, 47*(6), 732–741.
Glaser, B. G. (2002). Conceptualization: On theory and theorizing using grounded theory. *International Journal of Qualitative Methods, 1*(2), 1–31.
Goetz, J. P., & LeCompte, M. D. (1981). Ethnographic research and the problem of data reduction. *Anthropology and Education Quarterly, 12*(51–70).
Gofton, W. T., Dudek, N. L., Wood, T. J., et al. (2012). The Ottawa Surgical Competency Operating Room Evaluation (O-SCORE): A tool to assess surgical competence. *Academic Medicine, 87*(10), 1401–1407.

Graff, C., Roberts, K., & Thornton, K. (1999). An ethnographic study of differentiated practice in an operating room. *Journal of Professional Nursing, 15*(6), 364–371.

Greenberg, C. C., Roth, E. M., Sheridan, T. B., et al. (2006). Making the operating room of the future safer. *American Surgeon, 72*(11), 1102–1108.

Grober, E. D., Roberts, M., Shin, E. J., et al. (2010). Intraoperative assessment of technical skills on live patients using economy of hand motion: Establishing learning curves of surgical competence. *American Journal of Surgery, 199*(1), 81–85.

Groger, L., Mayberry, P. S., & Straker, J. K. (1999). What we didn't learn because of who would not talk to us. *Qualitative Health Research, 9*(6), 829–835.

Hales, B., Terblanche, M., Fowler, R., et al. (2008). Development of medical checklists for improved quality of patient care. *International Journal for Quality in Health Care, 20*(1), 22–30.

Hammersley, M. (2002). Ethnography and realism. In A. M. Huberman & M. B. Miles (Eds.), *The Qualitative Researcher's Companion*. Thousand Oaks, CA: Sage Publications.

Hammersley, M. (2007). The issue of quality in qualitative research. *International Journal of Research & Method in Education, 30*(3), 287–305.

Harris, K. T., Treanor, C. M., Salisbury, M. L. (2006). Improving patient safety with team coordination: Challenges and strategies of implementation. *Association of Women's Health, Obstetric, and Neonatal Nurses, 35*(4), 557–566.

Haynes, A. B., Weiser, T. G., Berry, W. R., et al. (2009). A surgical safety checklist to reduce morbidity and mortality in a global population. *New England Journal of Medicine, 360*(5), 491–499.

Haynes, R. B. (2002). What kind of evidence is it that evidence-based medicine advocates want health care providers and consumers to pay attention to? *Biomed Central Health Services Research, 2*(3).

Healey, A. N., Undre, S., Sedvalis, N., et al. (2006a). The complexity of measuring interprofessional teamwork in the operating theatre. *Journal of Interprofessional Care, 20*(5), 485–495.

Healey, A. N., Undre, S., & Vincent, C. A. (2004). Developing observational measures of performance in surgical teams. *Quality & Safety in Health Care, 13*(Suppl I), i33–i40.

Healey, A. N., Undre, S., & Vincent, C. A. (2006b). Defining the technical skills of teamwork in surgery. *Quality & Safety in Health Care, 15*, 231–234.

Henry, S. G. (2006). Recognizing tacit knowledge in medical epistemology. *Theoretical Medicine and Bioethics, 27*(3), 187–213.

Hindmarsh, J., & Pilnick, A. (2002). The tacit order of teamwork: Collaboration and embodied conduct in anesthesia. *Sociological Quarterly, 43*(2), 139–163.

Hirschauer, S. (1991). The manufacture of bodies in surgery. *Social Studies of Science, 21*(2), 279–319.

Hobbs, N. (1968). Ethics – Ethical issues in the social sciences. In D. L. Sills (Ed.), *International Encyclopedia of the Social Sciences* (Vol. 5). New York: The Macmillan Company & The Free Press.

Huberman, A. M., & Miles, M. B. (2002). *The Qualitative Researcher's Companion*. Thousand Oaks, CA: Sage Publications.

Huckson, S., & Davies, J. (2007). Closing evidence to practice gaps in emergency care: The Australian experience. *Academic Emergency Medicine, 14*(11), 1058–1063.

Hull, L., Arora, S., Aggarwal, R., et al. (2012). The impact of nontechnical skills on technical performance in surgery: A systematic review. *Journal of the American College of Surgeons, 214*(2), 214–230.

Høyland, S. (2005). *[Error management in a medical clinic – A product of organizational conditions].* Unpublished Masters Thesis, University of Stavanger, Stavanger.

Høyland, S. (2007). A theoretical understanding of safe work practices – A comparison of aviation and health care. In T. Aven & J. E. Vinnem (Eds.), *Risk, Reliability, and Societal Safety: Application Topics, Vol. 3* (pp. 2121–2128). London: Taylor & Francis.

Høyland, S. (2012). Developing and validating a scientific model for exploring safe work practices in interdisciplinary teams. *Safety Science, 50*(2), 316–325.

Høyland, S., & Aase, K. (2008a). *Designing interdisciplinary simulations within health care: A literature review of medical interdisciplinary simulation design aspects*. Paper presented at the International Conference on Healthcare Systems, Ergonomics and Patient Safety (HEPS).

Høyland, S., & Aase, K. (2008b). An exploratory study on human, technological, and organizational interactions within health care. *Safety Science Monitor, 12*(1), Article 1.

Høyland, S., & Aase, K. (2009). Does change challenge safety? Complexity in the civil aviation transport system. In S. Martorell, C. Guedes Soares & J. Barnett (Eds.), *Safety, Reliability and Risk Analysis: Theory, Methods and Applications, Vol. 2* (pp. 1385–1393). Boca Raton, FL: CRC Press.

Høyland, S., Aase, K., & Hollund, J. G. (2011a). Exploring varieties of knowledge in safe work practices – An ethnographic study of surgical teams. *Patient Safety in Surgery, 5*(1), 21.

Høyland, S., Aase, K., & Hollund, J. G. (2011b). Understanding the system in relation to safe medical work practices. *Safety Science Monitor, 12*(1), Article 5.

Infante, C. (2006). Bridging the 'system's' gap between interprofessional care and patient safety: Sociological insights. *Journal of Interprofessional Care, 20*(5), 517–525.

Inkeles, A. (1964). *What is sociology*. Englewood Cliffs, NJ: Prentice-Hall.

Kaissi, A., Johnson, T., & Kirschbaum, M. S. (2003). Measuring teamwork and patient safety attitudes of high-risk areas. *Nursing Economics, 21*(5), 211–218.

Kapoulas, A., & Mitic, M. (2012). Understanding challenges of qualitative research: rhetorical issues and reality traps. *Qualitative Market Research: An International Journal, 15*(4), 354–368.

Katz, P. (1981). Ritual in the operating room. *Ethnology, 20*(4), 335–350.

Kawulich, B. B. (2005). Participant observation as a data collection method. *Forum: Qualitative Social Research, 6*(2), Art. 43.

Kerlinger, F. N. (1973). *Foundations of Behavioral Research (2nd ed.)*. New York: Holt, Rinehart & Winston.

Kettles, A. M., Creswell, J. W., & Zhang, W. (2011). Mixed methods research in mental health nursing. *Journal of Psychiatric and Mental Health Nursing, 18*(6), 535–542.

Kirk, J., & Miller, M. L. (1986). *Reliability and Validity in Qualitative Research*. Beverly Hills, CA: Sage Publications.

Kyrkjebø, J. M., Brattebø, G., Smith-Strøm, H. (2006). Improving patient safety by using interprofessional simulation training in health professional education. *Journal of Interprofessional Care, 20*(5), 507–516.

Larsson, J., & Holmström, I. K. (2013). How excellent anaesthetists perform in the operating theatre: A qualitative study on non-technical skills. *British Journal of Anaesthesia, 110*(1), 115–121.

Larsson, S. (2009). A pluralist view of generalization in qualitative research. *International Journal of Research & Method in Education, 32*(1), 25–38.

Leach, L. S., Myrtle, R. C., Weaver, F. A., et al. (2009). Assessing the performance of surgical teams. *Health Care Management Review, 34*(1), 29–41.

Leape, L. L., Brennan, T. A., Laird, N., et al. (1991). The nature of adverse events in hospitalized patients. Results of the Harvard Medical

Practice Study II. *New England Journal of Medicine, 324*(6), 377–384.

LeCompte, M. D., & Goetz, J. P. (1982). Problems of reliability and validity in ethnographic research. *Review of Educational Research, 52*(1), 31–60.

Lee, S. L. (2010). The extended surgical time-out: Does it improve quality and prevent wrong-site surgery? *The Permanente Journal, 14*(1), 19–23.

Leech, N. L., & Onwuegbuzie, A. J. (2009). A typology of mixed methods research designs. *Quality & Quantity, 43*(2), 265–275.

Levin-Rozalis, M. (2004). Searching for the unknowable: A process of detection – abductive research generated by projective techniques. *International Journal of Qualitative Methods, 3*(2), 1–36.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. Newbury Park, CA: Sage Publications.

Lindlof, T. R., & Taylor, B. C. (2002). *Qualitative Communication Research Methods (2nd ed.)*. Thousand Oaks, CA: Sage Publications.

Lingard, L., Espin, S., Rubin, B., et al. (2005). Getting teams to talk: Development and pilot implementation of a checklist to promote interprofessional communication in the OR. *Quality & Safety in Health Care, 14*, 340–346.

Lingard, L., Reznick, R., Espin, S., et al. (2002). Team communications in the operating room: Talk patterns, sites of tension, and implications for novices. *Academic Medicine, 77*(3), 232–237.

Lingard, L., Whyte, S., Espin, S. et al. (2006). Towards safer interprofessional communication: Constructing a model of "utility" from preoperative team briefings. *Journal of Interprofessional Care, 20*(5), 471-483.

Little, D. (1991). *Varieties of Social Explanation: An Introduction to the Philosophy of Social Science*. Boulder, CO: Westview Press.

Lyndon, A. (2006). Communication and teamwork in patient care: How much can we learn from aviation? *Journal of Obstetric Gynecologic and Neonatal Nursing, 35*(4), 538–546.

Mackenzie, C. F., Xiao, Y., & Horst, R. (2004). Video task analysis in high performance teams. *Cognition, Technology & Work, 6*(3), 139–147.

Mackintosh, N., Berridge, E.-J., & Freeth, D. (2009). Supporting structures for team situation awareness and decision making: Insights from four delivery suites. *Journal of Evaluation in Clinical Practice, 15*, 46–54.

Makary, M. A., Sexton, J. B., Freischlag, J. A., et al. (2006). Operating room teamwork among physicians and nurses: Teamwork in the eye of the beholder. *Journal of the American College of Surgeons, 202*(5), 746–752.

Mangione-Smith, R., Elliott, M. N., McDonald, L., et al. (2002). An observational study of antibiotic prescribing behavior and the Hawthorne effect. *Health Services Research, 37*(6), 1603–1623.

Manser, T. (2009). Teamwork and patient safety in dynamic domains of healthcare: A review of the literature. *Acta Anaesthesiological Scandinavia, 53*(2), 143–151.

Marcoulides, G. A. (1998). *Modern Methods for Business Research*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc. Publishers.

Marshall, C., & Rossman, G. B. (1998). *Designing Qualitative Research*. Thousand Oaks, CA: Sage.

Maxwell, J. A. (1992). Understanding and validity in qualitative research. *Harvard Educational Review, 62*(3), 279–300.

Mayring, P. (2007). On generalization in qualitatively oriented research. *Forum: Qualitative Social Research, 8*(3).

Mays, N., & Pope, C. (2000). Qualitative research in health care: Assessing quality in qualitative research. *BMJ, 320*(7226), 50–52.

Mazzocco, K., Petitti, D. B., Fong, K. T., et al. (2009). Surgical team behaviors and patient outcomes. *American Journal of Surgery, 197*(5), 678–685.

McCulloch, P., Mishra, A., Handa, A., et al. (2009). The effects of aviation-style non-technical skills training on technical performance and outcome in the operating theatre. *Quality & Safety in Health Care, 18*(2), 109–115.

McGhee, G., Marland, G. R., & Atkinson, J. (2007). Grounded theory research: Literature reviewing and reflexivity. *Journal of Advanced Nursing, 60*(3), 334–342.

Medawar, P. B. (1969). *Induction and Intuition in Scientific Thought*. London: Methuen.

Mesman, J. (2009). The geography of patient safety: A topical analysis of sterility. *Social Science & Medicine, 69*(12), 1705–1712.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook (2nd ed.)*. Thousand Oaks, CA: Sage Publications.

Minnick, A. F., Donaghey, B., Slagle, J., et al. (2012). Operating room team members' views of workload, case difficulty, and nonroutine events. *Journal for Healthcare Quality, 34*(3), 16–24.

Misco, T. (2007). The frustrations of reader generalizability and grounded theory: Alternative considerations for transferability. *Journal of Research Practice, 3*(1), 1–11.

Mishra, A., Catchpole, K., Dale, T., et al. (2008). The influence of non-technical performance on technical outcome in laparoscopic

cholecystectomy. *Surgical Endoscopy and Other Interventional Techniques, 22*(1), 68–73.

Mishra, A., Catchpole, K., & McCulloch, P. (2009). The Oxford NOTECHS System: Reliability and validity of a tool for measuring teamwork behaviour in the operating theatre. *Quality & Safety in Health Care, 18*(2), 104–108.

Mohr, J. (2000). Forming, operating, and improving microsystems of care. Center for the Evaluative Clinical Sciences, Dartmouth College.

Mohr, J. J., Barach, P., Cravero, J. P., et al. (2003). Microsystems in health care – Microsystems in health care: Part 6, Designing patient safety into the microsystem. *Joint Commission Journal on Quality Improvement, 29*(8), 8.

Mohr, J. J., Batalden, P., Barach, P. (2004). Integrating patient safety into the clinical microsystem. *Quality & Safety in Health Care, 13*(Suppl II), ii34–ii38.

Moran-Ellis, J., Alexander, V. D., Cronin, A., et al. (2006). Triangulation and integration: processes, claims and implications. *Qualitative Research, 6*(1), 45–49.

Morey, J. C., Simon, R., Jay, G. D., et al. (2002). Error reduction and performance improvement in the emergency department through formal teamwork training: Evaluation results of the MedTeams project. *Health Services Research, 37*(6), 1553–1581.

Morse, J. M. (2004). Constructing qualitatively derived theory: Concept construction and concept typologies. *Qualitative Health Research, 14*(10), 1387–1395.

Moulton, C. A., Regehr, G., Lingard, L., et al. (2010). Slowing down to stay out of trouble in the operating room: Remaining attentive in automaticity. *Academic Medicine, 85*(10), 1571–1577.

Naveh, E., Katz-Navon, T., & Stern, Z. (2006). Readiness to report medical treatment errors: The effects of safety procedures, safety information, and priority of safety. *Medical Care, 44*(2), 117–123.

Neily, J., Mills, P. D., Young-Xu, Y., et al. (2010). Association between implementation of a medical team training program and surgical mortality. *JAMA, 304*(15), 1693–1700.

Newman, I., & Benz, C. R. (1998). *Qualitative-Quantitative Research Methodology: Exploring the Interactive Continuum*. Carbondale, IL: Southern Illinois University Press.

Nielsen, H. B. (1995). Seductive texts with serious intentions. *Educational Researcher, 24*(1), 4-12.

Nielsen, H. B. (2004). European gender lessons: Girls and boys at Scout camps in Denmark, Portugal, Russia and Slovakia. *Childhood, 11*(2), 207–226.

O'Brien, K., & Wright, J. (2002). How to write a protocol. *Journal of Orthodontics, 29*(1), 58–61

O'Cathain, A., Murphy, E., & Nicholl, J. (2008). The quality of mixed methods studies in health services research. *Journal of Health Services Research & Policy, 13*(2), 92–98.

Olsen, W. K. (2004). Triangulation in social research: Qualitative and quantitative methods can really be mixed. In M. Haralambos & M. Holborn (Eds.), *Developments in Sociology*. Ormskirk, UK: Causeway Press.

Olson, R., Verley, J., Santos, L., et al. (2004). What we teach students about the Hawthorne studies: A review of content within a sample of introductory I-O and OB textbooks. *The Industrial-Organizational Psychologist, 41*, 23–39.

Onwuegbuzie, A. J., & Leech, N. L. (2007). Validity and qualitative research: An oxymoron? *Quality and Quantity, 41*, 233–249.

Owens, B. P., & Hekman, D. R. (2012). Modeling how to grow: An inductive examination of humble leader behaviors, contingencies, and outcomes. *Academy of Management Journal, 55*(4), 787–818.

Patel, V. L., Cytryn, K. N., Shortliffe, E. H., et al. (2000). The collaborative health care team: The role of individual and group expertise. *Teaching and Learning in Medicine, 12*(3), 117–132.

Patton, M. (1990). *Qualitative Evaluation and Research Methods*. Newbury Park, CA: Sage Publications.

Pawson, R., Boaz, A., Grayson, L., et al. (2003). Types and Quality of Knowledge in Social Care.

Peebles, E., Subbe, C. P., Hughes, P., et al. (2011). Timing and teamwork – An observational pilot study of patients referred to a Rapid Response Team with the aim of identifying factors amenable to re-design of a Rapid Response System. *Resuscitation*.

Peirce, C. S. (1955). Abduction and Induction. In J. Buchler (Ed.), *Philosophical Writing of Peirce*. New York: Dover Publications.

Pelto, P. J., & Pelto, G. H. (1978). *Anthropological Research: The Structure of Inquiry*. Cambridge, UK: Cambridge University Press.

Pettigrew, K. E. (1999). Waiting for chiropody: Contextual results from an ethnographic study of the information behaviour among attendees at community clinics. *Information Processing and Management, 35*(6), 801–817.

Pluta, W. J., Chinn, C. A., & Duncan, R. G. (2011). Learners' epistemic criteria for good scientific models. *Journal of Research in Science and Teaching, 48*(5), 486–511.

Polit, D. F., & Beck, C. T. (2010). Generalization in quantitative and qualitative research: Myths and strategies. *International Journal of Nursing Studies, 47*(11), 1451–1458.

Polyani, M. (1966). *The Tacit Dimension*. London: RKP.

Portides, D. P. (2005). A theory of scientific model construction: The conceptual process of abstraction and concretisation. *Foundations of Science, 10*, 67–88.

Quinn, J. B. (1992). *The Intelligent Enterprise*. New York: Free Press.

Reader, T., Flin, R., Lauche, K., et al. (2006). Non-technical skills in the intensive care unit. *British Journal of Anaesthesia, 96*(5), 551–559.

Reason, J. (1997). *Managing the Risks of Organizational Accidents*. Aldershot, UK: Ashgate.

Reichertz, J. (2010). Abduction: The logic of discovery of grounded theory. *Forum: Qualitative Social Research, 11*(1), Art. 13.

Ridenour, C. S., & Newman, I. (2008). *Mixed Methods Research: Exploring the Interactive Continuum*. Carbondale, IL: Southern Illinois University Press.

Riley, R., & Manias, E. (2006). Governance in operating room nursing: Nurses' knowledge of individual surgeons. *Social Science & Medicine, 62*(6), 1541–1551.

Riley, R., & Manias, E. (2009). Gatekeeping practices of nurses in operating rooms. *Social Science & Medicine, 69*(2), 215–222.

Riley, W. (2009). High reliability and implications for nursing leaders. *Journal of Nursing Management, 17*(2), 238–246.

Rubin, A., & Babbie, E. R. (2010). *Research Methods for Social Work (7th ed.)*. Belmont, CA: Cengage Learning, Inc.

Rubin, H. J., & Rubin, I. S. (2005). *Qualitative Interviewing: The Art of Hearing Data (2nd ed.)*. Thousand Oaks, CA: Sage.

Russ, S., Arora, S., Wharton, R., et al. (2013). Measuring safety and efficiency in the operating room: Development and validation of a metric for evaluating task execution in the operating room. *Journal of the American College of Surgeons*.

Ryan, F., Coughlan, M., & Cronin, P. (2009). Interviewing in qualitative research: The one-to-one interview. *International Journal of Therapy and Rehabilitation, 16*(6), 309–314.

Rydenfalt, C., Johansson, G., Larsson, P. A., et al. (2012). Social structures in the operating theatre: How contradicting rationalities and trust affect work. *Journal of Advanced Nursing, 68*(4), 783–795.

Salas, E., Almeida, S. A., Salisbury, M., et al. (2009). What are the critical success factors for team training in health care? *Joint Commmission Journal on Quality and Patient Safety, 35*(8), 398–405.

Salas, E., Dickinson, T. L., Converse, S. A., et al. (1992). Toward an understanding of team performance and training. In R. W. Swezey & E. Salas (Eds.), *Teams: Their Training and Performance* (pp. 3-29). Norwood, NJ: Ablex.

Sale, J. E. M., Lohfeld, L. H., & Brazil, K. (2002). Revisiting the quantitative-qualitative debate: Implications for mixed-methods research. *Quality & Quantity, 36*(1), 43–53.

Sanchez, J. A., & Barach, P. R. (2012). High reliability organizations and surgical microsystems: Re-engineering surgical care. *Surgical Clinics of North America, 92*(1), 1–14.

Sayer, A. (1992). *Method in Social Science: A Realist Approach (2nd ed.)*. London: Routledge.

Schioler, T., Lipczak, H., Pedersen, B. L., et al. (2001). [Incidence of adverse events in hospitals. A retrospective study of medical records]. *Ugeskrift for Laeger, 163*(39), 5370–5378.

Schraagen, J. M., Schouten, T., Smit, M., et al. (2010). Assessing and improving teamwork in cardiac surgery. *Quality & Safety in Health Care, 19*(6), e29.

Schuh, K. L., & Barab, S. A. (2008). Philosophical perspectives. In J. M. Spector, M. D. Merrill, J. V. Merriënboer & M. P. Driscoll (Eds.), *Handbook of Research on Educational Communications and Technology*. New York: Taylor & Francis.

Schön, D. A. (1991). *The Reflective Practitioner: How Professionals Think in Action (2nd ed.)*. Aldershot, UK: Ashgate.

Seale, C. (2002). Quality issues in qualitative inquiry. *Qualitative Social Work, 1*(1), 97–110.

Sevdalis, N., Arora, S., Undre, S., et al. (2009). Distractions and interruptions in the operating room. In R. Flin & L. Mitchell (Eds.), *Safer Surgery – Analysing Behaviour in the Operating Theatre*. Farnham, UK: Ashgate Publishing Limited.

Sexton, J. B., Makary, M. A., Tersigni, A. R., et al. (2006). Teamwork in the operating room: Frontline perspectives among hospitals and operating room personnel. *Anesthesiology, 105*(5), 877–884.

Silverman, D. (2004). *Qualitative Research – Theory, Method, and Practice*. London: Sage Publications.

Smith, A. F., Goodwin, D., Mort, M., et al. (2003). Expertise in practice: An ethnographic study exploring acquisition and use of knowledge in anaesthesia. *British Journal of Anaesthesia, 91*(3), 319–328.

Smith, A. F., Pope, C., Goodwin, D., et al. (2006). What defines expertise in regional anaesthesia? An observational analysis of practice. *British Journal of Anaesthesia, 97*(3), 401–407.

Smith, J. K., & Deemer, D. K. (2000). The problem of criteria in the age of relativism. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of Qualitative Research (2nd ed.)* (pp. 877–896). Thousand Oaks, CA: Sage.

Snook, S. A. (2000). *Friendly Fire: The Accidental Shootdown of U.S. Black Hawks over Northen Iraq*. Princeton, NJ: Princeton University Press.

Soop, M., Fryksmark, U., Koster, M., et al. (2009). The incidence of adverse events in Swedish hospitals: A retrospective medical record review study. *International Journal for Quality in Health Care, 21*(4), 285–291.

Spradley, J. P. (1980). *Participant Observation* New York: Holt, Rinehart and Winston.

Sturmberg, J. P., & Martin, C. M. (2008). Knowing – in medicine. *Journal of Evaluation in Clinical Practice, 14*(5), 767–770.

Teller, P. (2001). Twilight of the perfect model model. *Erkenntnis, 55*, 393–415.

Thomas, E. J., Studdert, D. M., Burstin, H. R., et al. (2000). Incidence and types of adverse events and negligent care in Utah and Colorado. *Medical Care, 38*(3), 261–271.

Thornton, T. (2006). Tacit knowledge as the unifying factor in evidence based medicine and clinical judgement. *Philosophy, Ethics, and Humanities in Medicine, 1*(1), E2.

Thurmond, V. A. (2001). The point of triangulation. *Journal of Nursing Scholarship, 33*(3), 253–258.

Toledo-Pereyra, L. H. (2012). Research design. *Journal of Investigative Surgery, 25*(5), 279–280.

Treasure, T., Valencia, O., Sherlaw-Johnson, C., et al. (2002). Surgical performance measurement. *Health Care Management Science, 5*(4), 243–248.

Trochim, W. M. (2001). *The Research Methods Knowledge Base*. Mason, OH: Atomic Dog Publishing.

Undre, S., Healey, A. N., Darzi, A., et al. (2006). Observational assessment of surgical teamwork: A feasibility study. *World Journal of Surgery, 30*(10), 1774–1783.

van Beuzekom, M., Boer, F., Akerboom, S., et al. (2012). Patient safety in the operating room: An intervention study on latent risk factors. *BMC Surgery, 12*, 10.

Van Der Valk, T., Van Driel, J. H., & De Vos, W. (2007). Common characteristics of models in present-day scientific practice. *Research in Science Education, 37*, 469–488.

van Deventer, J. P. (2009). Ethical considerations during human centred overt and covert research. *Quality & Quantity, 43*, 45–57.

Vaughan, D. (1996). *The Challenger Launch Decision: Risky Technology, Culture, and Deviance at NASA*. Chicago: University of Chicago Press.

Vincent, C., Neale, G., & Woloshynowych, M. (2001). Adverse events in British hospitals: Preliminary retrospective record review. *BMJ, 322*(7285), 517–519.

Wadel, C. (1990). *[The Social Scientific Construction of Reality]*. Flekkefjord, Norway: Seek a/s.

Walliman, N. (2006). *Social Research Methods*. London: Sage Publications.

Wallin, C.-J., Meurling, L., Hedman, L. et al. (2007). Target-focused medical emergency team training using a human patient simulator: Effects on behaviour and attitude. *Medical Education, 41*, 173–180.

Waring, J., Harrison, S., & McDonald, R. (2007). A culture of safety or coping? Ritualistic behaviours in the operating theatre. *Journal of Health Services Research & Policy, 12*(Suppl 1), s1-3–9.

Weick, K. E., & Sutcliffe, K. M. (2001). *Managing the Unexpected*. San Francisco, CA: Jossey-Bass.

Weiser, T. G., Haynes, A. B., Lashoher, A., et al. (2010). Perspectives in quality: Designing the WHO Surgical Safety Checklist. *International Journal for Quality in Health Care, 22*(5), 365–370.

Wenger, E., McDermott, R., & Snyder, W. M. (2002). *Cultivating Communities of Practice*. Boston: Harvard Business School Press.

Whittemore, R., Chase, S. K., & Mandle, C. L. (2001). Validity in qualitative research. *Qualitative Health Research, 11*, 522–537.

Wiegmann, D. A., ElBardissi, A. W., Dearani, J. A., et al. (2007). Disruptions in surgical flow and their relationship to surgical errors: an exploratory investigation. *Surgery, 142*(5), 658-665.

Wilson, K. A., Burke, C. S., Priest, H. A., et al. (2005). Promoting health care safety through training high reliability teams. *Quality & Safety in Health Care, 14*, 303–309.

Wilson, R. M., Runciman, W. B., Gibberd, R. W., et al. (1995). The Quality in Australian Health Care Study. *Medical Journal of Australia, 163*(9), 458–471.

Wolcott, H. F. (1987). On ethnographic intent. In G. Spindler & L. Spindler (Eds.), *Interpretive Ethnography of Education: At Home and Abroad*. Hillsdale, NJ: Lawrence Erlbaum Associates Inc.

Wolf, F. A., Way, L. W., & Stewart, L. (2010). The efficacy of medical team training: Improved team performance and decreased operating room delays: a detailed analysis of 4863 cases. *Annals of Surgery, 252*(3), 477–483.

Wulf, H. (2002). Yo-yo fieldwork: Mobility and time in a multi-local study of dance in Ireland. *Anthropological Journal on European Cultures, 11*, 117–136.

Zegers, M., de Bruijne, M. C., de Keizer, B., et al. (2011). The incidence, root-causes, and outcomes of adverse events in surgical units: Implication for potential prevention strategies. *Patient Safety in Surgery, 5*(1), 13.

Østergaard, H. T., Østergaard, D., Lippert, A. (2004). Implementation of team training in medical education in Denmark. *Quality & Safety in Health Care, 13*(Suppl I), i91–i95.

Åkerström, M., Jacobsson, K., & Wästerfors, D. (2004). Reanalysis of previously collected material. In C. Seale, G. Gobo, J. F. Gubrium & D. Silverman (Eds.), *Qualitative Research Practice*. London: Sage Publications.

Part II

Presentation of Articles*

Part II contains the articles that constitute the thesis. The articles have been given similar formatting to avoid differences in publication standards. The articles are as follows:

I. Høyland, S., Aase, K. & Hollund, J. G. (2011). Exploring varieties of knowledge in safe work practices – An ethnographic study of surgical teams. *Patient Safety in Surgery*, *5*(21). doi:10.1186/1754-9493-5-21.

II. Høyland, S., Aase, K. & Hollund, J. G. (2011). Understanding the system in relation to safe medical work practices. *Safety Science Monitor*, *15*(1). ISSN 1443-8844.

III. Høyland, S. (2011). Exploring safe work practices in surgical operations – The role of time, patient, and operation. In S. Albolino et al. (Eds): *Healthcare Systems Ergonomics and Patient Safety 2011: Risks in OR, ICU and ER* (pp. 430–435). Leiden, Netherlands: CRC Press/Balkema. ISBN 978-0-415-68413-2.

IV. Høyland, S. (2012). Developing and validating a scientific model for exploring safe work practices in interdisciplinary teams. *Safety Science*, *50*(2), 316–325. doi: 10.1016/j.ssci.2011.09.008.

* Important notes:

(i) The phrase "confirm, adjust, or dismiss" (or similar terms) was applied in Articles I, II and IV, in the sense that a deeper understanding of a particular observation was sought during field work. In some cases, this lead to a completely new understanding of the observation, or a realization of what was "really going on." In these cases, the original understanding was "adjusted" or "dismissed." However, "dismiss" as well as "confirm" may give the impression that only one truth is sought. Therefore, when writing this thesis, I decided to use only terms such as "improve" and "adjust" throughout Part I of the thesis.

(ii) The terms "theme" and "trend," as used in Articles I and II respectively, are both defined as a clear "red line" that runs through more than one episode (cf. footnote 20 in Subchapter 3.2.1). To ensure consistency and to avoid any reader confusion, Part I of this thesis applies only the term "theme."

Article I

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Exploring varieties of knowledge in safe work practices – An ethnographic study of surgical teams

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Exploring varieties of knowledge in safe work practices – An ethnographic study of surgical teams

Sindre Høyland[1*], Karina Aase[1] and Jan Gustav Hollund[2]

*Corresponding author: Sindre Høyland sindre.hoyland@uis.no

[1]Department of Health Studies, Faculty of Social Sciences, University of Stavanger, Stavanger, Norway

[2]Department of Anesthesia, Stavanger University Hospital, Stavanger, Norway

Abstract

Background: Within existing research in health and medicine, the nature of knowledge on how teams conduct safe work practices has yet to be properly explored.

Methods: We address this concern by exploring the varieties in which knowledge is expressed during interdisciplinary surgical operations. Specifically, the study was conducted in a surgical section of a Norwegian regional general hospital, between January and April of 2010, by means of an ethnographic design combining detailed non-participant observations, conversations and semi-structured interviews.

Results: Based on an analysis of the gathered data, we identify three particular themes in how knowledge is expressed by operating room personnel: (i) the ability and variety individuals demonstrate in handling multiple sources of information, before reaching a particular decision, (ii) the variety of ways awareness or anticipation of future events is expressed, and (iii) the different ways sudden and unexpected situations are handled by the individual team members.

Conclusions: We conclude that these facets of knowledge bring different insights into how safe work practices are achieved at an individual and team level in surgical operations, thus adding to the existing understanding of the nature of knowledge in safe work practices in surgical operations. Future research should focus on exploring and documenting the relationships between various elements of knowledge and safe work practices, in different surgical settings and countries.

Keywords: Safe work practices; knowledge; interdisciplinary team work; surgical operations; Norway.

Background

Traditionally, the process of ensuring clinical competency have been subjected to what Schön (1991) terms a "technical rationality", that is a state of mind or mental model of problem solving using established scientific theories and techniques. However, health care literature in recent years have also looked to specific safety principles used in high reliability sectors (Burke, 2004; Gaba, 2000; Morey, 2002; Wilson, 2005), and recognized that the individual technical skills are only one part of the total skill repertoire applied by individuals as part of a team. Despite this, the dominance of the technical rationality seems to prevail, much of which can be attributed to weaknesses in the identification, understanding and training of health care specific team skills (Baker, et al., 2006; Lyndon, 2006), in the commitment of resources and time necessary to ensure team training (Burke, 2004; Harris, 2006), and in the overall focus on research and development of a scientifically grounded model to explore and measure the dynamics and performance of interdisciplinary teams (Baker, et al., 2006). This suggests that the nature of interdisciplinary teamwork in health care needs to be explored in ways that reveal the specific and unique characteristics of team practices in this sector. Understating the need for further explorations, Flin & Mitchell (2009) suggest that there is a lack of investigation into the culture and behavior patterns of surgical working life, i.e. the operating room. Specifically, while some studies have looked into the nature of knowledge in the operating room, such as team level tacit knowledge (Friedman & Bernell, 2006), nurses' knowledge of individual surgeons (Riley & Manias, 2006), and nurses' selective use of gatekeeping practices (Riley & Manias, 2009), other aspects of knowledge in the operating room remain unexplored and consequently unidentified. Thus, the aim of this paper is to explore and document the nature of the knowledge interdisciplinary teams use in surgical operations, in order to achieve safe work practices.

Main concepts

Given the aim of documenting the nature of knowledge in safe work practices, an understanding of both concepts should be provided.

From an evidence-based medicine (EBM) perspective, knowledge rests on the model of technical rationality, where an individual practices problem solving according to established scientific theories and techniques (Schön, 1991, p. 21). The EBM-perspective's dominance in medicine has resulted in a strong focus on the creation, storage and distribution of codified/explicit 'text-book' knowledge (Sandars & Heller, 2006), expressed as procedures, protocols, routines, etc. However, many researchers believe that one must also account for other kinds of knowledge health care personnel

use in practice, such as clinical judgment and expertise (Braude, 2009; Haynes, 2002; Henry, 2006; Malterud, 2001; Polyani, 1966; Thornton, 2006). Greenhalgh et al. (2008) support this view, stating that: "…multidisciplinary teams balance encoded knowledge, in the form of standardised outcome measurement, with tacit knowledge, in the form of intuitive judgement, clinical experience and expertise, in the process of clinical decision making" (p. 183). Thus, in this paper we define knowledge as comprised of explicit/encoded aspects shaped by text-book understandings of various procedures, and as comprised of tacit aspects shaped through experience and exposure to various clinical situations.

In understanding the concept of safe work practices, we focus on the connection between the concept's basic components; safety and practice. Within research in health and medicine, a first connection between safety and practice appears in the *safety-driven* focus on identifying and training individual and team-based skills, aimed at improving *clinical and surgical practice* (Healey, et al., 2006; Healey, et al., 2004; Salas, et al., 2009; Salas, et al., 2008). The concept "Community of Practice" (CoP) represents a second connection between safety and practice. Specifically, a CoP can be viewed as a network of people who share information, build on existing knowledge, and develop expertise to solve problems for a common purpose (Huckson & Davies, 2007; Wenger, et al., 2002). One such purpose is the pursuit of evidence to support current practices (Huckson & Davies, 2007), including the improvement of skills, outcomes and consequently safety. Thus, the individual's and team's ability to conduct and complete operations with a minimum of complications – that is safe work practices – can be understood as a product of the measures aimed at improving the skills, knowledge and/or expertise levels of individuals and teams.

Methods

This paper presents the results from a qualitative study. The goal of qualitative research is to gather an in-depth understanding of human behavior and the reasons that governs such behavior, or as Larsson (2009) states: "The aim of [qualitative] research is not to confirm or refute hypothesizes by using statistical methods, but to increase our understanding of complex human or social phenomena by discovering patterns of human thinking and acting. Anesthesiologists at work is one example of humans in action" (p. 444).

More specifically, within a qualitative research tradition, the study presented in this paper applies an ethnographic approach (Marcus, 1998), combining detailed non-participant observations, conversations and semi-structured interviews. By ethnography we imply "a general approach to the exploration and understanding of social settings and social processes" (Atkinson & Pugsley, 2005, p. 228). The main

benefit of ethnography is that it enables the researcher to "…enter into close and relatively long-term contact with people in their everyday life" (Huberman & Miles, 2002, p. 66).

Ethical concerns

The study was conducted in a surgical unit of a Norwegian regional general hospital. Based on the approval and recommendations of the Norwegian Social Science Data Services (NSD), all potential participants of the study (sample) were informed via presentations prior to the fieldwork. During these presentations, participants were handed a written information form that included information on the aim of the study and anonymity issues, and also a field for signing informed consent. Observations were only conducted when every member of the operating team had agreed to be observed. In situations where information had not been given and/or consent not obtained beforehand, this was taken care of before the operation began.

Sample

A typical operating team consists of 1-2 operators (surgeons), 2 operating room nurses, 1-2 nurse anesthetists, and 1 anesthetist physician. Table 1 illustrates the groups observed, the total sample size, the numbers who gave their informed consent, the numbers who were actually observed, and the numbers who were interviewed. The interviews lasted an average of 43 minutes. It is relevant to note that the overall composition of the operating teams varied constantly from one operation to the next (ad hoc), also documented in other studies (Leach, et al., 2009). Thus, the total of 27 observed operations also represent the number of observed team variations.

Table 1: Distribution of observations and interviews

Groups observed	**Sample**	**Informed**	**Observed**	**Interviewed**
Anesthetist physician	9	5	5	2
Nurse anesthetist	15	14	11	3
Operating room nurse	22	15	15	2
Operator (surgeon)	45	16	16	4
Manager (interviews)	NA	NA	NA	4
Total (% of sample)	91	50 (55)	47 (52)	15 (16)

Interviews and observations were sampled to cover variety. In interviews this was achieved by ensuring variety across different types of professions, as shown in table

1. Variety was also achieved through age groups (33-54 years, 43.9 years on average), sexes (5 females, 10 males), and levels of experience as a specialist (2-36 years, 12.6 years on average). In terms of the observations, variety was achieved within the two main categories of elective (planned) and immediate (within 72 hours) surgery, and by attending different types of operations within the main categories, as listed in table 2.

Table 2: Distribution of observation type and duration

Type of observations	**Elective**	**Immediate**	**Total/Hours**
Variants of fracture	1 (00:45)	11 (21:50)	12 (22:35)
Variants of revision	2 (03:30)	1 (02:00)	3 (05:30)
Achilles extension	3 (06:30)	NA	3 (06:30)
Back stabilization	2 (12:30)	NA	2 (12:30)
Other	7 (15:20)	NA	7 (15:20)
Total/Hours	15 (38:35)	12 (23:50)	27 (62:25)

Practical methodology

At the beginning of each observation, the operation was numbered (1-n) and specified in terms of type of operation and participants. A principal researcher (SH) and a co-researcher (JGH) were present at the majority of the operations, to ensure comparison and internal validity of the observations. Validity can be understood as the researcher's ability to interpret observations that corresponds accurately to the real world. Hereunder, internal validity refers to "the extent to which scientific observations and measurements are authentic representations of some reality" (LeCompte & Goetz, 1982, p. 32), implying that the comparison of observations between two or more researchers will strengthen this type of validity. Furthermore, transcriptions were done individually, and focused on identifying emergent themes. This was followed by comparison of transcriptions and themes between observers, by means of discussions, to confirm, adjust or dismiss the understandings. To further strengthen the correspondence between the observations made by the researchers and the real world (validity), validation via respondents (respondent validation) also occurred during conversations and interviews.

In terms of the interviews, the main priority was to achieve a working synergy between the observations and the interviews, given our interest in respondent validity. This required that the interviews had an open nature that allowed for the inclusion of observational findings. Hence, a semi-structured interview guide was constructed,

focusing on the acquisition and use of knowledge and skills, such as personal techniques, reaction to problems and critical situations, formalized training, and so forth. Both the principal researcher (SH) and the co-researcher (JGH) conducted the interviews, mainly individually but also in tandem (during 2 interviews).

Identical to the semi-structured interviews, the main purpose for initiating conversations was to approve, adjust or dismiss existing observations. A total of 35 informal conversations were conducted.

Analysis

One aspect of the analysis process was the triangulation of findings from observations, not only via researcher comparison of notes and transcripts but also via respondent validation during interviews and conversations (Patton, 1990). This triangulation helped to identify, adjust and dismiss emergent themes, and also assisted in improving the general understanding and the specific details of what was going on in the operating room. Through analytical triangulation (Patton, 1990), all three researchers (SH, KA, and JGH) were involved in the analysis process. Specifically, the analysis consisted of repeatedly reading the raw observational and conversational data, until the relationships between the series of events that occurred during the particular operation became clear. These events created an episode, defined as a series of related events that form a "bigger story". The episodes were then read and compared repeatedly by the researchers, individually and in tandem, until the particular emergent theme became visible in the material. A theme is defined as a clear "red line" that runs through more than one episode. Combined, the two analyzing strategies for identifying episodes and themes complemented each other. Specifically, the emphasis on episodes is supported by Nielsen's (2004) story telling approach, providing *a rich and unique picture* of findings, while a focus on themes are comparable to the categorization techniques described by Miles and Huberman (1994), providing *a structured and transparent picture* of findings.

Results

The findings include episodes that demonstrate varieties and themes in how knowledge is expressed in interdisciplinary operations, as part of safe work practices. The selected episodes, derived from field notes (transcripts of notes from observations and conversations), are representative of the particular theme.

Theme 1 – The processing of multiple sources of information – a requisite in decision making

The first identified theme in the data material is the ability and variety individuals demonstrate in handling multiple sources of information before reaching a particular decision. This is observed in the following episodes:

Episode 1 – "The operator's decision making"

> Before starting the procedure in this particular operation, the main operator gathers his team for a briefing by a monitor displaying the patient's x-rays. During the briefing, the main operator describes the patient's condition and history, and he also explains the specific steps involved in the coming procedure (pointing and illustrating via the x-rays). He seems to be seeking approval of the procedure. At a later time in the procedure, the main operator is confronted with a choice between method A and method B. He again gathers his team by the x-rays, and receives inputs from his team and from what he sees in the pictures. The operator then makes his decision. Several x-rays are later taken, to confirm the decision.

Episode 2 – "Problem solving kicks in"

> During preparations for this operation, uncertainty concerning the patient's position can be seen. Problem solving then kicks in: The anesthetist nurse checks the planning system Orbit for information on the pre-anesthesia assessment of the patient from the day before. She also confers with the 1st operating room nurse. Neither the system nor the operating room nurse provide any clear answers. The 1st operating room nurse takes over the problem solving task, and asks the 2nd operating room nurse to enquire with the main operator. At last, an answer is obtained on the position of the patient.

Both episodes illustrate how information gathering from multiple sources, both technological and human in nature, enables the individual and team to reach a particular decision when confronted with uncertainty.

Theme 2 – The anticipation of future events – a way of "being prepared"

A second theme in the data is seen from the variety of ways awareness or anticipation of future events is expressed. The following episodes display this theme:

Episode 1 – "Combining tacit and explicit elements"

> During the preparations for this particular operation, the 1st nurse anesthetist prepares the anesthesia equipment, including back-up solutions, prior to the patient's arrival. These preparations are regulated by procedures, she explains. Before the operation begins, the 1st nurse anesthetist scans the patient's urinary

bladder to make sure it is empty. Upon enquiry, she explains that this activity is not regulated by procedures, but a result of previous experiences from situations where too much urine accumulated in the patient's bladder. Before the operation begins, the 1st operating room nurse has also prepared several alternative sets of gloves. She explains this action by the need to be prepared, since a plastic surgeon she is unfamiliar with will be present. Later in the operation, the 2nd nurse anesthetist (that replaces the first due to a break) notices that the large plastic syringe with the sleeping medicament is about to be depleted, but he has prepared a new one beforehand. At the end of the operation, the 2nd nurse anesthetist has already called on the patient for the upcoming operation.

Episode 2 – "A continuous focus on injury prevention"

During this operation, the position of the patient is checked several times and at different stages, by the anesthetist nurses, the operating room nurses and the main operator. Specifically, during preparations belts and blankets are removed from the operating bench. This, we are explained, is to prevent pressure injury when a patient remains in a given position for a prolonged period. When the main operator arrives in the operating room, he also reviews and confirms the patient's position. During the procedure, the operating room nurse massages and also lifts the arms and legs of the patient, in order to improve circulation and prevent damage. Near the end of the procedure, the operating room nurse looks under the table to check the patient's position and to make sure no injury has occurred during the operation.

Actions in both episodes are triggered either by procedures (preparing equipment, preventing damage) or experience (*continuous* focus on preventing injury, checking urine, preparing gloves and syringe, calling on patient early), thereby demonstrating that the ability to plan ahead of future events depends on a combination of both explicit and tacit knowledge elements.

Theme 2, concerning the anticipation of future event, is supported by an interview with an anesthetist physician: "It is partially a craft… the basic principles are necessary, but techniques can be adapted to achieve the same goal. For example, during a procedure where entering of a needle is involved… I use to mark the skin with the hollow end of a pen, to ensure that when a swelling occurs the mark will still be there, and I will not need to "feel" [my way to the artery] again when I enter the needle. [This is also important] when the pulse gets weak, the patient is ill, and you do not know where the artery really is." This personal technique illustrates how a procedure for entering the vein is "transformed" into a tacit ability for anticipating

and handling future events of this kind, such as the patient turning ill and the vein access becoming more difficult.

Theme 3 – The handling of the unforeseen – when it happens

A third theme in the data is displayed through the different ways sudden and unexpected situations are handled by the individual team members. Our definition of the unexpected is situations that occur infrequently during operations. The following episodes are illustrative:

Episode 1 – "The physician's handling of the unforeseen"

> During the preparations for this particular operation, a patient associated with difficult vein access arrives. It is discovered that the patient has received no pain relieving medicaments (the "unforeseen" event). The nurse anesthetist tries to insert a needle into the patient's arm, with no luck. The same occurs when the anesthetist physician attempts to enter the patient's foot. Reflecting out loud on this information, including the difficult vein access of the patient, the physician explains that it is better to proceed inside the operating room, to gain more space and limit circulation of people. Once in, the physician attempts a few more times to enter the veins of the patient's arm, with no success. He then considers going into the groin, but rejects this alternative. Upon enquiry later, he explains that this decision was made based on the unclean state of the groin area, and also the fact that the placement of a cannula here would become uncomfortable to the patient for her scheduled stay at the hospital over several days. Following this reflection, the anesthetist physician decides to enter the neck, and uses ultrasound equipment to locate an area with potentially good veins. He then repeatedly attempts to insert needles and locate a vein in the identified area, with no success. The physician takes a step back and seems to calm down and reflect on the current situation, before he decides to make a new attempt in another area of the neck. In preparation of this task, he asks that the table is tipped over more so that the head points down (Trendelenburg Position), to improve circulation. Finally, he hits a vein.

In this episode, the anesthetist physician was able to handle the unforeseen element by building on existing information (knowledge of patient type and the failed attempts), by being aware of the current situation and equipment (moving into a less crowded room, use of ultrasound equipment), and also by considering the future consequences of his actions (rejecting insertion into the groin). The combination of all these tacit knowledge elements enabled him to handle the unforeseen situation successfully.

Episode 2 – "The helping hand, and calmness…"

> During preparations for an operation, the team is suddenly informed that a dental hygienist is to conduct a parallel procedure, to remove tartar. This was not planned for by the team, as expressed by the main operator: "I was not informed that a dental hygienist would be present today – I first received this information in the entrance to the operating room". A conversation with the nurse anesthetist reveals the same impression: "It is terrible to get caught in the middle – it is as if you know nothing at all". However, despite individual concerns for not being informed and prepared, the team shows no signs of increased stress levels during the operation. This is seen in the general willingness to lend each other a "helping hand". For example, the main operator asks the dental hygienist whether she needs any equipment, followed by the operating room nurse assisting in obtaining the particular equipment the dentist requests. The operator also helps in positioning the operation lamp, to improve the lighting conditions for the dental hygienist.

This episode demonstrates two specific tacit knowledge elements that enabled the handling of this particular unforeseen situation: (1) The ability to remain calm, and (2) assist each other in the completion of individual tasks.

Theme 3, on the handling of the unforeseen, is also supported by an interview with an operator: "As the main operator… you apply previous experiences… if plan A does not work, it is important to know what equipment is available, [and for example] I know that the plastic surgeons have something I can borrow. If something is missing, we then know that we have the same dimensions on the screws [in another instrument shrine] to replace what we dropped on the floor." In this example, when confronted with the unexpected, the operator draws on her own experiences, the knowledge of available equipment (also external), and the ability to improvise by using similar equipment. The example also illustrates that a decision on how to proceed, given the lack of a particular piece of equipment, depends on both personal experiences with similar situations (existing information) and a knowledge of what equipment exists and/or can be improvised on (current information). The coordination of these information types supports theme 1 concerning the processing of multiple sources of information.

Next, we will discuss how our findings relate to existing health and medicine literature, to test the validity of the findings, followed by a reflection on the practical implications to surgical practices.

Discussion

In analyzing the results presented above, a comparison can be made to the understanding of an expert within anesthesia, as described by Smith et al. (2003). In their view, an expert is characterized by the ability to simultaneously balance many different sources of knowledge, such as past learning (formal and experienced) and an understanding of the dynamic situation (patient and equipment signals). This balancing is exemplified by the ability the anesthetist physician demonstrated (episode 1, theme 3) in handling an unforeseen situation (lack of anesthesia), by combining and understanding the existing information (patient type), the current situation (failed access to vein, access to ultrasound machine), and the future consequences of actions (patient information). In other words, the handling of the unforeseen through an awareness of existing information, current and past experiences and situational possibilities becomes an expression of what constitutes an expert.

In another study, Patel et al. (2000) identify the ability a primary care team demonstrates in distributing responsibility for a particular patient problem according to expertise. This ability allows the team to process large amounts of patient information, thereby reducing the load on the single individual. The finding by Patel et al. (2000) can be compared to the different ways individuals demonstrate in handling multiple sources of information in this study, before reaching a particular decision (theme 1). For example, the operator (episode 1, theme 1) handled information from multiple sources during his decision making process, but the information was clearly defined within his "zone of responsibility" (how to proceed with the operation and procedure). Many sources of information can thus be combined within each zone that, when put together, enables the team to process large amounts of information. The finding supports the understanding of distributed responsibility, as described by Patel et al. (2000).

Another comparison can be made between the ability to anticipate future events (theme 2), and what Friedman & Bernell (2006) identifies as an ability to anticipate another team member's actions due to shared experiences. While theme 2 does not bring additional clarity to the understanding of "shared experience", the theme and related episodes suggest that the ability to anticipate is comprised of both explicit knowledge, such as procedural elements (equipment preparation, patient positioning, injury prevention), and tacit knowledge, such as unscripted elements (checking urine, preparing gloves and syringe, calling on patient early, *continuous* focus on preventing injury).

We have described the unique ways members of the operating team combine different elements of knowledge, in order to handle the unforeseen, process large amounts of information, and anticipate future events. How can this insight be transferred to and benefit actual operating room practices? We suggest that one approach is to gather all operating room staff at the particular section/department at regular weekly or monthly meetings, where experiences on combining knowledge in the operating room can be discussed and reflected upon in plenum, to benefit the overall section/department and thus also the surgical teams. We believe such an approach could create a bridge to overcome the difficulty surgeons have of appreciating the value of interpersonal skills in patient safety (Flin, et al., 2007; Youngson & Flin, 2010), i.e. in this paper the sharing/communication of insights across disciplines on how to combine different types of knowledge in surgery.

Another approach would be to include questions in the World Health Organization (WHO) surgical safety checklist, on the types of knowledge used during a particular operation (i.e. does the team have knowledge from previous experiences with the particular type of operation that could aid safe work practices?). The checklist safety tool has increasingly been adopted worldwide and has also demonstrated reduction in the rates of death and complications during surgery (Haynes, et al., 2009; Weiser, et al., 2010). We believe inclusion in the checklist could provide further benefits to surgery, by strengthening the individual and team awareness of knowledge elements and possibly also adaption to current surgical practices.

Finally, we suggest that insights into ways of combining knowledge should be embedded into the current medical and nursing educational curricula and training efforts, to further enhance safe work practices.

Conclusions

The paper set out to explore and document the nature of the knowledge interdisciplinary teams use in surgical operations, in order to achieve safe work practices. What we found was that different elements of knowledge are combined to achieve safe work practices in surgical operations. We also found that these elements overlap with existing findings in health and medicine literature, while at the same time providing nuances of their own. We believe these nuances are an essential part of the repertoire operating teams need in their everyday practices, in order to move "beyond competence at needle insertion to incorporate unwritten strategies for increasing success" (Smith, et al., 2006, p. 405). Thus, future research efforts should be used on exploring and documenting the relationships between various elements of knowledge and safe work practices, in different surgical settings and countries.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

SH was responsible for the study conception and design, drafting of the manuscript, data collection, data analysis, and critical revisions for important intellectual content. KA participated in the study conception and design, data analysis, and made critical revisions of the manuscript. JGH participated in the data collection, data analysis, and made critical revisions of the manuscript. All authors read and approved the final manuscript.

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References

Atkinson, P., Pugsley, L. (2005). Making sense of ethnography and medical education. *Medical Education, 39*, 228-234.

Baker, D. P., Day, R., & Salas, E. (2006). Teamwork as an essential component of high-reliability organizations. *Health Services Research, 41*(4 (Pt 2)), 1576-1598.

Braude, H. D. (2009). Clinical intuition versus statistics: Different modes of tacit knowledge in clinical epidemiology and evidence-based medicine. *Theoretical Medicine and Bioethics, 30*(3), 181-198.

Burke, C. S., Salas, E., Wilson-Donnelly, K., et al (2004). How to turn a team of experts into an expert medical team: Guidance from the aviation and military communities. *Quality & Safety in Health Care, 13*(Suppl I), i96-i104.

Flin, R., & Mitchell, L. (Eds.). (2009). *Safer Surgery - Analysing Behaviour in the Operating Theatre*. Farnham: Ashgate Publishing Limited.

Flin, R., Yule, S., Paterson-Brown, S., et al. (2007). Teaching surgeons about non-technical skills. *Surgeon, 5*(2), 86-89.

Friedman, L. H., & Bernell, S. L. (2006). The importance of team level tacit knowledge and related characteristics of high-performing health care teams. *Health Care Management Review, 31*(3), 223-230.

Gaba, D. M. (2000). Structural and organizational issues in patient safety: A comparison of health care to other high-hazard industries. *California Management Review, 43*(1), 83-102.

Greenhalgh, J., Flynn, R., Long, A. F., et al. (2008). Tacit and encoded knowledge in the use of standardised outcome measures in multidisciplinary team decision making: A case study of in-patient neurorehabilitation. *Social Science & Medicine, 67*(1), 183-194.

Harris, K. T., Treanor, C. M., Salisbury, M. L. (2006). Improving patient safety with team coordination: Challenges and strategies of implementation. *The Association of Women's Health, Obstetric, and Neonatal Nurses, 35*(4), 557-566.

Haynes, A. B., Weiser, T. G., Berry, W. R., et al. (2009). A surgical safety checklist to reduce morbidity and mortality in a global population. *New England Journal of Medicine, 360*(5), 491-499.

Haynes, R. B. (2002). What kind of evidence is it that evidence-based medicine advocates want health care providers and consumers to pay attention to? *Biomed Central Health Services Research, 2*(3).

Healey, A. N., Undre, S., Sedvalis, N., et al. (2006). The complexity of measuring interprofessional teamwork in the operating theatre. *Journal of Interprofessional Care, 20*(5), 485-495.

Healey, A. N., Undre, S., & Vincent, C. A. (2004). Developing observational measures of performance in surgical teams. *Quality & Safety in Health Care, 13*(Suppl I), i33-i40.

Henry, S. G. (2006). Recognizing tacit knowledge in medical epistemology. *Theoretical Medicine and Bioethics, 27*(3), 187-213.

Huberman, A. M., & Miles, M. B. (2002). *The Qualitative Researcher's Companion*. Thousand Oaks, CA: Sage Publications.

Huckson, S., & Davies, J. (2007). Closing evidence to practice gaps in emergency care: The Australian experience. *Academic Emergency Medicine, 14*(11), 1058-1063.

Larsson, J. (2009). Studying tacit knowledge in anesthesiology: A role for qualitative research. *Anesthesiology, 110*(3), 2.

Leach, L. S., Myrtle, R. C., Weaver, F. A., et al. (2009). Assessing the performance of surgical teams. *Health Care Management Review, 34*(1), 29-41.

LeCompte, M. D., & Goetz, J. P. (1982). Problems of reliability and validity in ethnographic research. *Review of Educational Research, 52*(1), 31-60.

Lyndon, A. (2006). Communication and teamwork in patient care: How much can we learn from aviation? *Journal of Obstetric Gynecologic and Neonatal Nursing, 35*(4), 538-546.

Malterud, K. (2001). The art and science of clinical knowledge: Evidence beyond measures and numbers. *Lancet, 358*(9279), 397-400.

Marcus, G. (1998). *Ethnography Through Tick & Thin*. Princeton, New Jersey: Princeton University Press.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook (2nd ed)*. Thousand Oaks, California: Sage Publications.

Morey, J. C., Simon, R., Jay, G. D. et al (2002). Error reduction and performance improvement in the emergency department through formal teamwork training: evaluation results of the MedTeams project. *Health Services Research, 37*(6), 1553-1581.

Nielsen, H. B. (2004). European gender lessons: Girls and boys at scout camps in Denmark, Portugal, Russia and Slovakia. *Childhood, 11*(2), 207-226.

Patel, V. L., Cytryn, K. N., Shortliffe, E. H., et al. (2000). The collaborative health care team: The role of individual and group expertise. *Teaching and Learning in Medicine, 12*(3), 117-132.

Patton, M. (1990). *Qualitative Evaluation and Research Methods*. California: Sage Publications.

Polyani, M. (1966). *The Tacit Dimension*. London: RKP.

Riley, R., & Manias, E. (2006). Governance in operating room nursing: nurses' knowledge of individual surgeons. *Social Science & Medicine, 62*(6), 1541-1551.

Riley, R., & Manias, E. (2009). Gatekeeping practices of nurses in operating rooms. *Social Science & Medicine, 69*(2), 215-222.

Salas, E., Almeida, S. A., Salisbury, M., et al. (2009). What are the critical success factors for team training in health care? *Joint Commission Journal on Quality and Patient Safety, 35*(8), 398-405.

Salas, E., DiazGranados, D., Klein, C., et al. (2008). Does team training improve team performance? A meta-analysis. *Human Factors, 50*(6), 903-933.

Sandars, J., & Heller, R. (2006). Improving the implementation of evidence-based practice: A knowledge management perspective. *Journal of Evaluation in Clinical Practice, 12*(3), 341-346.

Schön, D. A. (1991). *The Reflective Practitioner: How Professionals Think in Action (2nd ed)*. Aldershot, UK: Ashgate.

Smith, A. F., Goodwin, D., Mort, M., et al. (2003). Expertise in practice: An ethnographic study exploring acquisition and use of knowledge in anaesthesia. *British Journal of Anaesthesia, 91*(3), 319-328.

Smith, A. F., Pope, C., Goodwin, D., et al. (2006). What defines expertise in regional anaesthesia? An observational analysis of practice. *British Journal of Anaesthesia, 97*(3), 401-407.

Thornton, T. (2006). Tacit knowledge as the unifying factor in evidence based medicine and clinical judgement. *Philosophy, Ethics, and Humanities in Medicine, 1*(1), E2.

Weiser, T. G., Haynes, A. B., Dziekan, G., et al. (2010). Effect of a 19-item surgical safety checklist during urgent operations in a global patient population. *Annals of Surgery, 251*(5), 976-980.

Wenger, E., McDermott, R., & Snyder, W. M. (2002). *Cultivating Communities of Practice*. Boston, MA: Harvard Business School Press.

Wilson, K. A., Burke, C. S., Priest, H. A., et al (2005). Promoting health care safety through training high reliability teams. *Quality & Safety in Health Care, 14*, 303-309.

Youngson, G. G., & Flin, R. (2010). Patient safety in surgery: Non-technical aspects of safe surgical performance. *Patient Safety in Surgery, 4*(1), 4.

Article II

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Understanding the system in relation to safe medical work practices

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Understanding the system in relation to safe medical work practices

S. Høyland and K. Aase
University of Stavanger

J. G. Hollund
Stavanger University Hospital

Abstract

Within existing health care safety research, limited attention has been paid to the significance of "the system" in relation to team work, and the term system is also commonly considered to be something vague and therefore unapproachable. In light of this, we explore how different factors of the system influence interdisciplinary operations and safe work practices (research aim #1). We also focus on replicating existing methodological approaches, and on linking our findings to previous research (research aim #2). We find that two particular trends stand out from the data: (1) various combinations of system factors contribute to disrupt the "operational flow", but the particular operation continues and completes normally, and (2) various system factors compensate for the vulnerabilities and disruptions that arise during operations. We then compare the study findings to existing research, with a focus on identifying the similarities, nuances and differences between the study findings and existing findings.

1. Introduction

Current health care safety research suggests that further efforts are needed to reveal the specific and unique characteristics of team practices in the health care sector (Baker, et al., 2006; Lyndon, 2006). Intuitively, this includes an understanding of how different types of knowledge and skills are applied in actual team work practices (Greenhalgh, et al., 2008; Smith, et al., 2006). However, the research also points to the importance of exploring system factors in relation to team work practices (Catchpole, et al., 2006; Infante, 2006). Specifically, the "system" is commonly perceived as something vague and indefinable (Infante, 2006), and currently only a handful of studies document original findings that can be related to system factors (Catchpole, et al., 2007; Christian, et al., 2006; Leach, et al., 2009; Mackintosh, 2009). Judging by the limited efforts that has gone into understanding the system factors surrounding interdisciplinary teams and safe work practices, there is a need for

studies that not only reveal the character of the system factors but also relate the particular findings to existing research to support a continuation of research efforts. This represents our incentive for studying the system in relation to interdisciplinary team practices.

2. Main definitions

In this article, the understanding of system includes "the local surroundings", defined as the team-related factors that exist within the operating room (such as staff, equipment and supply), and also "the outer structures", defined as all factors that exist outside of the operating room, anchored to structures and management (such as policies, workload and operating room size). When it comes to the definition of safe work practices, Vincent takes an indirect approach to the safety concept by seeing the study of failure as "…only a necessary step in the more general quest to understand how success is achieved and how safety can be gained and lost in the moment" (Flin & Mitchell, 2009, xxiv). Derived from this understanding, safe work practices in this article is defined as an interdisciplinary health care team's ability to create and maintain work practices that promote safety and contribute to a successful patient outcome (patient safety).

3. Research approach

Given the weaknesses in health care safety research identified above, we attempt to improve the current system understanding, by exploring how different factors of the system affect interdisciplinary team operations and safe work practices (research aim #1). We also attempt to replicate elements of existing methodologies, and link our findings to existing findings, in order to achieve a continuation of previous research efforts (research aim #2).

3.1 Overall methodology of the study

The study applied an ethnographic approach (Marcus, 1998), grounded in a combination of detailed non-participant observations, conversations and a series of semi-structured interviews. The main benefit of ethnography is that it provides an insight into the actions and explanations of individuals that is hard to quantify, or as Silverman (2004) says: "… the phenomena studied cannot be deduced but require empirical observation" (p. 10). In this study, the particular phenomenon being explored is the nature of the system factors affecting interdisciplinary operations and safe work practices.

3.2 Ethical concerns

The study was conducted in one section of a Norwegian regional general hospital. Based on the approval and recommendations of the Norwegian Social Science Data Services (NSD), all potential participants of the study (sample) were informed via presentations prior to the fieldwork. During these presentations, participants were handed a written information form (based on a template from NSD) that included information on the aim of the study and anonymity issues, and also a field for signing informed consent. Observations were only conducted when every member of the operating team had agreed to be observed. In situations where information had not been given and/or consent not obtained beforehand, this was taken care of before the operation began.

3.3 Selections

A typical operating team consists of 1-2 operators (surgeons), 2 operating room nurses, 1-2 nurse anesthetists, and 1 anesthetist physician. Table 1 illustrates the groups observed, the total sample size, the numbers who gave their informed consent, the numbers who were actually observed, and the numbers who were interviewed. The interviews lasted an average of 43 minutes.

Table 1: Distribution of observations and interviews

Groups observed	**Sample**	**Informed**	**Observed**	**Interviewed**
Anesthetist physician	9	5	5	2
Nurse anesthetist	15	14	11	3
Operating room nurse	22	15	15	2
Operator (surgeon)	45	16	16	4
Manager (interviews)	NA	NA	NA	4
Total (% of sample)	91	50 (55)	47 (52)	15 (16)

Interviews and observations were sampled to cover variety. In interviews this was achieved by ensuring variety across different types of professions, as shown in table 1. Variety was also achieved through age groups (33-54 years, 43.9 years on average), sexes (5 females, 10 males), and levels of experience as a specialist (2-36 years, 12.6 years on average). In terms of the observations, variety was achieved within the two main categories of elective (planned) and immediate (within 72 hours) surgery, and by attending different types of operations within the main categories, as listed in table 2.

Table 2: Distribution of observation type and duration

Type of observations	**Elective**	**Immediate**	**Total/Hours**
Variants of fracture	1 (00:45)	11 (21:50)	12 (22:35)
Variants of revision	2 (03:30)	1 (02:00)	3 (05:30)
Achilles extension	3 (06:30)	NA	3 (06:30)
Back stabilization	2 (12:30)	NA	2 (12:30)
Other	7 (15:20)	NA	7 (15:20)
Total/Hours	15 (38:35)	12 (23:50)	27 (62:25)

3.4 Creating and realizing a research protocol

To ensure that the study and findings later could be compared to existing health care safety research, a methodological replication strategy was selected. The goal of the replication was to mimic elements of how previous ethnographic research in a health care setting has been executed. With this goal in mind, we conducted an extensive review of existing health care safety literature, and identified one article that stood out from the rest in terms of methodological detailing; Smith et al. (2003). The field research protocol of the study was shaped by the elements in Smith et al. (2003), from the overall methodology to the specific practical steps to be taken during observations and interviews. Specifically, the protocol was given a sectional layout, directly reflected in the sub-headings next (3.4.1-3.4.3).

3.4.1 Practical methodology for observations

At the beginning of each observation, the operation was numbered (1-n) and specified in terms of type of operation and participants. A principal researcher (SH) and a co-researcher (JGH) were present at the majority of the operations, to ensure comparison and internal validity of the observations. During the observations, the nursing background of JGH clarified technical aspects and helped to improve the precision of the field notes taken by SH, while SH provided clarifications on safety issues that helped improve JGH's understanding and notes in this regard. This added to internal validity. Given the nature of the observed operations, where one operation replaced the previous in immediate transitions (shift began 07.30 and lasted in average to 15.00), the opportunity to fully transcribe notes occurred in the afternoons. The transcriptions were done individually, and focused on identifying emergent themes. This was followed by comparison of transcriptions and themes between observers, by means of discussions, to confirm, adjust or dismiss the understandings. To further

address validity concerns, respondent validation also occurred during conversations and interviews, to improve emerging themes and understandings.

3.4.2 Practical methodology for interviews

The main priority in the design of the interviews was to achieve a working synergy between the observations and the interviews, given our interest in respondent validity. This required that the interviews had an open nature that allowed for the inclusion of observational findings. Hence, a semi-structured interview guide was constructed from original findings in existing health care safety research. The guide was systemized into different sub-themes of "system" (supported by Catchpole, et al., 2007; Christian, et al., 2006; Leach, et al., 2009; Mackintosh, 2009). One sub-theme focused on the local surroundings, including the influence (on work practices) of unexpected patient anatomy, weaknesses or defects in equipment, and interruptions from mobile phones or people entering the operating room. Another sub-theme emphasized the outer structures, such as the relevance of high workload, and conflicting or competing demands from other parts of the hospital. In practice, the guide appeared both flexible and relevant during the interviews, by triggering reflections in the respondents and also by enabling the researcher to naturally relate his observations to the particular question. Both the principal researcher (SH) and the co-researcher (JGH) conducted the interviews, mainly individually but also in tandem (2 interviews).

3.4.3 Practical methodology for conversations

Identical to the semi-structured interviews, the main purpose for initiating conversations was to approve, adjust or dismiss existing observations. However, during the field stay, both the principal researcher (SH) and co-researcher (JGH) experienced that conversations not only provided an important source for validation, but also became an important means for gaining acceptance for the presence of the observers. This was evident from the fact that the respondents approached us more often, and from the fact that these conversations typically lasted longer.

3.5 A concern for "field blindness"

The observational period lasted 7 weeks in total, following an on-site and off-site system. Through the off-site periods in this yo-yo system (Wulf, 2002), the intention was to achieve a distance to the field that would reduce the proneness to "field blindness" and stimulate to more "sober" reflections (Fangen, 2005). The practical value of applying a field distancing strategy is described next.

3.6 Analysis

One aspect of the analysis process was the triangulation of findings from observations (including conversations), not only via researcher comparison of notes and transcripts but also via respondent validation during interviews and conversations (Patton, 1990). This triangulation helped to identify, adjust and dismiss emergent themes, and also assisted in improving the general understanding and the specific details of what was going on in the operating room. The triangulation in the field provided a set of initial and "immature" emergent themes. A more thorough analysis was performed in the month following the first field stay (the "off in the field" period). Through analytical triangulation (Patton, 1990), all three researchers (SH, KA, and JGH) were involved in the analysis process. Specifically, the analysis consisted of repeatedly reading the raw observational and conversational data, until the relationships between the series of events that occurred during the particular operation became clear. These events created an episode, defined as a series of related events that form a "bigger story". The episodes were then read and compared repeatedly by the researchers, individually and in tandem, until the particular emergent theme or trend became visible in the material. A trend is defined as a clear "red line" that runs through more than one episode. In cases where observational data did not provide a red line supportive of a particular trend, the researchers relied on the red lines identified in conversational and interview data. Combined, the two analyzing strategies for identifying episodes and trends complemented each other. Specifically, the emphasize on episodes are supported by Nielsen's (2004) story telling approach, providing *a rich and unique picture* of findings, while a focus on trends are comparable to the categorization techniques described by Miles and Huberman (1994), providing *a structured and transparent picture* of findings. The analysis process for identifying episodes and trends was repeated for all the off-site periods of the study. Based on field experiences in this study, the main benefit of the off-weeks analysis is that it provides an indication on the degree of success or failure of current research efforts in the field. This information, in turn, can be used to determine the ideal focus of the coming field stay.

4. Findings

The study findings have been categorized into trends and episodes that demonstrate how different factors of the system affect safe work practices in interdisciplinary operations. The included episodes are representative of the particular trend (selection criterion).

4.1 Trend 1 – Various combinations of system factors contribute to disrupt the "operational flow", but the particular operation continues and completes normally…

A trend in the data material is the different ways combinations of system factors in the local surroundings and in the outer structures appear to disrupt the normal flow of the operational activities. However, the particular operation proceeds and ends normally. In this study, we define normal as when the individual team member focuses on his or her safe work practices throughout the operation, typically by running the necessary procedures, by monitoring patient status continuously, and by working together as a team. In the descriptions next, the first three of the observed episodes are from immediate surgery. An analysis and comparison of the episodes are provided after the initial descriptions.

4.1.1 Episode 1 – "The operation schedule triggers discussions"

During preparations for this operation, the main operator enters the operating room and a discussion is triggered between the operator and the 1st operating room nurse (inexperienced) concerning the type of operation scheduled. The 1st operating room nurse has been informed of mobilization and testing in anesthesia, but the main operator claims that an open surgery is scheduled. The nurse seems annoyed, seeing how she now needs to obtain equipment unplanned for. Meanwhile, the main operator is seen walking restlessly across the floor. The discussion continues regarding which patient was assigned to the operating room (of two patients that arrived simultaneously). The 2nd operating room nurse (experienced) claims that they (the team) only followed the plan. She is supported by the nurse anesthetist, who explains to the main operator that she selected the patient from the list in Orbit. The main operator replies by placing the responsibility for the two patients on another individual, suggesting that he did not make the priorities. Despite a heated discussion, the operation proceeds as normal and concludes with no remarks.

4.1.2 Episode 2 – "Lack of equipment, inexperience… and mobile phones"

Early in this operation, the operator claims that the 2nd operating room nurse should have more equipment prepared for this type of surgery. The nurse leaves the room to obtain what he asks for. This event is followed by a call from a colleague on his mobile phone. The operator decides to address it properly, even though the conversation does not concern the operation. At a later stage of the procedure, the main operator continues to request equipment. The equipment is not directly available in the operating room, and is also hard to obtain right away. The operator seeks alternative solutions. He also becomes increasingly annoyed at the "instrument service", particularly when the 1st operating room nurse demonstrates trouble in obtaining the requested instruments. The annoyance seems to escalate with the nurse's displays of inexperience, when finally he decides to walk over and get the

instruments himself. Again, the operation proceeds as normal and concludes with no remarks.

4.1.3 Episode 3 – "X-ray trouble"

At the beginning of the operation, the main operator request better positioning of the x-ray machine only to discover that the machine is malfunctioning. He criticizes the 2nd operating room nurse (experienced) for not making sure the x-ray machine worked. The nurse defends herself by explaining that she had not found any tags indicating a problem with the machine, so she assumed it was cleared. The operator then asks the nurse to contact the transporter, and comments on how time that becomes available should be spent on controlling the equipment. The 1st operating room nurse (inexperienced) agrees. The operator becomes impatient when the transporter does not show up, and suggests that the 2nd operating room nurse should obtain one if the delay is any longer. When the new x-ray machine arrives he decides that he cannot use it, but then reconsiders and asks that the machine is positioned at the opposite side of the previous x-ray machine. The 1st operating room nurse tries to maneuver the new machine into position, but she has to move equipment to make room. Again the operator becomes impatient, and orders her to move it into position immediately. The nurse complies and also tries to adjust the monitor of the x-ray machine. The operator barks at her to stay away. Despite the equipment trouble and the tense atmosphere, the operation proceeds as normal and concludes with no remarks.

4.1.4 Episode 4 – "Missing the check points"

At the beginning of this operation, a time out reveals that no blood-screening has been conducted before the patient arrived (this is important if blood should be required). The main operator informs that he expects a blood loss of about 500ml, and considers this a risk factor. The 1st nurse anesthetist proceeds to contact the blood bank, to get a definitive answer on the screening. She receives a negative response, and the main operator is asked to postpone the start of the operation until the 2nd nurse anesthetist has collected the samples and sent them to the blood bank. In a conversation, the 1st nurse anesthetist explains that blood samples should have been collected at the time the patient was admitted ("first check point"), and this should also have been checked at the ward before the patient was sent to operation ("second check point"). During the reception of the patient and the first part of the Safe Surgery Check List, this should also have been noticed ("third check point"). The reason for the "slip" at the last check point, the 1st nurse anesthetist explains, was due to a late shift the night before that had resulted in one individual being unable to assume his day shift (the individual has an 11 hour quarantine time). The following shift then became one

individual short. As a consequence, one person on this shift became responsible for two patients simultaneously. The nurse believes that such situations increase the work load and stress levels, which can lead to mistakes. The operation proceeds as normal and concludes with no remarks.

4.1.5 When does an operation become vulnerable?

Judging by the four episodes, it would appear that for an operation to become vulnerable and experience disruptions in the normal operational flow, a combination of local and external system factors typically needs to be triggered simultaneously. Specifically, external structural factors include changes in the operating schedules (episode 1), lack of planning in preparing operational equipment (episode 2), less ideal ad-hoc team compositions, such as inexperience under immediate/demanding surgery (episodes 1-3), delays in equipment arrivals, once requested (episode 3), and lapses in individual control checks at several levels of the organization, enhanced by a late shift resulting in the next shift being one individual short (episode 4). Factors in the local surroundings include the mood of the team members (episodes 1-3), mobile phone disruptions (episode 2), equipment failure and lack of control (episode 3), and lack of equipment in the operating room (episode 2). The episodes suggest that once the external and local factors interact, in some way, the operations become vulnerable. Three of the four episodes also occurred during immediate surgery, implying that this type of operations, characterized by at <72 hours timeframe and naturally less time to plan, check and prepare (causing stress build-up), might be more vulnerable than elective (planned) operations.

However, besides the time-delays and personal mood changes none of the described disruptions resulted in any observable or outspoken concerns for patient-related errors. As for why the operations progressed in this way – seemingly unaffected and with emphasis on safety – an explanation can be found in that the nature of operations, besides being vulnerable and prone to disruptions under circumstances where certain system factors interact, are also a product of various compensating system factor. These factors are described next, and discussed in relation to trend 1.

4.2 Trend 2 – Various system factors compensate for the vulnerabilities and disruptions that arise during operations

In each of the episodes above, the outcome of the related operation was normal, meaning that the focus on the "job" and on safety was present throughout the operations. This suggests that the hospital section has "built-in" certain system factors that enables it to compensate for vulnerabilities and disruptions that arise during operations. The compensating nature of these system factors represents a second trend

in the data material, supported by conversational and interview data described next. The reason why conversations and interviews are used to support this particular trend, instead of the observational episodes described in relation to trend 1, has to do with the difficulty associated with observing these particular system factors directly.

4.2.1 Conversation 1 – "On becoming one section"

The nurse anesthetist approaches the researchers, and begins to discuss the current organization of the surgical unit (where operating and anesthesia personnel have belonged to the same section for ten years). He believes that this has improved the individual confidence levels among nurse anesthetists. Specifically, it is easier to know what type of equipment is required, compared to the uncertainty characteristic of the earlier separate organization where they moved around a lot more. This uncertainty often resulted in bringing either too much or too little equipment to the operating room. He sees the benefit of getting to know the specific routines, operations, and equipment at one section – this improves the ability to use the right equipment at the right time. As if underlining his point, he explains that this particular operation will be long and require a good amount of fluids. Because of this, he has prepared a liquid warmer to prevent the fluids from cooling down the patient.

4.2.2 Conversation 2 – "More on becoming one section – specialization and staffing"

A conversation with a nurse anesthetist brings more insight into what the results has been of the organization into one section. One of the benefits, he explains, is a higher specialization within a specific area, such as the particular type of surgery being carried out at the section. The conversation is later continued with the nurse, who describes that he has never witnessed any medication errors, and claims that the "system" contributes to this. This includes, he specifies, the good staffing. Even under less ideal circumstance, such as weekends where only one nurse anesthetist is present, the operations almost always turn out fine. He believes the fact that one operator always is on duty, contributes to this outcome.

4.2.3 Summary and interview perspectives

Based on the two conversations, it is clear that the history of this particular hospital section plays a direct role in the ability to compensate for operational vulnerabilities and disruptions. Specifically, according to the team members longer exposure to the particular operations, practices and organizing at this section has (1) improved the confidence in finding the right equipment for the particular operation, (2) improved the ability to use the right equipment at the right time, and (3) strengthened the specialized knowledge within a specific area of competency. In addition, a respondent

believes that (4) the staffing level contributes to why he has never witnessed medication errors. This impression is strengthened by interviews with a team member and a manager at the section.

The manager discusses the current staffing: "At the section we work day and evenings, and then we are on call duty at home from half past midnight. And those that are on this call duty, if they are called in during the night… given that they are required to have eleven hours of rest before they come back… [this] will of course have consequences the next day when they should have begun the morning shift… if they cannot be there it will have consequences for when we can begin with the next day's patients. So it was decided that [our section] should have a staffing level that would ensure that even if [those on call duty at home] had been called in, we would be sufficiently staffed to startup operations in all operating rooms." The researcher adds that he sees this as an operational buffer: "*That* is a buffer, yes. Of course if [those on call duty] had not been in [during the night], and gone home at the usual time, they will return to work at the normal hour in the morning, and then we have a buffer of two operating room nurses and one nurse anesthetist… every day. This is a very, very, very good way of organizing [that also] gives us a buffer in terms of sickness… and it strengthens the working environment of course, [since] several people share the work load." Later in the interview the manager addresses the availability of operating rooms: "So the section has in recent years increased its capacity from three operating rooms in the day and one in the evening… to guaranteed startup of operations every day, plus four operating rooms Monday, Wednesday, Friday, and two operating rooms Tuesday evening. So we have had quite a large increase in capacity in recent years".

When asked about the outer structures and work load at the section, an anesthetist physician comments: "I have to say, we rarely lack anything on the equipment and personnel front… I rarely experience that my work load becomes too high. [The exceptions] are sickness or unexpected things… some days can be very busy, but this is not a problem." The researcher comments that it is quite a positive impression he provides. "Yes, but this is not the case at [other sections]… there is supposed to be flexibility [at our section], it is a buffer that enables us to increase our capacity suddenly, since the need fluctuates… it is [organized in this way] because we need emergency readiness 24/7"

In sum, the data from conversations (episodes) and interviews demonstrate several facets of the system's ability to compensate for vulnerabilities and disruptions during operations. Specifically, buffers in terms of staffing, equipment, and operating rooms constitute the outer structures and factors of the system, and part of the compensating

ability during operations. The anesthetist physician suggested that these buffers can reduce the individual work load, and thereby strengthen the working environment in this respect. These buffers also help to explain why the operations continue as normal, despite disruptions such as less ideal ad-hoc team compositions under demanding surgery (trend 1, episodes 1-3) interacting with the mood of the team members (trend 1, episodes 1-3). Another compensating system factor appears to lie in operating personnel's exposure to one section, over time, boosting both the specialized knowledge and confidence levels, and also the ability to become proficient with the equipment and use the right equipment at the right time.

5. Discussions

Given the focus on vulnerabilities and disruptions, the first trend can be linked to findings in a study by Catchpole et al. (2007). Specifically, the authors attempt to identify system factors that can be improved, and find that complications during operations resulted from an escalation of smaller problems, caused by the context in which the operation took place. This includes unnecessary distractions (telephones, pagers), difficulties with equipment (availability and function), unexpected problems with patient anatomy, and conflicting demands on team members from other parts of the hospital system. Our findings support the findings in Catchpole et al. (2007) related to inner structures, such as distracting mobile phones and difficulty with equipment. In addition, we find that the mood of team members plays a role. In terms of outer structural factors, however, our findings do not support the relevance of conflicting demands on team members from others parts of the hospital in Catchpole et al. (2007). Instead, relevant outers system factors in our findings include (1) changes in the operating schedules, (2) lack of planning in preparing operational equipment, (3) less ideal ad-hoc team compositions, (4) delays in equipment arrivals, and (5) lapses in individual control checks at different organizational levels.

In another study, by Leach et al. (2009), the focus is on understanding the nature of surgical teams and their performance. While this perspective is not directly transferable to the understanding in our study that various system factors compensate for the vulnerabilities and disruptions during operations (trend 2), the core system factors in both studies are highly related, but reversed, in terms of impact on the particular organization. Specifically, while Leach et al. (2009) identify problems with operating schedules, the availability to operating rooms, and a shortage of staff, equipment and supply, our findings suggest that the operating room, staffing and equipment represent the main strengths of the section we studied. This is in itself an important finding, suggesting that the conditions for conducting operations might differ significantly from one setting to another, and so also the ability to ensure safe

work practices. Besides the above similarities, we also found a relevant system factor to be the operating personnel's exposure to one section, over time.

In sum, our findings support existing findings, but also provide new insights into how the system relates to safe work practices in interdisciplinary operations.

6. Conclusions

The concept of system vulnerabilities is nothing new in organizational safety research, and is commonly seen in the understanding of latent failures that can build up in a system (Reason, 1997), or in descriptions of the importance of being vigilant and mindful of one's role and surroundings (Weick, 2001). What this study adds is (1) an insight into the rich nuances of the vulnerabilities and disruptions caused by different combinations of system factors, unique to this particular hospital section and setting, and also (2) an insight into how the organization uniquely compensates, through various system factors, to prevent the vulnerabilities and disruptions from affecting work practices and patient safety. In other words, although it initially may seem daunting to look at the system as a feature of an organization that can be explored, our findings demonstrate that it is possible to gain both a rich picture, via episodes and conversations, and an overall understanding, via trends, of how the system affects interdisciplinary operations.

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References

Baker, D. P., Day, R., & Salas, E. (2006). Teamwork as an essential component of high-reliability organizations. *Health Services Research, 41*(4 (Pt 2)), 1576-1598.

Catchpole, K. R., Giddings, A. E. B., Wilkinson, M., et al. (2007). Improving patient safety by identifying latent failures in successful operations. *Surgery, 142*(1), 102-110.

Catchpole, K. R., Giddings, A. E. B., De Leval, M. R., et al. (2006). Identification of systems failures in successful paediatric cardiac surgery. *Ergonomics, 49*(5-6), 567-588.

Christian, C. K., Gustafson, M. L., Roth, E. M., et al. (2006). A prospective study of patient safety in the operating room. *Surgery, 139*(2), 159-173.

Fangen, K. (2005). *Deltakende observation*. Stockholm: Lieber Forlag.

Flin, R., Mitchell, L. (Ed.). (2009). *Safer Surgery - Analysing Behaviour in the Operating Theatre*. Farnham: Ashgate Publishing Limited.

Greenhalgh, J., Flynn, R., Long, A. F., et al. (2008). Tacit and encoded knowledge in the use of standardised outcome measures in multidisciplinary team decision making: A case study of in-patient neurorehabilitation. *Social Science & Medicine, 67*(1), 183-194.

Infante, C. (2006). Bridging the ''system's'' gap between interprofessional care and patient safety: Sociological insights. *Journal of Interprofessional Care, 20*(5), 517-525.

Leach, L. S., Myrtle, R. C., Weaver, F. A., et al. (2009). Assessing the performance of surgical teams. *Health Care Management Review, 34*(1), 29-41.

Lyndon, A. (2006). Communication and teamwork in patient care: How much can we learn from aviation? *Journal of Obstetric Gynecologic and Neonatal Nursing, 35*(4), 538-546.

Mackintosh, N., Berridge, E-J., Freeth, D. (2009). Supporting structures for team situation awareness and decision making: Insights from four delivery suites. *Journal of Evaluation in Clinical Practice, 15*, 46-54.

Marcus, G. (1998). *Ethnography Through Tick & Thin*. Princeton, New Jersey: Princeton University Press.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook (2nd ed)*. Thousand Oaks, California: Sage Publications.

Nielsen, H. B. (2004). European gender lessons: Girls and boys at scout camps in Denmark, Portugal, Russia and Slovakia. *Childhood, 11*(2), 207-226.

Patton, M. (1990). *Qualitative Evaluation and Research Methods*. California: Sage Publications.

Reason, J. (1997). *Managing the Risks of Organizational Accidents*. Aldershot, UK: Ashgate.

Silverman, D. (2004). *Qualitative Research - Theory, Method, and Practice*. London: Sage Publications.

Smith, A. F., Goodwin, D., Mort, M., et al. (2003). Expertise in practice: An ethnographic study exploring acquisition and use of knowledge in anaesthesia. *British Journal of Anaesthesia, 91*(3), 319-328.

Smith, A. F., Pope, C., Goodwin, D., et al. (2006). What defines expertise in regional anaesthesia? An observational analysis of practice. *British Journal of Anaesthesia, 97*(3), 401-407.

Weick, K. (2001). *Making Sense of the Organization*. UK: Blackwell Publishing.

Wulf, H. (2002). Yo-yo fieldwork: Mobility and time in a multi-local study of dance in Ireland. *Anthropological Journal on European Cultures, 11*, 117-136.

Article III

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Exploring safe work practices in surgical operations – The role of time, patient, and operation

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Exploring safe work practices in surgical operations – The role of time, patient, and operation

Sindre Høyland

Summary

This article focuses on identifying elements of the individual's and team's ability to conduct and complete operations with a minimum of complications, defined as safe work practices. Based on a content analysis of 15 semi-structured interviews with operating room (OR) personnel, safe work practices are identified as comprised of (i) *the individual's ability to disregard stress/pressure and apply the time and considerations necessary to the job properly,* (ii) *the individual's ability to sense and communicate patient-related problems, enhanced by the specialized patient focus,* and (iii) *the team's reliance on the individual's competency and ability to both plan and improvise, when challenged during an operation*. In conclusion, the findings contribute to fill the current gap in knowledge on the particular nature of team work within the health care context, and specifically the surgical OR setting. The findings also suggest that future studies should look into the relevance and potential duality of time in surgical operations.

1. Background & Aim

Findings on how speedier completions of operations can be directly associated with improvements in situation awareness and leadership (Catchpole, et al., 2008), or findings on how the unscripted and unspoken knowledge becomes an essential part in a team's ability to anticipate others and handle a crisis (Friedman & Bernell, 2006), or findings on how external factors such as the schedule and size of the OR, and shortage of staff and supplies can influence team performance (Mackintosh, 2009), suggest that there exists a broad range of factors that can affect interdisciplinary team practices in the OR. The original findings above represent a selection of the limited number of studies that have been undertaken to explore the particular nature of team work within the health care context (Baker, et al., 2006; Leach, et al., 2009; Lyndon, 2006). The paper seeks to address this current gap in knowledge. Specifically, based on an empirical study, this paper attempts to identify and describe, via a content analysis, the themes most frequently discussed in relation to the individual's and team's ability to conduct and complete operations with a minimum of complications (safe work practices).

2. Methodology

By means of a content analysis, this paper explores 15 semi-structured interviews with operating room personnel (surgeon/operator, operating room nurse, anesthetist physician, nurse anesthetist) in one section of a Norwegian regional general hospital. A content analysis is defined as a systematic process for organizing large amounts of raw data into categories and themes, based on explicit rules of coding (Berelson, 1952; Krippendorff, 1980; Weber, 1990).

QSR Nvivo was used to analyze the transcribed raw interview data. In the first phase of the analysis each transcribed interview was entered into the program as a "source", and a word frequency query was conducted. In reviewing the results from the query, any words addressing aspects of the OR was identified. To ensure a minimum level of distribution, 10 or more references were chosen as the criterion for inclusion in further analysis. The resulting 91 identified words were stored as individual "nodes" in Nvivo. In phase two, all nodes were reviewed to determine whether the individual words could be combined into clusters of similar words or meanings (Weber, 1990). The resulting 33 clustered nodes were stored and labeled. The clustered nodes provided direct access to the raw interview data through the "text" pane function of the node, where Nvivo highlights occurrences of the particular words in the raw text material. This enabled an efficient access to explore the respondent's understanding of safe work practices in relation to the particular words. This exploration represented the third phase of the analysis process.

3. Results

Word clusters	**Sources**	**References**
Time, clock, hour, minutes	15	197
Patient, patients	14	170
Operation, operations	14	167
Problem, problems	13	124
Surgeon, surgeons, operator, operators	14	121
Equipment, equipments, instruments	14	110
Job, jobs, jobbed	14	99
Situation, situations	12	94
Average (sources) & Total (references):	14	1082

Table 1: Nvivo query on word frequency (source = interview)

Table 1 illustrates the most frequent occurrences of word clusters in the raw interview material. The top three themes – time, patient and operation – demonstrate particularly many references, and for that reason becomes the focus of this paper.

3.1 Time as a requisite in planning and performance (theme 1)

The most frequently occurring theme of *time* is often discussed in relation to doing a proper job in the OR:

"For an inexperienced operating room nurse, it can become stressful when the surgeons arrive and you feel that now I am too late, even if the work is being done entirely as it should and the time is quite acceptable. You feel that you do not get "things" done well enough. This is similar for anesthesia, where a highly experienced nurse anesthetist, for example, has no problem with using his/her time on a procedure. You have to use your time, and it is nothing to discuss, even though people are waiting" (Nurse anesthetist)

"Undeniably, there is a focus on getting things done quickly, so sometimes the young people feel that there is a pressure to get things done quickly. If they spend too much time to put a blockade in the arm, spinal anesthesia and so forth, they feel that others pressure them without saying it directly. I tend to say that there is nothing to worry about, and that they should take the time they need to do it properly" (Anesthetist physician)

"I think that the work we do takes time. It is not something you can skip, it requires time" (Operating room nurse)

The excerpts suggest that time is often considered necessary to do one's job properly, in importance superseding stress or pressure. Time is also considered an important factor in planning, as the considerations involved in calling for assistance and generally preparing suggest:

"It is like a procedure, or algorithm that during a really critical situation the first priority is to call for help" […] *"When you call for a new person, he judges the situation. Maybe he will start where you were, but he might do exactly as you intended. The point is that you get a second opinion. However, time also passes then, so it is always a trade-off whether to call for help for something that is not urgent. That is, it is not certain that less time passes then compared to if you just keep trying yourself, because now you already have a good overview of the situation"* (Anesthetist physician)

"I try to plan. I ask around which surgeon will perform the surgery, and I plan a little in terms of who participates and who you work with. If you are more experienced you do not spend time on this, but if you are new then you have quite a lot of attention there, yes" (Operating room nurse)

"Earlier today when we operated the sliding hip screws, I was more aware in terms of where to insert the screws. I was the main operator, after all. I brought with me a more experienced assistant surgeon who guided me along a bit. Being the main operator you have to read up a bit in advance, if it has been a while since you did the particular operation. You look through what you should do and what instruments [to bring]*... one must try to prepare"* (Surgeon)

In sum, the first element of safe work practices can be identified as the individual's ability to disregard stress/pressure and apply the time and considerations necessary to the job properly, including the decision to involve a second person/opinion during a procedure and/or ability to think ahead by calling on assistance to save precious time in a critical situation.

3.2 Patient-anchored awareness and specialization (theme 2)

The theme of *patient* is seen in views on situational awareness:

"Sometimes we have good conversations with surgeons, when we encounter problems… critical situations where we say that 'the patient is not quite well, we have some problems with this, do you have much to be done or can we cut down on something?'. I have tried to communicate this a few times, and I have received good response and good feedback from surgeons who understand it and accept it, and sometimes they ask 'is it okay with the patient?'. I think that the more complicated the patient's situation is, the better the communication works. It is often the more mundane things that are more of a hassle, where it can sometimes lack a little bit more. And really, it is good that things work better in a critical situation" (Anesthetist physician)

"You read the journal before entering the operating room. So if the patient has problems... a leg fracture… it is not just a leg fracture. That is, if the patient has a lot of other problems or you see he is very thin you need to somehow... what you see on the form or what you see with your clinical gaze makes you either think that everything is okay or that you should begin... by being an operating room nurse, you should think ahead of the surgeon somehow. You are somehow a step ahead, right. You have set up your equipment... when it is your turn, you are ready. To stay ahead... it is very person-dependent, but many surgeons are good at planning. They want to

keep track of their patients and be in control of what they need [for the coming operation]*"* (Operating room nurse)

"Very often the rest of the team do not register that the patient is critically ill. If [for example] *you have a patient with a bad heart that is having a nail put into the hip, and we administer spinal anesthesia, sometimes the blood pressure becomes very low because the pulse beats so bad that we work really hard to keep the patient alive. While on the other side of the coverage, they operate unaffectedly"* (Nurse anesthetist)

The excerpts above suggest that situational awareness concerns the individual ability to sense and communicate patient-related problems and/or judge the criticality of the patient situation. The last excerpt also illustrates the specialized task-focus of the two "sides" of the OR-team. Specifically, while the specialization appear to separate the awareness of the operating team as a whole, it also enables the team to remain focused and in control of both the surgical procedure and the respiratory/vital functions of the patient.

Views on situational awareness are also related to the considerations involved in conducting more demanding procedures/surgery:

"... When you rotate, cut over the thighbone of a young person, it is not really something you want to do. It causes a huge damage to the patient, right… it is not that hard to do, it is about not making mistakes. No, I think it is important to be skilled in such situations, to reduce the risk of errors, of misjudgments, right. In this respect I am very supportive of being two surgeons, when you do operations that can go wrong. There are some operations that might be a little more risky than others. If you do something that really has consequences for the patient, and you know that you cause them huge problems afterwards, I think there should be two people present... in which both understand the operation. It does not help to have someone who has never been involved in the type of operation, who becomes more of a spectator... he can of course do something, be given a few commands and help, but this does not help you in the decision-making" (Surgeon)

Derived from the excerpts above, other elements of safe work practices are seen in the individual's ability to sense patient-related problems (experience-dependent) and/or judge and communicate the criticality of a patient situation, and also the team's trust in the specialized patient focus (respiratory/vital functions vs. surgical procedure) of the particular team member.

3.3 The team's trust in the individual when challenged (theme 3)

When it comes to *operation*, this theme is often discussed in relation to responsibility-taking:

"I think that an operation can occasionally develop from being a banality to becoming something really critical. Then it is important to sort information and the importance of the information, and take action when things really escalate. The person in charge in such a situation is the one that detects the problem and makes the decision there and then. If you decide to call in more expertise, then you leave the responsibility to another person to a certain degree. It is because you believe that your skills are not sufficient and that you need to call in more expertise to deal with this patient" (Nurse anesthetist)

"I feel that we do not have clearly defined tasks. The anesthesia personnel handle fluid balance and the anesthetics and so forth, and we will of course not push through with the operation if anesthesia says it is not medically justifiable to continue with the planned operation" (Surgeon)

"On the anesthesia side [at our section] *we determine what we do. It is the anesthetist physician who is in charge, but often prior to the surgery we have an arrangement. We can demand that in order for the patient to be anesthetized, it must happen in a specific way. There we can determine whether the patient will be anaesthetized or not"* (Anesthetist physician)

As the excerpts suggest, the main responsibility-determinant is (trust in) the competency levels of the particular individual/specialization, meaning that a nurse anesthetist's medical judgment is heard during the operation, and can even result in suspension of an operation.

Planning and improvisation are also an important aspect of the operation theme:

"You have to be spontaneous, but you have to plan [the preparation of instruments]. *I remove a lot of instruments because it is incredibly important that you use as few instruments as possible. The fewer instruments you have and need to "manage", the easier you make it for yourself. A beginner has many instruments, like I had. Now you can turn off the light, and I will know where my five instruments are, right"* (Operating room nurse)

"When you are the main operator, you usually have to solve the problems that occur by relying on previous experience, right. To put it this way, I have worked for so many years that I know we have different methods to fixate. So if plan A fails, we try to

approach it in another way, by using clamps or we can... it is a good idea to know the equipment available. I know that the plastic surgeons have something that I can borrow, and if something is missing… you know, we lost a screw on the floor [in an operation recently], *and then we know that they have the same screw dimensions in the distal radius* [forearm fracture] *shrine. In that situation we picked up that shrine to replace what we had lost on the floor,* [so] *it is an advantage if you know what the different shrines contain"* (Surgeon)

"It is always good if you bring an instrument shrine you have seen before. Of course some of the equipment that you loan you will not always [have experience with]. *Particularly equipment borrowed for a special* [read: rare] *operation. If possible, we usually go through these shrines a day prior to the operation, and clarify that 'you will be handling this' or 'you will have to look into this'"* (Operating room nurse)

"It varies how you do things and carry out the operation. When you need to improvise, like in the previous operation where they were operating a screw in a toe and did not have the correct dimensions of the screws, you have to convert it to a slightly different type of operation" […] *"Sometimes you just have to do it a bit there and then, because the instrument is missing or because often you do not have time to review the operation. If a lot is going on at the section, you do not have much time to prepare for the operation"* (Surgeon)

The excerpts taken together, the final element of safe work practices can be identified as the team's reliance on the individual's competency and ability to both plan and improvise when challenged by a problem or an unforeseen situation occurring during an operation.

4. Discussion

In recent health research literature on quality and safety, the *theme of time* is often viewed as a concern. For example, Carl et al. (2010) look at complications associated with perioperative issues, and find that OR-time could derail a surgical outcome even with an otherwise uneventful surgical technique. In another study, Lee (2010) looks at the implementation of extended surgical time-out (STO) in pediatric surgery, and finds that the time used on the STO did not disrupt the operational workflow. In contrast to these accounts and the view on time as something negative, this paper highlights *the individual's ability to disregard stress/pressure and apply the time and considerations necessary to the job properly* – thus, taking your time becomes a positive element that enables safe work practices.

In relation to the theme of patient, this paper suggests that safe work practices are comprised of *the individual's ability to sense and communicate patient-related problems, enhanced by the specialized patient focus*. The specialized patient focus can be viewed as a property of how a team delegates tasks to those most skilled (distributed responsibility), enabling the team to process large amounts of information (cf. Patel, et al., 2000). The sensing and communicating aspects are similar to Catchpole et al.'s (2008) finding that a low rate of errors in surgical technique can be associated with higher situational awareness among surgeons, in terms of the ability to notice what is happening, understanding the implications, and thinking ahead.

When it comes to the *theme of operation*, this paper suggests that safe work practices are comprised of *the team's reliance on the individual's competency and ability to both plan and improvise, when challenged during an operation.* The former element – reliance on individual competency – is comparable to Patel et al.'s (2000) understanding of distributed responsibility. The latter element – planning and improvising – supports the findings in Smith et al. (2003) and Greenhalgh et al. (2008), who in understanding learning and decision-making respectively identify a team's and an individual's ability to combine formal/encoded knowledge (technical skills, theoretical learning, measures/scores) with other types of knowledge (clinical, social, electronic, experiential/tacit).

5. Conclusion

While the findings in this paper support existing findings in health research literature on quality and safety, they also represent an effort in the important step of filling the current gap in knowledge on the particular nature of team work within the health care context, and specifically the surgical OR setting. In particular, the theme of time should be subjected to further exploration, judging by the duality seen in the contrast between the existing findings and the findings in this paper.

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References

Baker, D. P., Day, R., & Salas, E. (2006). Teamwork as an essential component of high-reliability organizations. *Health Services Research 41*, 1576-1598.

Berelson, B. (1952). *Content Analysis in Communication Research*. Glencoe, Illinois: The Free Press.

Carl, A., Kaufman, E., & Lawrence, J. (2010). Complications in spinal deformity surgery: Issues unrelated directly to intraoperative technical skills. *Spine (Phila Pa 1976), 35*, 2215-2223.

Catchpole, K., Mishra, A., Handa, A., et al. (2008). Teamwork and error in the operating room - Analysis of skills and roles. *Annals of Surgery 247*, 699-706.

Friedman, L. H., & Bernell, S. L. (2006). The importance of team level tacit knowledge and related characteristics of high-performing health care teams. *Health Care Management Review, 31*, 223-230.

Greenhalgh, J., Flynn, R., Long, A. F., et al. (2008). Tacit and encoded knowledge in the use of standardised outcome measures in multidisciplinary team decision making: A case study of in-patient neurorehabilitation. *Social Science & Medicine, 67*, 183-194.

Krippendorff, K. (1980). *Content Analysis: An Introduction to Its Methodology*. Newbury Park, CA: Sage Publications.

Leach, L. S., Myrtle, R. C., Weaver, F. A., et al. (2009). Assessing the performance of surgical teams. *Health Care Management Review, 34*, 29-41.

Lee, S. L. (2010). The extended surgical time-out: Does it improve quality and prevent wrong-site surgery? *The Permanente Journal, 14*, 19-23.

Lyndon, A. (2006). Communication and teamwork in patient care: How much can we learn from aviation? *Journal of Obstetric Gynecologic and Neonatal Nursing, 35*, 538-546.

Mackintosh, N., Berridge, E-J., & Freeth, D. (2009). Supporting structures for team situation awareness and decision making: Insights from four delivery suites. *Journal of Evaluation in Clinical Practice 15*, 46-54.

Patel, V. L., Cytryn, K. N., Shortliffe, E. H., et al. (2000). The collaborative health care team: The role of individual and group expertise. *Teaching and Learning in Medicine, 12*, 117-132.

Smith, A. F., Goodwin, D., Mort, M., et al. (2003). Expertise in practice: An ethnographic study exploring acquisition and use of knowledge in anaesthesia. *British Journal of Anaesthesia, 91*, 319-328.

Weber, R. P. (1990). *Basic Content Analysis* (2nd ed). Newbury Park, CA: Sage Publications.

Article IV

Høyland, S. (2012)

Developing and validating a scientific model for exploring safe work practices in interdisciplinary teams

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Developing and validating a scientific model for exploring safe work practices in interdisciplinary teams

Sindre Høyland

Department of Health Studies, Faculty of Social Sciences, University of Stavanger, 4036 Stavanger, Norway. E-mail: sindre.hoyland@uis.no Mobile: (+47) 922 30 965. Fax: (+47) 51 83 10 50.

Abstract

Health research literature on quality and safety in recent years has pointed to a need to explore the characteristics of interdisciplinary team work unique to the health care sector and the particular organization. The literature also has identified a need for scientific models that explore and integrate existing findings concerning team dynamics. In this article, I attempt to address these concerns by developing and validating a scientific model for exploring safe work practices of interdisciplinary OR teams. Specifically, existing health research literature on quality and safety is reviewed to identify and incorporate various team-related aspects into dimensions of the proposed model. To further validate the model, I conduct an ethnographic study of safe work practices within an interdisciplinary OR setting. I find that safe work practices can be viewed as a product of the individual's and team's ability to draw on and combine explicit and tacit knowledge repertoires, which again is a product of the particular inner and outer structural conditions of a system. While the findings add their own unique distinctiveness to the scientific model, the findings also compare to the existing aspects and dimensions of the model. I conclude that the fit of the empirical data to the model improves the validity of the model, and also the potential application of the model in ethnographic research within different medical and/or team settings.

Keywords: Safety; scientific model; literature review; ethnographic research; interdisciplinary surgical setting.

1. Introduction

Safety principles used in high reliability sectors, such as civil aviation, have received increased recognition in health research literature on quality and safety over the recent years (Burke, 2004; Gaba, 2000; Morey, 2002; Riley, 2009; Salas, et al., 2009; Wilson, 2005), and it is now commonly believed that training in team skills, within a simulated or clinical environment, can lead to improvement of these skills, safer practices, and overall higher levels of occupational safety and patient safety. However, the claim regarding safety improvement remains to be documented. Specifically, health research literature on quality and safety points to weaknesses in the identification and understanding of, and training for, health care specific team skills (Baker, et al., 2006; Lyndon, 2006; Reader, 2006); in the commitment of resources and time necessary to ensure team training (Burke, 2004; Harris, 2006); and in the focus on research and development of scientifically grounded models that can integrate existing findings (Manser, 2009) and that can be applied to explore and measure the dynamics and performance of interdisciplinary teams (Baker, et al., 2006; Healey, et al., 2004, 2006b). The above concerns are summarized by Flin & Mitchell (2009): **"**Given the importance of anaesthetic, theatre nursing and surgical tasks for patient safety during an operation, it is surprising how little scientific investigation of working life has taken place in this domain. There are very few reports of the culture and behaviour patterns in surgical and anaesthesia units" (p. 1). Thus, the nature of interdisciplinary teamwork in health care has yet to be properly explored, particularly in terms of integration into existing training programs and designs.

In this article, I attempt to answer the above calls to explore team work characteristics and to integrate existing findings (Manser, 2009) into a scientifically grounded model (Baker, et al., 2006; Healey, et al., 2004, 2006b). Specifically, my first approach in answering the two calls is to review empirically-based team-related health research to incorporate the findings as aspects and dimensions of a scientific model for exploring safe work practices of interdisciplinary teams. My second approach is to validate the proposed model, specifically by means of an ethnographic study I conducted within an interdisciplinary OR setting (Høyland, et al., 2011a, 2011b). Combined, the two approaches provide the model's scientific foundation as well as anchor to both existing findings (literature review) and new findings (ethnographic study).

2. Developing a scientific model – review methodology

In order to develop the scientific model I conduct a three-phased literature review process. Specifically, I combine online searches and searches within a local EndNote database, to identify and later determine the specific team-related aspects and dimensions of the model. In response to Manser's (2009) identification of the need for

a scientifically grounded model that can integrate existing findings, I have specifically identified empirically-based/original articles and findings.

2.1 Review phase 1

The first review priority was to identify team-related aspects commonly addressed in original health research literature on quality and safety. Given this aim, I searched the electronic online databases PubMed, Web of Science, and Academic Search Elite on abstract, title, topic, and/or key words containing "team" and "health care" and "result" or "finding." The emphasis on abstract, title, topic and/or key words and "result" or "finding" (in separate searches) helped to narrow the searches significantly by filtering out articles that did not include original findings. The actual hits in the online databases varied between approximately 100 and 400 articles. Among these hits, many articles did not focus on the team primarily but rather on topics of mental illness, elderly care, delivery of care, management of risks, patient experiences with illnesses and care, and so forth. Of the hits that did focus on the team primarily, for example in relation to a particular profession or in relation to primary care or surgery, I identified the following recurrent aspects (closely related aspects are grouped): (1) communication, (2) training or performance, (3) experience or learning, (4) management or organization, and (5) complex or context.

2.2 Review phase 2

After the preliminary identification of team-related aspects, I systemized the identified aspects according to specific dimensions that could fit a scientifically grounded model for exploring safe work practices. *System* became a "natural" category for including aspects such as management or organization and complex or context. As for support within health research literature on quality and safety specifically, Catchpole et al. (2006) explore the systemic aspects affecting paediatric cardiac surgery, described as patient threats (related to anatomy and physiology) and environmental threats (related to equipment, workspace and external resources). Another account within health research literature on quality and safety supportive of the system dimension is seen in Infante (2006), who argues that a systems model needs to be developed that makes the broader system dimension explicit, including the environment, organizational factors, structural factors, system design, adaptation, and policy (p 520). There is also general support for viewing health care as a system of a complex and adaptive nature, in which people can act in unpredictable ways and actions between patient, clinicians, and technology are interconnected in so-called clinical microsystems (Barach & Johnson, 2006; Donaldson & Mohr, 2000; Mohr, 2000; Mohr, et al., 2003; Mohr, et al., 2004; Quinn, 1992).

The common factor in systemizing the remaining aspects – communication, training or performance, and experience or learning – is their basic anchor to *knowledge*. A clarification of the concept is thus needed. From an evidence-based medicine (EBM) perspective, knowledge rests on the model of technical rationality, where an individual practices problem solving according to established scientific theories and techniques (Schön, 1991, p. 21). The technical rationality model represents the "proven and explicit knowledge repertoire" that OR personnel rely on, comprised of procedures, protocols, routines, etc. However, critiques of the technical rationality view argue that one must account for the kinds of knowledge health care personnel actually use in practice, where not only the explicit but also tacit elements of knowledge such as clinical judgment and expertise come into play (Braude, 2009; Haynes, 2002; Henry, 2006; Polyani, 1966). With this understanding, the connection between knowledge and the remaining identified aspects can be made. Specifically, the communication aspect has explicit knowledge elements expressed as protocols or routines that over time have proven to be "the right way of doing things". Checklists, for example, are typically used as cognitive aids during task completion (Hales, et al., 2008), and has proved important to information exchange and team cohesion in the operating room (Lee, 2010; Lingard, 2005). Other ways of communicating occur through the use of body language and listening (Friedman & Bernell, 2006), and also through the selective use and control of information flow (Riley & Manias, 2009) The last examples illustrate the less visible sides of communication; the tacit knowledge elements. Similarly, performance will be shaped by the explicit knowledge elements developed through training, such as the focus on economy of hand motion to measure technical competence (Grober, et al., 2010) or the focus on formal instruction for more advanced technical skills (Benson, et al., 2010). However, performance will also be formed by skilled judgment based on personal experience (Thornton, 2006), enhancing the ability to handle patient and recognize the limit of safe practice (Smith, et al., 2006), i.e. tacit knowledge elements. In sum, the described links between different types of knowledge and the remaining aspects identified from the literature review, suggests that knowledge represents a potential second dimension of the scientific model.

2.3 Review phase 3

To determine additional support for and validity of the two identified dimensions of system and knowledge, I utilized a local EndNote database on health research literature. The database contains about 500 scientific references to publications in the area of health research on quality and safety. These publications mainly feature articles addressing a wide range of health care safety topics from training and simulation to culture and risk governance published in the period between 1990 and

2010. The database references originate from searches conducted mainly via electronic online databases such as ArticleFirst, Medline/PubMed, Web of Science, ISI Web of Knowledge, and Academic Search Elite. To obtain an overview of relevant publications in this database, I explored combinations of key words and search phrases from review phase 1 in relation to the identified dimensions and aspects:

- The knowledge dimension was searched according to "team" and "finding" or "result" in combination with "communication" (55 hits), "training" or "performance" (73 hits), "experience" or "learning" (50 hits)

- The system dimension was searched according to "team" and "finding" or "result" in combinations with "management" or "organization" (94 hits), "context" or "complex" (45 hits)

Judging from the number of hits on articles that addressed the system and knowledge dimensions, both dimensions have support in health research literature on quality and safety. To represent this finding, I included a number of articles representative of the identified aspects and dimensions in the article. The included articles had to demonstrate both original findings and a high relevance to the identified team-related aspects and dimensions (selection criteria).

Given the exploratory nature of this review, triangulation techniques (Denzin, 1978; Patton, 1990) were applied to ensure validity of the literature review process:

- Several electronic data sources online and a local source (EndNote database) were triangulated (data triangulation).

- With no predefined theory and a general openness to perspectives, I looked for emergent team-related aspects to develop a scientific model (theory triangulation).

- The review process combined online and local searches via electronic databases, in addition to a three-phased process of determining the final dimensions and aspects of the scientific model (methodological triangulation).

According to Yin (2009), completing these three steps ensures that the events and facts of the phenomenon under study, in this case team related aspects commonly addressed in health research literature on quality and safety, are supported by more than a single source of evidence.

3. Review findings and a proposed scientific model

Tables 1 and 2 systemize the identified aspects and dimensions of the review process described above.

ARTICLES RELATED TO THE KNOWLEDGE DIMENSION			
Author(s), year	**Methodology and 1st researcher**	**Aspects addressed**	**Aim and findings**
Lingard et al. (2005)	Ethnographic approach (observations & interviews); communication researcher	Communication – related to checklist assessment	*Aim:* To assess team members' reception and use of a communication checklist in the operating room, as well as the perceived functions of the list during team discussions. *Findings:* The authors describe variable workflow patterns as the main barrier to "checklist use", while the checklist appeared to promote information exchange and team cohesion.
Propp, et al. (2010)	Grounded theory (interviews); communication researcher	Communication – related to critical nurse-team processes and practices	*Aim*: To examine and identify the specific nurse–team communication practices critical to team work and patient outcome. *Findings*: The authors identify two processes critical to team and practices; "ensuring quality decisions" (such as seeking and processing information) and "promoting team synergy" (such as coordinating, mentoring and empowering team members).
Patel, et al. (2000)	Ethnographic approach (observations & interviews); health care researcher	Training or performance – related to team interaction and individual expertise	*Aim*: To characterize the nature of team interaction and its relation to education and training *Findings*: The authors describe how the particular patient problem determines which individual expertise, among team members, is required. This distributed responsibility allows the team to process large amounts of patient information, thereby reducing the load on the single individual. The authors suggest that the distributed responsibility should be addressed in education and training.
Catchpole, et al. (2008)	Direct observations w/scoring and measurement; health care researcher	Training or performance – related to patient outcome	*Aim*: To analyze the effects of surgical, anesthetic, and nursing teamwork skills on technical outcomes in the OR. *Findings*: The authors find that improved team skills, in terms of situation awareness and leadership and

			management, are associated with speedier completion of operations. In addition, subteams within the OR, such as surgeons, anesthetists, and nurses, show different patterns and levels of team skills.
Smith, et al. (2003)	Qualitative approach (non-participant observations & semi-structured interviews); health care researcher	Experience or learning – related to what constitutes an expert	*Aim*: To explore the way different types of knowledge are learned and used in anaesthetic practice *Findings*: The authors find that experts have mastered technical skills but are also able to understand the dynamic and uncertain condition of the anaesthetized patient and respond to changes in it. The expert is able to reconcile and interpret many sources of knowledge – clinical, social, electronic, and experiential – and formal theoretical learning.
Friedman & Bernell (2006)	Semi-structured interviews; health care researcher	Experience or learning – related to team level tacit knowledge, experience, and performance	*Aim*: To explore how team level tacit knowledge and related characteristics influence team performance. *Findings*: The unscripted and unspoken knowledge and understanding, where one knows what to do even when no words are exchanged, is described as essential to the team's ability to anticipate others' actions and handle a crisis. The importance of keeping teams together to forge a history of shared experiences is emphasized.
Greenhalgh, et al. (2008)	Qualitative approach (observations, interviews); health care researcher	Experience or learning – related to tacit and explicit aspects	*Aim*: To explore how teams balance encoded knowledge (measures/scores) with tacit knowledge (intuitive judgment, clinical experience and expertise), during clinical decision making. *Findings*: The authors show how clinicians sometimes supplement, adjust or dismiss the scores and instead rely on clinical experience and intuition in judging the patients likely rehabilitation, change in therapy and/or need for support in discharge.

Table 1: Identified articles and aspects that support the knowledge dimension

ARTICLES RELATED TO THE SYSTEM DIMENSION			
Author(s), year	**Methodology and 1st researcher**	**Aspects addressed**	**Aim and findings**
Catchpole, et al. (2007)	Qualitative observations w/classification & performance indicators; health care researcher	Management or organization – related to latent failures in successful operations	*Aim*: To develop a model for assessing team skills and to identify system factors that can be improved. *Findings*: The authors find that complications during operations resulted from an escalation of smaller problems, caused by the context in which the operation took place. System problems included unnecessary distractions (telephones, pagers), difficulties with equipment (availability and function), unexpected problems with patient anatomy, and conflicting demands on team members from other parts of the hospital system.
Mackintosh (2009)	Qualitative approach (structured non-participant observations); health care researcher	Management or organization – related to team supporting structures	*Aim*: To explain and contrast mechanisms supporting team situation awareness. *Findings*: The author demonstrates the importance of whiteboards, handovers, and coordinator in facilitating work and the overall team situation awareness.
Christian, et al. (2006)	Qualitative observations and analysis, using coding; medical researcher	Complex or context – related to system features affecting patient safety	*Aim*: To better understand the operating room as a system and to identify system features that influence patient safety. *Findings*: The authors emphasize how team performance and patient safety are negatively affected by high workload and multiple competing tasks.
Leach, et al. (2009)	Qualitative approach (direct observations, semi-structured interviews); health care researcher, w/nursing background	Complex or context – related to external influences on OR-team	*Aim*: To describe the nature of surgical teams and their performance, and overall to contribute to a broader knowledge of high-reliability teams in health care settings. *Findings*: The authors describe external factors influencing team performance, including schedule of OR-rooms, room size appropriate for the procedure, shortage of staff, equipment and supply, and the availability of up-to-date policies and procedures.

Table 2: Identified articles and aspects that support the system dimension

Tables 1 and 2 provide the particular dimensions and aspects of a scientific model for exploring safe work practices (illustrated in Figure 1). By developing the model, I have incorporated recent calls in health research literature for developing models that address the dynamics of team work and integrate existing findings (Baker, et al., 2006; Healey, et al., 2004, 2006b; Infante, 2006; Manser, 2009). In terms of the practical applications of the model, Figure 1 is intended to serve as a general and inductive frame of reference during fieldwork ("a frame for exploration"), implying that the model needs to be continuously adjusted to accommodate particular aspects of phenomena that emerge during fieldwork ("inductive model adjustment").

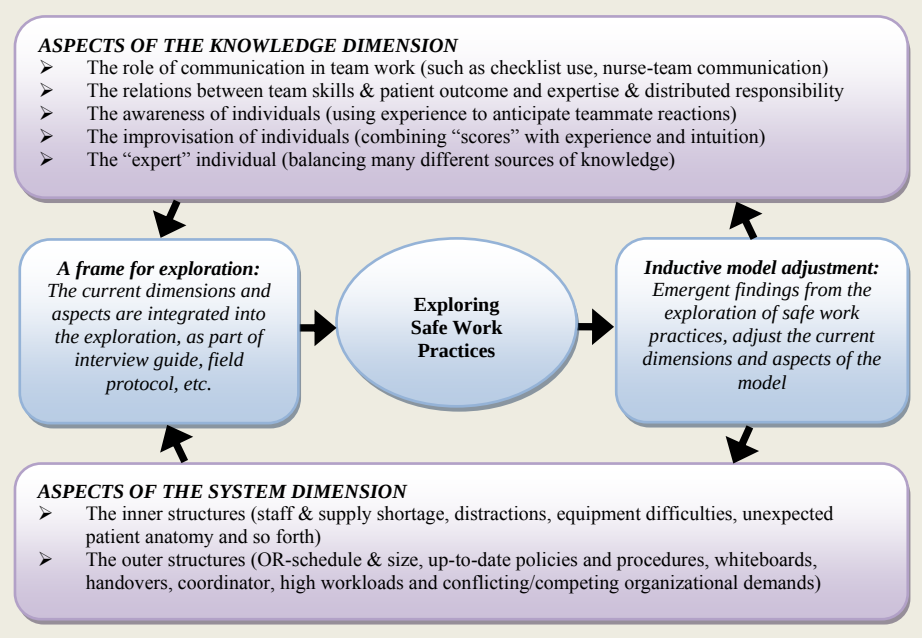

Figure 1: A scientific model for exploring safe work practices, based on the literature review

The health research literature I reviewed did not provide a clear distinction between the identified aspects of the system dimension shown in Figure 1. For this reason, I define the "outer structures" in the model to include all aspects that exist outside of the operating room anchored to structures and organization, whereas I understand the "inner structures" as all team-related aspects that exist within the operating room.

When it comes to understanding the figurative and literal center of the model that the dimensions are oriented towards exploring, I focus on the basic components of the

concept safe work practices – safety and practice – and how they connect. In health research literature on quality and safety, the connection between safety and practice appears in the quality- and *safety-driven* focus on identifying and training the skills of the individual (in performing a task) or the team (in working together), in order to improve cognitive, affective, and performance outcomes of individuals and teams in *clinical and surgical practice* (Healey, et al., 2006a, 2004; Salas, et al., 2009; Salas, et al., 2008). Another connection between practice and safety appears in the concept of "Community of Practice" (CoP). A CoP is defined as a network of people who share information, build on existing knowledge, and develop expertise to solve problems for a common purpose in an ongoing way (Huckson & Davies, 2007; Wenger, et al., 2002). An example of a common CoP purpose is the pursuit of evidence to support current practices (Huckson & Davies, 2007), including the improvement of skills, outcomes and consequently safety. Thus, safe work practices, or a safe outcome of work practices for the individual, the team and the patient, can be understood as the product of the particular organizational or CoP initiated measures aimed at improving the skills, knowledge and/or expertise levels of individuals and teams in clinical and surgical practice.

4. Validating the scientific model using an ethnographic study

We conducted a study in a surgical unit of a Norwegian regional general hospital, with the main unit of analysis being the surgical teams typically consisting of 1-2 operators (surgeons), 2 operating room nurses, 1-2 nurse anesthetists, and 1 anesthetist physician. The fieldwork consisted of approximately 60 hours of observations of surgical procedures (typically variants of fractures and revisions), 15 semi-structured interviews, and 35 informal conversations over a period of four months in 2010. In terms of methodology, we applied an ethnographic approach (Marcus, 1998; Smith, et al., 2003), grounded in a combination of detailed non-participant observations, conversations and a series of semi-structured interviews. Two observers, a principal researcher and a co-researcher, were present during the observations, to ensure comparison and internal validity. Specifically, the co-observer, an experienced nurse anesthetist, provided the in-depth 'technical' understanding of the operating room (such as procedures and terminology), while the principal researcher, experienced in conducting safety-oriented projects within health care and civil aviation, provided the safety perspectives to the fieldwork. This safety researcher/health worker duality strengthened validity. The goal of the study was to explore the nature of the knowledge and system aspects affecting interdisciplinary surgical operations and safe work practices and, by means of this exploration, also to validate the proposed literature-based scientific model. For more comprehensive descriptions of the study methodology, see Høyland et al. (2011a, 2011b).

4.1 Practicing validation in the field

In validating the scientific model, I applied the techniques of analytical triangulation (Denzin, 1978; Patton, 1990) and also respondent validation (Mays & Pope, 2000) during the ethnographic study. Specifically, analytical triangulation relies on multiple researchers to conduct observations and analyze findings (Denzin, 1978; Patton, 1990). In this study, two researchers conducted observations in tandem, and subsequently reviewed, compared and analyzed not only the transcribed field notes but also the interviews and conversational data material. In respondent validation, the respondent is confronted with the researcher's account of what he/she observed, to determine the level of correspondence between the two interpretations. The respondent's understanding is then incorporated into the study findings (Mays & Pope, 2000). In this study, this occurred through both conversations and interviews. Overall, these two validation techniques helped me determine the strength of the dimensions/aspects of the proposed scientific model (Cook & Campbell, 1979; Lincoln & Guba, 1985), i.e. whether the model is able to capture what the researcher sees and hears through observations, conversations and interviews.

In the analytical triangulation, a research protocol was constructed that incorporated the two dimensions and aspects of the model as a basic checklist of "what to look for" during the observations. Applied at the fieldwork, my co-observer and I regularly compared the emergent findings we identified against the checklist in the protocol. We found that the emergent empirical findings fitted the two main dimensions of the model. Specifically, whether the findings compared directly to or adjusted the existing aspects and dimensions of the model, or whether the findings made new additions to the dimensions (as aspects), the findings were supportive of the existing dimensions. During a later triangulation analysis, comparison between the two observers and a third researcher revealed variations in each researcher's findings that can be attributed to the uniqueness of each individual's interpretations. However, the constant was the main findings that showed only minor variations between researchers. The main findings were also supportive of the existing dimensions of the model.

In the respondent validation, we replicated the dimensions and aspects of the model as sections in a semi-structured interview guide. For example, the main theme of "system" consisted of the sub-themes "inner structures" and "outer structures" with associated questions related to the aspects identified in table 2. The two observers found that respondents were able to identify with the dimensions and questions, even though we made minor adjustments for clarification purposes. The open nature of the semi-structured interview guide also enabled us to introduce and compare our observational findings and understandings against the respondents' interpretation of

our findings. Overall, the respondent validation process helped to verify, adjust or dismiss not only the existing dimensions and aspects of the model, but also the new understandings and emergent findings from the empirical study.

In conclusion, the analytical triangulation among researchers as well as the respondent validation of the interview guide and the emergent findings support and add validity to the dimensions of knowledge and system in the original scientific model (Figure 1).

4.2 Exploring the safe work practices in surgical operations

In order to validate the scientific model, I present findings from an ethnographic study conducted in a surgical unit of a regional hospital in Norway. For comparison purposes, the findings are organized according to the two main dimensions of the model.

4.2.1 The system dimension

One pattern in the data material can be seen in the different ways combinations of system factors in the inner and outer structures interact. This is illustrated in the following observations, taken from two separate operations: (Operation A) "Early in this operation, the operator claims that the 2nd operating room nurse should have more equipment prepared for this type of surgery. The nurse leaves the room to obtain what he asks for. This event is followed by a call from a colleague on his mobile phone. The operator decides to address it properly, even though the conversation does not concern the operation. At a later stage of the procedure, the main operator continues to request equipment. The equipment is not directly available in the operating room, and is also hard to obtain right away. The operator seeks alternative solutions. He also becomes increasingly annoyed at the "instrument service", particularly when the 1st operating room nurse demonstrates trouble in obtaining the requested instruments. The annoyance seems to escalate with the nurse's displays of inexperience, when finally he decides to walk over and get the instruments himself." (Operation B) "During preparations for this operation, the main operator enters the operating room and a discussion is triggered between the operator and the 1st operating room nurse (inexperienced) concerning the type of operation scheduled. The 1st operating room nurse has been informed of mobilization and testing in anesthesia, but the main operator claims that an open surgery is scheduled. The nurse seems annoyed, seeing how she now needs to obtain equipment unplanned for. Meanwhile, the main operator is seen walking restlessly across the floor. The discussion continues regarding which patient was assigned to the operating room (of two patients that arrived simultaneously). The 2nd operating room nurse (experienced) claims that they (the

team) only followed the plan. She is supported by the nurse anesthetist, who explains to the main operator that she selected the patient from the list in Orbit. The main operator replies by placing the responsibility for the two patients on another individual, suggesting that he did not make the priorities." In sum, various system factors appear to disrupt the normal flow of the operational activities the team conducts in the operating room.

However, other system factors appear to compensate for the described negative influences on team behavior above, thus demonstrating a second pattern in the data. This is seen in the following conversation with a nurse anesthetist, during an operation: 'The nurse anesthetist approaches the researchers, and begins to discuss the current organization of the surgical unit (where operating and anesthesia personnel have belonged to the same section for ten years). He believes that this has improved the individual confidence levels among nurse anesthetists. Specifically, it is easier to know what type of equipment is required, compared to the uncertainty characteristic of the earlier separate organization where they moved around a lot more. This uncertainty often resulted in bringing either too much or too little equipment to the operating room. He sees the benefit of getting to know the specific routines, operations, and equipment at one section – this improves the ability to use the right equipment at the right time.' The conversation with the nurse anesthetist continues later in the operation, bringing more insight into what the results has been of the organization into one section: 'One of the benefits, he explains, is a higher specialization within a specific area, such as the particular type of surgery being carried out at the section. The conversation is later continued with the nurse, who describes that he has never witnessed any medication errors, and claims that the "system" contributes to this. This includes, he specifies, the good staffing. Even under less ideal circumstance, such as weekends where only one nurse anesthetist is present, the operations almost always turn out fine. He believes the fact that one operator always is on duty, contributes to this outcome.'

The above impression, of compensating system factors, is strengthened by interviews with a team member and a manager at the section. The manager discusses the current staffing: "At the section we work day and evenings, and then we are on call duty at home from half past midnight. And those that are on this call duty, if they are called in during the night… given that they are required to have eleven hours of rest before they come back… [this] will of course have consequences the next day when they should have begun the morning shift… if they cannot be there it will have consequences for when we can begin with the next day's patients. So it was decided that [our section] should have a staffing level that would ensure that even if [those on call duty at home] had been called in, we would be sufficiently staffed to startup

operations in all operating rooms." The researcher adds that he sees this as an operational buffer: "*That* is a buffer, yes. Of course if [those on call duty] had not been in [during the night], and gone home at the usual time, they will return to work at the normal hour in the morning, and then we have a buffer of two operating room nurses and one nurse anesthetist… every day. This is a very, very, very good way of organizing [that also] gives us a buffer in terms of sickness… and it strengthens the working environment of course, [since] several people share the work load." Later in the interview the manager addresses the availability of operating rooms: "So the section has in recent years increased its capacity from three operating rooms in the day and one in the evening… to guaranteed startup of operations every day, plus four operating rooms Monday, Wednesday, Friday, and two operating rooms Tuesday evening. So we have had quite a large increase in capacity in recent years". When asked about the outer structures and work load at the section, an anesthetist physician comments: "I have to say, we rarely lack anything on the equipment and personnel front… I rarely experience that my work load becomes too high. [The exceptions] are sickness or unexpected things… some days can be very busy, but this is not a problem." The researcher comments that it is quite a positive impression he provides. "Yes, but this is not the case at [other sections]… there is supposed to be flexibility [at our section], it is a buffer that enables us to increase our capacity suddenly, since the need fluctuates… it is [organized in this way] because we need emergency readiness 24/7."

4.2.2 The knowledge dimension

Three specific patterns relate to the knowledge dimension of Figure 1. The first pattern in the data is displayed through the different ways sudden and unexpected situations are handled by the individual team members. The following observation from an operation is illustrative: "During the preparations for this particular operation, a patient associated with difficult vein access arrives. It is discovered that the patient has received no pain relieving medicaments (the "unforeseen" event). The nurse anesthetist tries to insert a needle into the patient's arm, with no luck. The same occurs when the anesthetist physician attempts to enter the patient's foot. Reflecting out loud on this information, including the difficult vein access of the patient type, the physician explains that it is better to proceed inside the operating room, to gain more space and limit circulation of people. Once in, the physician attempts a few more times to enter the veins of the patient's arm, but realizes that his efforts are in vain. He then considers going into the groin, but rejects this alternative. Upon enquiry later, he explains that this decision was made based on the unclean state of the groin area, and also the fact that the placement of a cannula here would become uncomfortable to the patient for her scheduled stay at the hospital over several days. Following this

reflection, the anesthetist physician decides to enter the neck, and uses ultrasound equipment to locate an area with potentially good veins. He then repeatedly attempts to insert needles and locate a vein in the identified area, with no success. The physician takes a step back and seems to calm down and reflect on the current situation, before he decides to make a new attempt in another area of the neck. In preparation of this task, he asks that the table is tipped over more so that the head points down (to improve circulation). Finally, he hits a vein."

A second pattern is the ability and variety individuals demonstrate in handling multiple sources of information before reaching a particular decision, observed in the following operations: (Operation A) "Before starting the procedure in this particular operation, the main operator gathers his team for a briefing by a monitor displaying the patient's x-rays. During the briefing, the main operator describes the patient's condition and history, and he also explains the specific steps involved in the coming procedure (pointing and illustrating via the x-rays). He seems to be seeking approval of the procedure. At a later time in the procedure, the main operator is confronted with a choice between method A and method B. He again gathers his team by the x-rays, and receives inputs from his team and from what he sees in the pictures. The operator then makes his overall decision. Several x-rays are later taken, to confirm the decision." (Operation B) "During this observation, focus is on the Safe Surgery Check List that is initiated during the handover of the patient between the ward nurse and nurse anesthetist. Normally, the patient's name tag is scanned to confirm the identity of the patient, but in this case the patient (a child) has a name tag with no barcode. The father is asked to read and confirm the name and date of birth of his child. The nurse anesthetist takes down the information in the list, manually. The father is also enquired to confirm the type of operation scheduled, and both the child and the father are asked whether the operating area has been marked. This is confirmed by the child, the father and the ward nurse. The father is then asked whether the child has any allergies, and whether the digestion of food and liquids has followed normal precautionary rules. The ward nurse is enquired whether the patient has received the pre-medication dosage. She confirms, and patient is moved along."

A third pattern in the data is seen from the variety of ways awareness or anticipation of future events is expressed, as seen in these observations: (Operation A) "During this operation, the position of the patient is checked several times and at different stages, by the anesthetist nurses, the operating room nurses and the main operator. Specifically, during preparations belts and blankets are removed from the operating bench. This, we are explained, is to prevent pressure injury when a patient remains in a given position for a prolonged period. When the main operator arrives in the operating room, he also reviews and confirms the patient's position. During the

procedure, the operating room nurse massages and also lifts the arms and legs of the patient, in order to improve circulation and prevent damage. Near the end of the procedure, the operating room nurse looks under the table to check the patient's position and to make sure no injury has occurred during the operation." (Operation B) "At the beginning of this operation, the nurse anesthetist and the operating room nurse discuss the most ideal position for the right arm and hand of the patient. The initiator of the discussion appears to be the operating room nurse, who reflects on several different approaches to the situation. They continue their discussion until both agree on the proper positioning. Further observations of the operating room nurse, during the operation, reveal his foresight in terms of organizing and preparing the particular instrument ahead of the main operator's requests (not regulated by procedure). He also delivers the instrument swiftly and correctly every time. The nurse anesthetist later explains that his general strategy is to think ahead to what can go wrong. This prevents one from being surprised, he says."

4.3 Comparing the empirical findings to the scientific model

Given the aim of validating the scientific model in this article, I further describe how the findings from the ethnographic study compare to the existing findings identified through the literature review (cf. the tables 1 & 2 and Figure 1).

In terms of the system dimension, Catchpole et al. (2007) attempt to identify system factors that can be improved, and find that complications during operations resulted from an escalation of smaller problems, caused by the context in which the operation took place. This includes unnecessary distractions (telephones, pagers), difficulties with equipment (availability and function), unexpected problems with patient anatomy, and conflicting demands on team members from other parts of the hospital system. Supportive of these findings, we found that inner structural factors, such as distracting mobile phones and difficulty with equipment cause disruptions in the operational flow. In addition, we found that the mood of team members plays a role (typically an agitated surgeon interacting with an inexperienced operating room nurse). However, in terms of outer structural factors, our findings do not support the relevance of conflicting demands on team members from others parts of the hospital, as shown in Catchpole et al. (2007). Instead, relevant outers system factors in our findings include (1) changes in the operating schedules, (2) lack of planning in preparing operational equipment, (3) less ideal ad-hoc team compositions, and (4) delays in equipment arrivals. In another study, by Leach et al. (2009), the focus is on understanding the nature of surgical teams and their performance. While Leach et al. (2009) describe problems associated with operating schedules, the availability to operating rooms, and a shortage of staff, equipment and supply, we found that the

availability of operating rooms, staffing and equipment represent the main strengths of the surgical unit and the teams we studied. This is in itself an important finding, suggesting that the conditions for conducting operations might differ significantly from one setting to another, and so also the ability to ensure safe work practices. Besides this reversed "similarity" between our findings and the literature-based scientific model, we also found a relevant system factor to be the operating personnel's exposure to one surgical unit exclusively boosting both the specialized knowledge and confidence levels, and also the ability to become proficient with the equipment and use the right equipment at the right time.

In terms of the knowledge dimension, a comparison can be made to the understanding of an expert within anesthesia, as described by Smith et al. (2003). In the authors' view, an expert is characterized by the ability to simultaneously balance many different sources of knowledge, such as past learning (formal and experienced) and an understanding of the dynamic situation (patient and equipment signals). In our study, this balancing is exemplified in the ability an anesthetist physician demonstrated in handling an unforeseen situation (patient had not received pain relieving medicaments) by building on the existing information he had (a challenging patient type and the difficulties he experienced in entering the veins), by being aware of the current situation and equipment (he decided to move into a less crowded room, and used ultrasound equipment to locate an area of good veins), and also by considering the future consequences of his actions (he rejected insertion into the groin due to the unclean state of this area, with risk of infection). In other words, the team member's handling of the unforeseen through an awareness of existing information, current and past experiences and situational possibilities becomes an expression of what constitutes an expert. This supports the finding by Smith el al. (2003). In another study, Patel et al. (2000) identify the ability a primary care team demonstrates in distributing responsibility for a particular patient problem according to expertise. This ability allows the team to process large amounts of patient information, thereby reducing the load on the single individual. The finding by Patel et al. (2000) can be compared to observations we made of how different individuals demonstrate different ways of handling multiple sources of information, before reaching a particular decision. For example, a surgeon handled information from multiple sources during his decision making process (x-rays, his colleagues, and his own experience), but the information was clearly defined within his "zone of responsibility" (how to proceed with the operation and procedure). In another situation, the nurse anesthetist handled information from a number of sources (patient, father, ward nurse), as part of her defined role and responsibility in preparing the patient for the operation. In both examples, it is clear that information is processed based on a natural zone of responsibility. Many sources of information can thus be combined within each zone

that, when put together, enables the team to process large amounts of information. The finding supports the understanding of distributed responsibility, in Patel et al. (2000). A final comparison can be made to what Friedman & Bernell (2006) identifies as an ability to anticipate another team member's actions due to shared experiences. While our data do not bring additional clarity to the understanding of "shared experience", we find that the ability to anticipate future events (such as positioning of patient and possible pressure injuries to patient) is comprised of both explicit knowledge, such as procedural elements (related to injury prevention, equipment preparation, and patient positioning), and tacit knowledge (healthy skepticism, handling of instruments, and continuous checking on patient). Combined, the findings in Friedman & Bernell (2006) and in this study demonstrate different aspects of the team member's ability to anticipate future events.

To conclude, the findings from the ethnographic study compare to and support the existing findings from the literature review, and thus also the scientific model. At the same time, the findings provide new insights into how aspects of the system and knowledge dimensions relate to safe work practices in an interdisciplinary OR setting.

5. Revisiting the proposed scientific model

In Figure 2, the findings from the ethnographic study have been incorporated in the scientific model for exploring safe work practices. The new findings fit the existing dimensions of system and knowledge in the model, and also support the existing findings identified from the literature review as shown in figure 1. The fit of data to the model (validity) suggests that the model has application value in future ethnographic research within medical/team settings. In terms of potential weaknesses of the model, the broad and inclusive dimensions could be viewed as a concern. However, findings in the ethnographic study suggest the broadness should be viewed as an advantage. Specifically, the scientific model was integrated into the field protocol as a basic checklist of what to look for during the fieldwork – an approach that reduced the feeling of being overwhelmed by the many field impressions, particularly in the initial phase of the fieldwork. In addition, the checklist provided a basic foundation for organizing the findings at an early stage of the fieldwork. Above all, the broad nature of the model helped us approach the field relatively open-minded to anything related to system and knowledge, in contrast to the alternative – a highly specific model focusing exclusively on communication, expertise or similar – a situation more likely to narrow the researcher's disposition and vision.

Taken together, the empirical findings represented in the dimensions and aspects of Figure 1 and 2 create a scientific framework of what may constitute safe work practices in interdisciplinary OR settings. Specifically, from what I observed during

the surgical operations the focus on a minimum of errors and complications represented an important aspect of the individual's and team's work philosophy, supportive of patient safety. As the emergent findings in Figure 2 suggest, the work philosophy was achieved through the continuous efforts by the particular individual and team in drawing on and combining various aspects of both explicit and tacit knowledge. The emergent findings also suggest that safe work practices are the product of the individual's and team's continuous efforts in adjusting to and compensating for vulnerabilities and disruptions during operation, as well as the ability the individual and team demonstrates in utilizing the resources that are accessible. From this understanding, safe work practices can be defined as the dynamic and continuous effort by each individual team member and the overall team in combining and drawing on the explicit and tacit knowledge repertoires, in order to achieve a successful operation with minimal errors and complications. Safe work practices can also be viewed as the overall organization's ability to maintain inner and outer (system) conditions that are strong enough to support the individual's and team's ability to combine and draw on their knowledge repertoires.

6. Discussion and implications for future research

Health research literature on quality and safety suggests that one of the key challenges lies in the currently limited understanding of the particular nature of team work within the health care context (Baker, et al., 2006; Lyndon, 2006). It follows that a necessary question to rise is whether the nature of team-related aspects and challenges *are* relevant to address, compared to the technical expertise of the individual health care professional (Schön, 1991). From a theoretical point of view, the answer is "yes", based on the fact that evidence-based medicine has been unable to account for the type of individual, social, cultural and organizational "mechanisms" that enable us to apply text book (explicit) knowledge in an appropriate way within a particular organization (Duguid, 2005). From an empirical point of view, the answer is also "yes", based on the observations from the ethnographic study described in this paper. Specifically, the findings suggest that safe work practices are the product of the individual's and team's ability to draw on and combine explicit and tacit knowledge, which again is a product of the particular inner and outer system conditions of the organization. In sum, the theoretical and empirical views suggest that not only team-related aspects and challenges are relevant to address in future research, but also the specific system conditions that affect the individual and team level.

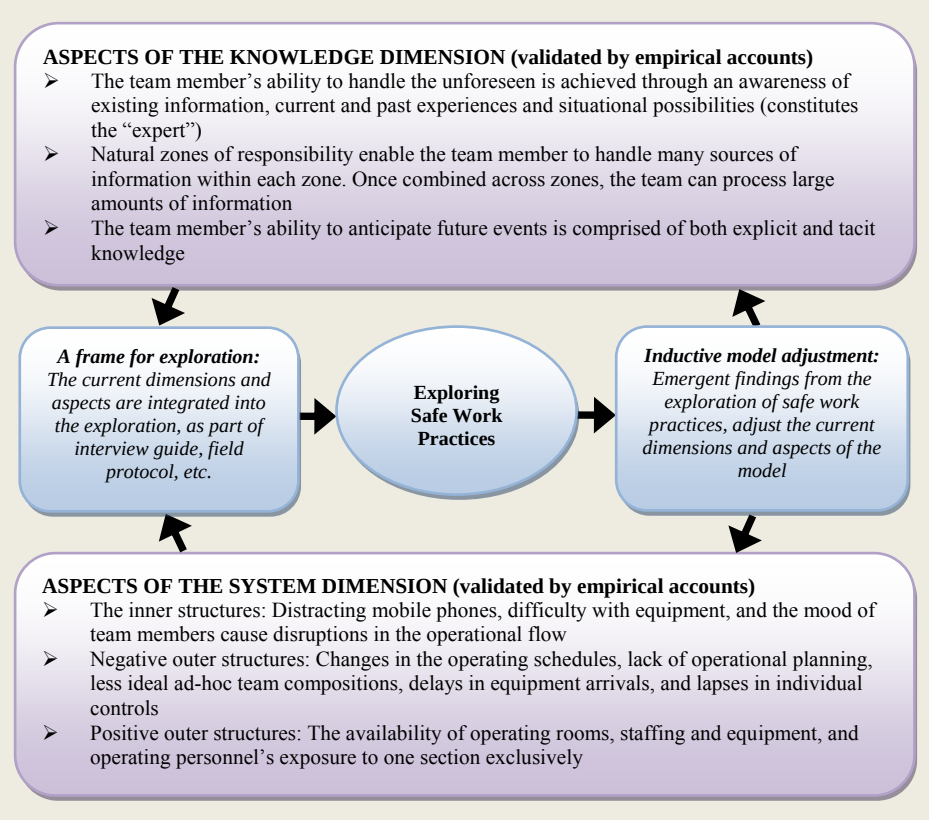

Figure 2: The scientific model revisited, incorporating findings from an ethnographic study

The review conducted in this article suggests that whereas different team related aspects have been addressed in health research literature on quality and safety, the identified aspects have yet to be systemized into scientifically sound models for exploring team dynamics, as called for by Duguid (2005), Henry (2006) and Infante (2006). To illustrate this, none of the recent articles in table 2 referred to the original findings of the earlier articles, despite how they share a general focus on aspects outside of the team, such as system, latent, or external factors influencing team work, and also in terms of how they share similar specific focuses, such as conflicting demands/competing tasks (Catchpole, et al., 2007; Christian, et al., 2006) or equipment/supply (Catchpole, et al., 2007; Leach, et al., 2009). Similarly, in table 1, despite being thematically related in terms of addressing communication aspects (Lingard, 2005; Propp, et al., 2010) and also specifically related in terms of addressing the experience aspects of tacit knowledge (Friedman & Bernell, 2006;

Greenhalgh, et al., 2008; Smith, et al., 2003), none of the recent articles referred to findings in the earlier articles. I believe this lack of continuation and systemizing of various findings represents a relevant challenge within health research literature on quality and safety. In this article, the challenge was approached by developing a scientific model to incorporate and compare existing and new findings. The implication for future research is that although qualitative research and findings have a unique nature, often specific to the context and organization that are being studied, it is possible to systemize findings into scientifically-based models, emphasizing the above calls.

7. Conclusion

In this paper, I found that reflections within health research literature on quality and safety have been oriented towards:

- Identifying team related aspects, ranging from specific findings on and understandings of communication, training or performance and experience or learning to management or organization and complex or context.

- Establishing specialized models that build on the findings of the particular study, such as models for addressing team skills and system factors (Catchpole, et al., 2007), or models for understanding the mechanisms supporting team situation awareness (Mackintosh, 2009).

I also found that reflections have yet to be properly extended beyond the frames of the specialized models and understandings above, to strengthen:

- In-depth explorations that investigate and identify team specific behaviors, patterns, skills and so forth. unique to the particular health care organization and/or health care context (Baker, et al., 2006; Flin & Mitchell, 2009; Lyndon, 2006; Reader, 2006).

- Follow-up initiatives that build on and integrate existing explorations and findings, to develop scientifically grounded models for understanding interdisciplinary team dynamics (Duguid, 2005; Henry, 2006; Infante, 2006; Manser, 2009).

The scientific model proposed in this article, represents one attempt at elevating efforts from specialized to more general applicable models for exploring team dynamics that also integrate existing explorations and findings. It follows that an

implication for future studies and theoretical developments is to address the identified gaps or weaknesses in current team-related research within health care.

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References

Baker, D. P., Day, R., & Salas, E. (2006). Teamwork as an essential component of high-reliability organizations. *Health Services Research, 41*, 1576-1598.

Barach, P., & Johnson, J. K. (2006). Understanding the complexity of redesigning care around the clinical microsystem. *Quality & Safety in Health Care, 15*, I10-I16.

Benson, A. D., Kramer, B. A., Boehler, M., et al. (2010). Robot-assisted laparoscopic skills development: Formal versus informal training. *Journal of Endourology, 24*, 1351-1355.

Braude, H. D. (2009). Clinical intuition versus statistics: Different modes of tacit knowledge in clinical epidemiology and evidence-based medicine. *Theoretical Medicine and Bioethics, 30*, 181-198.

Burke, C.S., Salas, E., Wilson-Donnelly, K., et al. (2004). How to turn a team of experts into an expert medical team: Guidance from the aviation and military communities. *Quality & Safety in Health Care, 13*, i96-i104.

Catchpole, K., Mishra, A., Handa, A., et al. (2008). Teamwork and error in the operating room - Analysis of skills and roles. *Annals of Surgery, 247*, 699-706.

Catchpole, K. R., Giddings, A. E. B., Wilkinson, M., et al. (2007). Improving patient safety by identifying latent failures in successful operations. *Surgery, 142*, 102-110.

Catchpole, K. R., Giddings, A. E. B., De Leval, M. R., et al. (2006). Identification of systems failures in successful paediatric cardiac surgery. *Ergonomics, 49*, 567-588.

Christian, C. K., Gustafson, M. L., Roth, E. M., et al. (2006). A prospective study of patient safety in the operating room. *Surgery, 139*, 159-173.

Cook, T. D., & Campbell, D. T. (1979). *Quasi-Experimentation: Design and Analysis for Field Settings*. Chicago: Rand McNally.

Denzin, N. K. (1978). *Sociological Methods*. New York: McGraw-Hill.

Donaldson, M. S., & Mohr, J. J. (2000). Improvement and innovation in health care microsystems, A technical report for the Institute of Medicine Committee on the Quality of Health Care in America. Princeton: Robert Wood Johnson Foundation.

Duguid, P. (2005). "The art of knowing": Social and tacit dimensions of knowledge and the limits of the community of practice. *The Information Society, 21*, 109-118.

Flin, R., & Mitchell, L. (Eds.). (2009). *Safer Surgery - Analysing Behaviour in the Operating Theatre*. Farnham, UK: Ashgate Publishing Limited.

Friedman, L. H., & Bernell, S. L. (2006). The importance of team level tacit knowledge and related characteristics of high-performing health care teams. *Health Care Management Review, 31*, 223-230.

Gaba, D. M. (2000). Structural and organizational issues in patient safety: A comparison of health care to other high-hazard industries. *California Management Review, 43*, 83-102.

Greenhalgh, J., Flynn, R., Long, A. F., et al. (2008). Tacit and encoded knowledge in the use of standardised outcome measures in multidisciplinary team decision making: A case study of in-patient neurorehabilitation. *Social Science & Medicine, 67*, 183-194.

Grober, E. D., Roberts, M., Shin, E. J., et al. (2010). Intraoperative assessment of technical skills on live patients using economy of hand motion: Establishing learning curves of surgical competence. *American Journal of Surgery, 199*, 81-85.

Hales, B., Terblanche, M., Fowler, R., et al. (2008). Development of medical checklists for improved quality of patient care. *International Journal for Quality in Health Care, 20*, 22-30.

Harris, K. T., Treanor, C. M., & Salisbury, M. L. (2006). Improving patient safety with team coordination: Challenges and strategies of implementation. *Association of Women's Health, Obstetric, and Neonatal Nurses, 35*, 557-566.

Haynes, R. B. (2002). What kind of evidence is it that evidence-based medicine advocates want health care providers and consumers to pay attention to? *Biomed Central Health Services Research, 2*.

Healey, A. N., Undre, S., Sedvalis, N., et al. (2006a). The complexity of measuring interprofessional teamwork in the operating theatre. *Journal of Interprofessional Care, 20*, 485-495.

Healey, A. N., Undre, S., & Vincent, C. A. (2004). Developing observational measures of performance in surgical teams. *Quality & Safety in Health Care, 13*, i33-i40.

Healey, A. N., Undre, S., & Vincent, C. A. (2006b). Defining the technical skills of teamwork in surgery. *Quality & Safety in Health Care, 15*, 231-234.

Henry, S. G. (2006). Recognizing tacit knowledge in medical epistemology. *Theoretical Medicine and Bioethics, 27*, 187-213.

Huckson, S., & Davies, J. (2007). Closing evidence to practice gaps in emergency care: The Australian experience. *Academic Emergency Medicine, 14*, 1058-1063.

Høyland, S., Aase, K., & Hollund, J. G. (2011a). Exploring varieties of knowledge in safe work practices - An ethnographic study of surgical teams. *Patient Safety in Surgery, 5*, 21.

Høyland, S., Aase, K., & Hollund, J. G. (2011b). Understanding system factors in relation to safe work practices - An ethnographic study of surgical teams. *Safety Science Monitor, 12*, Article 5.

Infante, C. (2006). Bridging the ‘‘system’s’’ gap between interprofessional care and patient safety: Sociological insights. *Journal of Interprofessional Care, 20*, 517-525.

Leach, L. S., Myrtle, R. C., Weaver, F. A., et al. (2009). Assessing the performance of surgical teams. *Health Care Management Review, 34*, 29-41.

Lee, S. L. (2010). The extended surgical time-out: does it improve quality and prevent wrong-site surgery? *The Permanente Journal, 14*, 19-23.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic Inquiry*. Newbury Park, CA: Sage Publications.

Lingard, L., Espin, S., Rubin, B., et al. (2005). Getting teams to talk: Development and pilot implementation of a checklist to promote interprofessional communication in the OR. *Quality & Safety in Health Care, 14*, 340-346.

Lyndon, A. (2006). Communication and teamwork in patient care: How much can we learn from aviation? *Journal of Obstetric Gynecologic and Neonatal Nursing, 35*, 538-546.

Mackintosh, N., Berridge, E-J., & Freeth, D. (2009). Supporting structures for team situation awareness and decision making: Insights from four delivery suites. *Journal of Evaluation in Clinical Practice, 15*, 46-54.

Manser, T. (2009). Teamwork and patient safety in dynamic domains of healthcare: A review of the literature. *Acta Anaesthesiological Scandinavia, 53*, 143-151.

Marcus, G. (1998). *Ethnography Through Tick & Thin*. Princeton, NJ: Princeton University Press.

Mays, N., & Pope, C. (2000). Qualitative research in health care. Assessing quality in qualitative research. *BMJ 320*, 50-52.

Mohr, J. (2000). Forming, operating, and improving microsystems of care. Center for the Evaluative Clinical Sciences, Dartmouth College, Hanover.

Mohr, J. J., Barach, P., Cravero, J. P., et al. (2003). Microsystems in health care - Microsystems in health care: Part 6, Designing patient safety into the microsystem. *The Joint Commission Journal on Quality Improvement, 29*, 8.

Mohr, J. J., Batalden, P., Barach, P. (2004). Integrating patient safety into the clinical microsystem. *Quality & Safety in Health Care, 13*, ii34-ii38.

Morey, J. C., Simon, R., Jay, G. D., et al. (2002). Error reduction and performance improvement in the emergency department through formal teamwork training: Evaluation results of the MedTeams project. *Health Services Research, 37*, 1553-1581.

Patel, V. L., Cytryn, K. N., Shortliffe, E. H., et al. (2000). The collaborative health care team: The role of individual and group expertise. *Teaching and Learning in Medicine, 12*, 117-132.

Patton, M. (1990). *Qualitative Evaluation and Research Methods*. Newbury Park, CA: Sage Publications.

Polyani, M. (1966). *The Tacit Dimension*. London: RKP.

Propp, K. M., Apker, J., Zabava Ford, W. S., et al. (2010). Meeting the complex needs of the health care team: Identification of nurse-team communication practices perceived to enhance patient outcomes. *Qualitative Health Research, 20*, 15-28.

Quinn, J. B. (1992). *The Intelligent Enterprise*. New York: Free Press.

Reader, T., Flin, R., Lauche, K., et al. (2006). Non-technical skills in the intensive care unit. *British Journal of Anaesthesia, 96*, 551-559.

Riley, R., & Manias, E. (2009). Gatekeeping practices of nurses in operating rooms. *Social Science & Medicine, 69*, 215-222.

Riley, W. (2009). High reliability and implications for nursing leaders. *Journal of Nursing Management, 17*, 238-246.

Salas, E., Almeida, S. A., Salisbury, M., et al. (2009). What are the critical success factors for team training in health care? *Joint Commission Journal on Quality and Patient Safety, 35*, 398-405.

Salas, E., DiazGranados, D., Klein, C., et al. (2008). Does team training improve team performance? A meta-analysis. *Human Factors, 50*, 903-933.

Schön, D. A. (1991). *The Reflective Practitioner: How Professionals Think in Action* (2nd ed). Aldershot, UK: Ashgate.

Smith, A. F., Goodwin, D., Mort, M., et al. (2003). Expertise in practice: An ethnographic study exploring acquisition and use of knowledge in anaesthesia. *British Journal of Anaesthesia, 91*, 319-328.

Smith, A. F., Pope, C., Goodwin, D., et al. (2006). What defines expertise in regional anaesthesia? An observational analysis of practice. *British Journal of Anaesthesia, 97*, 401-407.

Thornton, T. (2006). Tacit knowledge as the unifying factor in evidence based medicine and clinical judgement. *Philosophy, Ethics, and Humanities in Medicine, 1*, E2.

Wenger, E., McDermott, R., & Snyder, W. M. (2002). *Cultivating Communities of Practice*. Boston: Harvard Business School Press.

Wilson, K. A., Burke, C. S., Priest, H. A., et al. (2005). Promoting health care safety through training high reliability teams. *Quality and Safety in Health Care, 14*, 303-309.

Yin, R. K. (2009). *Case Study Research: Design and Methods (4th ed)*. CA: Sage Publications.

Appendices

Appendix I: The field research protocol

Appendix II: The semi-structured interview guide

The field research protocol – "a sandwich list for the field"

Overall methodology

- We attempt to mirror/build on the methodology by Andrew F. Smith and colleagues (published between 2003–2008), which includes:
  - An ethnographic approach based on detailed observations and a series of in-depth semi-structured interviews.

Practical methodology during observations

- We build on specific elements in the methodology by Smith and colleagues, including:
  - a systematic specification of each operation (numbered, type, participants, emergent themes, and so forth);
  - both a main observer and co-observer are present, to ensure the possibility of researcher comparison and internal validity;
  - the observers transcribe their field notes and thoughts individually, aimed at identifying emergent themes (including conflicting themes and the need to elaborate on themes);
  - following the individual transcriptions, the observers compare the emergent themes identified individually to improve the understandings;
  - we do not use data clinics, understood as a session where the operating team reads the transcripts and clarifies technical aspects, because of the co-observer's operating room experience and (technical) insights – strengthened by the respondent validation in the next bullet point;
  - we apply a high degree of respondent validation during the in-depth interviews and conversations to improve emergent themes, technical understandings, and so forth.

Practical methodology during the semi-structured interviews

- We combine elements in Smith and colleagues with our own approaches that, as a whole, creates an anchor to existing findings and also provides dynamic adjustments to the field:
  - Questions in the interview guide are derived from findings in literature, related to the knowledge and system dimensions (our approach);
  - As the fieldwork progresses, questions in the interview guide are adjusted according to observations and identified emergent themes (Smith and colleagues' approach);

- The outcome of the interviews provides insight into which themes and aspects we should observe further, and also whether the guide is working or needs to be adjusted;
- The timing of the interviews is governed by our sense that the observations have matured sufficiently (our approach).

A summary of the observational steps:

1. *Specification of operation number/type/participants/etc.*
2. *Individual transcription and identification of emergent themes*
3. *Comparison between main observer and co-observer of emergent themes, aimed at improving understandings of the particular theme*
4. *Respondent validation via interviews and conversations*

A summary of the interview steps:

1. *The interview guide and questions are shaped by existing findings in literature.*
2. *The interview guide is adjusted according to our findings in the field (during observations).*
3. *The outcome of the interview informs us of themes or aspects in need of further exploration during our observations.*
4. *The outcome of the interview, in terms of imprecision, informs us of whether the guide needs to be adjusted.*
5. *The timing of the interviews is adjusted according to observational maturity.*

A practical list of aspects to be mindful of during the fieldwork:

- Aspects of knowledge, gathered from various literature (Patel et al., 2000; Lingard et al., 2005; Friedman & Bernell, 2006; Greenhalgh et al., 2008; Propp et al., 2010):
  - Does the patient's problem determine the expertise/the person who addresses the problem? (so called "distributed responsibility")
  - Use of a checklist (use of the list vs. work load/pressure)
  - The nurse's ability to strengthen the team (inform/communicate/create trust)
  - Balancing of tacit vs. explicit knowledge (intuition/experience/implicit understanding vs. technical knowledge/"outcome scores")
  - **Generally**, the idea is to map nontechnical aspects, related to knowledge, that can influence the ability to create and maintain safe work practices in a team (that is, to view experience, intuition, etc. [tacit

knowledge] in light of communication, decision making, error solving, planning, resource management, team conflicts, awareness).

- Aspects of the system, gathered from various literature (Christian et al., 2006; Catchpole et al., 2007; Mackintosh, 2009; Leach et al., 2009):
  - The inner structures (unexpected patient anatomy, weaknesses or defects in equipment, interruptions [mobile phones], lack of material or people/roles)
  - The outer structures (size of operating room vs. type of procedure, significance of whiteboards, coordinator and information transfer, up to date procedures and policies, high workload and conflicting/competing demands from other parts of the hospital)
  - A relevant issue in connection with inner structures: the interplay between humans and machines (signals/interpretation and handling of signals)
  - **Generally**, the idea is to map aspects of the system that can affect the ability to create and maintain safe work practices.

The semi-structured interview guide, structured according to the knowledge and system themes

Clarification of the methodology

The interview guide is semi-structured in the sense that the particular question is intended to trigger the respondent's reflection process; that is, the respondent will interpret and steer the interview towards relevant aspects and explanations. The questions are anchored to health research literature, primarily empirical/original publications, to ensure the possibility of comparison during later analysis.

The study background

Recent health research literature on quality and safety describes the need for in-depth explorations of the interdisciplinary team dynamics. We are particularly interested in understanding how the attention to safety is expressed through team practices, in terms of the increasing emphasis on "tacit knowledge" (for example, intuition, experience-based knowledge, unspoken knowledge) as well as aspects related to patient, environment, task, organization, and so forth (the "system").

The respondent's background

Gender:
Age:
Education/profession:
Current position:
Experience (type/years):

Theme I – Knowledge

Questions 1–8 deal with acquisition and use of knowledge/skills, based on thematic elements in Smith, Goodwin et al., 2003; Smith, Mort, et al., 2003; Smith et al., 2005; Smith et al., 2006; and Pope et al., 2003:

1. To what extent **have you** developed and benefited from personal techniques during teamwork? In other words, to what extent do you apply experiences that lie outside of the "textbook"? Can you recall a (recent) case illustrative of this?

2. To what extent do you perceive that **other team members** have developed and benefited from personal techniques during teamwork? Can you recall a (recent) case illustrative of this?

3. How **do you react** to problems that occur during an operation? Do you handle it on your own, do you inform other team members, or do your leave the responsibility to others? Can you recall a (recent) case illustrative of this?

4. How do you perceive that **other team members** react to problems that occur during an operation/anesthesia? Can you recall a (recent) case illustrative of this?

5. Have you encountered problems during administering of anesthesia? In what ways? What caused this and how was it handled by the team?

6. In cases where **problems** occurring during an operation are **critical to the patient**, how do you and your team members react to this? Can you recall a (recent) case illustrative of this?

7. Do you feel that you are encouraged to pursue **formal and informal training** and development of skills that are important to your everyday practices? In what ways, and what obstacles do you see?

8. **Do others share your view** on whether one is encouraged to pursue formal and informal training and development of skills that are important to one's everyday practices?

Questions 9–13 concern nontechnical aspects related to knowledge, based on studies of surgeons' nontechnical skills and related to the ANTS + NOTECHS classification systems (cf. Flin & Maran, 2004; Yule et al., 2006; Mishra et al., 2008; Mishra et al., 2009; and Mackintosh et al., 2009):

9. Who among the team members assumes **leadership and makes the decisions** during an operation? Does this affect task priorities, and do conflicts arise? Can you recall a (recent) case illustrative of this?

10. How does the team **communicate** during an operation? Does communication follow a hierarchical structure, and are inputs/feedback considered? Does communication occur spontaneously/randomly, or is this decided in advance through assignment of tasks and responsibilities? Examples/illustrations?

11. Are you or your team members **mentally prepared** for problems that can occur during an operation? Is there a focus on anticipating a given problem in an early phase of the operation ("situation awareness"), followed by information sharing and handling of the problem as a team? Can you recall cases illustrative of mental preparedness and awareness?

12. How do you and your team members handle **stress and fatigue**? Can you recall examples illustrative of this?

The above questions are adjusted according to emergent themes identified during preliminary analysis of observations (cf. Smith, Mort et al., 2003), and also based on insights gained through interviews.

Theme II – The System

Questions 1–5 focus on the "system" that surrounds operations, spanning both the inner and outer structures (cf. Christian et al., 2006; Catchpole et al., 2006; Catchpole et al., 2007; Catchpole et al., 2008; Leach et al., 2009; Mackintosh, 2009; Mishra et al., 2008; and McCulloch et al., 2009):

1. How do **the inner structures**, like patient anatomy, weaknesses or defects in equipment, interruptions (mobile phones, people entering and leaving, etc.) and lack of material (blood) and people (specializations), affect the ability of you and your team to complete the operation in the best possible way? Can you recall examples/cases illustrative of the way you and your team handled these challenges?

2. How do **the outer structures**, like high workload and conflicting or competing demands from other parts of the hospital, affect the ability of you and your team to complete an operation in the best possible way? Can you recall examples/cases illustrative of the way you and your team handled these challenges?

The next three questions elaborate on the first two:

3. How do **technical equipment and devices** affect the ability of you and your team to complete a given operation in the best possible way? Have you experienced problems related to the configuration of equipment, in the use of equipment, or in the organizing of equipment (equipment not plugged in, etc.)? Can you recall examples/cases illustrative of the way you and your team handled these challenges?

4. What **significance does the patient have**, in terms of the ability of you and your team to complete a given operation in the best possible way? Have you experienced a situation in which planning and completion of an operation was complicated by certain patient aspects (like anatomical abnormalities)? Can you recall examples/cases illustrative of the way you and your team handled these challenges?

5. Have your experienced a situation in which **local interruptions** (mobile phones, people entering and leaving, etc.) affected the ability of you and your team to complete an operation in the best possible way? Can you recall examples/cases illustrative of the way you and your team handled these challenges?

The above questions are adjusted according to emergent themes identified during preliminary analysis of observations (cf. Smith, Mort, et al., 2003), and also based on insights gained through interviews.

Improving the understandings of observations

List elements below:

KNOWLEDGE:

SYSTEM: