From The Department of Clinical Science, Intervention and Technology (CLINTEC), Division of Orthopedics and Biotechnology
Karolinska Institutet, Stockholm, Sweden

FIELD STUDIES IN SIMULATION-BASED TEAM TRAINING

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Cover page illustrating training viewed from the control room. Photo: Rickard Kilström
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Field studies in simulation-based team training

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“If you want to go fast, go alone. If you want to go far, go together”

ABSTRACT

Simulation technology enables students and staff to learn and practice teamwork skills without risk to patients. Simulation was introduced in Swedish healthcare less than 30 years ago but other industries e.g. aviation had already since long used this technology in order to practice technical and teamwork skills. Therefore healthcare could learn from aviation and others regarding simulation-based teamwork training.
Since simulators are expensive and training is demanding regarding faculty, simulation-based education has rightly been questioned. Is simulation-based teamwork training really a reasonable priority in public healthcare?

The common theme in this thesis is to add evidence on how simulation-based teamwork training can be money well spent. The studies included are all performed during regular simulation-based teamwork courses. This approach enabled inclusion of experienced staff as well as students from a number of settings, but also posed limitations, as the courses could not be fully standardized.

The first two studies assessed situational motivation as a prerequisite for learning in simulation-based education and beyond. Intrinsic motivation is known to enhance deep learning and retention of knowledge and increased significantly with training both in a cohort of medical students and in inter-professional training for professional operating room staff. The five participating operating room professions all increased situational motivation alike. Analysis of interviews conducted after training could provide information regarding how participants were motivated and how knowledge and skills from the simulation can be transferred to the workplace. Interestingly staff perceived barriers to communication in the operating room and the training was mentioned as a possibility to enhance safety and improve communication.

The third study specifically investigated participants´ and educators´ perceptions of low and higher fidelity simulators. Interestingly few differences regarding participants´ individual reactions to training with low tech compared to a more sophisticated manikin was found. On the other hand, low tech was more demanding for the facilitators. It seems like skillful instruction can compensate for lower technology. The finding led to the fourth study where the facilitators´ actions were assessed in more detail in a qualitative multidisciplinary multicenter study on in-scenario instruction. A significant variation regarding methods used and features of instruction such as tempo and timing was found and instruction had an impact on participants´ actions and interaction.

Altogether, the studies underpin the possibilities to use simulators for learning and practicing teamwork skills not only in undergraduate training, but also in inter-professional training for experienced staff. Results suggest that design and facilitation of the training are essential to optimize benefit from simulation technology.

LIST OF SCIENTIFIC PAPERS

I. **Cecilia Escher**, Johan Creutzfeldt, Lisbet Meurling, Leif Hedman, Ann Kjellin, Li Felländer-Tsai. **Medical students´ situational motivation to participate in simulation based team training is predicted by attitudes to patient safety.** BMC Medical Education 2017 vol 10;17:37

II. **Cecilia Escher**, Hans Rystedt, Johan Creutzfeldt, Lisbet Meurling, Leif Hedman, Li Felländer-Tsai, Ann Kjellin. **Breaking professional barriers – a mixed-methods study on simulation-based teamwork training for OR teams.** Manuscript

III. Lisbet Meurling, Leif Hedman, Karl-Johan Lidefelt, **Cecilia Escher**, Li Felländer-Tsai, Carl-Johan Wallin. **Comparison of high-and low equipment fidelity during paediatric simulation team training: a case control study.** BMC Medical Education 2014 vol 18;14:221

IV. **Cecilia Escher**, Hans Rystedt, Johan Creutzfeldt, Lisbet Meurling, Sofia Nyström, Johanna Dahlberg, Samuel Edelbring, Torben Nordahl Amorøe, Håkan Hult, Li Felländer-Tsai, Madeleine Abrandt-Dahlgren. **Method matters: impact of in-scenario instruction on simulation-based teamwork training.** Advances in Simulation 2017 vol 28;2:25

CONTENTS

LIST OF ABBREVIATIONS

AHA	American Heart Association
AM	Amotivation
ANOVA	Analysis of Variance
ANTS	Anaesthetists´ Non-Technical Skills
APSQ	Attitudes to Patient Safety Questionnaire
ATEAMS	All Team Member Scale
CAMST	Center for Advanced Medical Simulation and Training
CONSORT	Consolidated Standards of Reporting Trials
CRM	Crew Resource Management
ER	External Regulation
IM	Intrinsic Motivation
IR	Identified Regulation
KI	Karolinska Institutet
NOTSS	Non-Technical Skills for Surgeons
OR	Operating room
PCQ	Post Course Questionnaire
SAQ	Safety Attitudes Questionnaire
SBAR	Situation Background Assessment Recommendation
SBTT	Simulation-Based Teamwork Training
SD	Standard Deviation
SDT	Self-determination Theory
SE	Self-efficacy
SEm	Standard error of the mean
SIMS	Situational Motivation Scale
SPLINTS	Scrub Practitioners´ List of Intra-operative Non-Technical Skills
STROBE	Strengthening the Reporting of Observational Studies in Epidemiology
WHO	World Health Organization

1 FOREWORD

Graduating medical school in the early 1990s, I felt knowledgeable but not well prepared to care for patients, even less to be an efficient leader or follower in an emergency team. During the first years of postgraduate training I had many excellent tutors, most of whom I did not even notice as educators at the time. There were all these skilled professionals who taught me teamwork skills not knowing the vocabulary existed and long before I first came across the notion non-technical skills.

There was the surgeon who always made short sum ups involving the entire team during trauma resuscitation. We all noticed how smoothly we could work when he did so even though none of us knew it had a name and was part of a set of teamwork skills. There was also this nurse anesthetist who helped me back on track just by looking me in the eyes supporting me by telling, “we can handle this” while resuscitation a newborn. I could feel the stress vanish and we started our ABCDE together with the pediatric staff.

When I first came across scenario training, it immediately struck me as a great tool to prepare healthcare students and staff for teamwork by allowing us to practice in a learning environment. The efficient behaviors I had recognized had names and could be taught. The belief that non-technical skills are important and can be trained is and has been a great inspiration for me as a physician, educator and researcher.

Photo: Rickard Kilström

2 INTRODUCTION

2.1 PATIENT SAFETY

2.1.1 Non-technical skills and patient safety

Non-technical skills as a construct emanates from psychology. Flin defines non-technical skills as: "*the cognitive, social and personal resource skills that complement technical skills, and contribute to safe and efficient task performance*" [1]. The concept has been used to explain skills required for good performance especially in high-risk industries.

The same set of non-technical skills have been found important for performance in many areas such as aviation, marine, military, oil and gas as well as in medicine [2]. According to Flin et al. the main categories of non-technical skills are: Situation awareness, decision-making, communication, teamworking, leadership, managing stress and coping with fatigue. Larson et al. by using ethnographic methodology found almost the same non-technical skill categories when experienced nurse anesthetists were asked about expert anesthetist behavior [3]. Larson's empirical finding strengthened the relevance of the non-technical skills categories in the context of Swedish perioperative care.

Patient care, especially in hospitals, is inter-professional and multidisciplinary and demand highly technically skilled staff, but also teams proficient in non-technical skills to ensure good patient outcome [1, 2, 4]. As emphasized by Reason [5] front line staff´s non-technical skills are not only causing incidents and harm, good non-technical skills regularly help staff to prevent adverse events caused by organizational, human and technical flaws.

There is a number of studies linking non-technical skills to patient safety [6-8]. Some are based upon investigations of adverse events [9-11], others on staff´s perception [12] or observed quality of teamwork versus mortality and morbidity data [8, 13, 14].

2.1.2 Resilience in healthcare

Resilience is a concept describing a system or team dealing with uncertainty and unexpected events in a flexible way by noticing and acting timely protecting patients from harm[15, 16]. A study on pediatric cardiac surgery displayed that the number of errors during a procedure did not correlate to the outcome of the patient because the team could cope so well and avoid the errors to cause harm [17]. This ability to adapt to the situation thereby working efficiently in a number of circumstances is called resilience and is discussed in safety management in a number of high stakes areas. Resilience relies on the assumption that everything cannot and should not be standardized in order to work safely, as not all situations can be foreseen [15, 16]. Resilience is argued to be of particular importance in healthcare were adverse events are far more common due to larger complexity and more unknown factors compared to other industries [18].

2.1.3 The Crew Resource Management concept

In order to improve task performance for frontline staff, the Crew Resource Management (CRM) concept for non-technical skills training was launched in aviation in the 1980s as a response to a number of accidents [19]. The concept has been developed ever since and regular simulation-based team training founded on CRM principles is since many years routine in civil aviation. To identify and use all available resources in terms of information, equipment and people is the overarching aim of CRM [20]. CRM training courses have been developed for many industries including offshore, shipping, railways and healthcare.

Non-technical skills training for expert performance in healthcare were first adopted in anesthesia [21-23] and training modules based on “aviation-style” CRM for anesthesiologists started in the end of the 1980s. Since then the importance of non-technical skills for safe healthcare has been acknowledged worldwide. From the 1990s the applicability of non-technical skills gained acceptance in a wide range of healthcare settings and is now taught and trained at undergraduate as well as postgraduate levels in most acute care settings [20].

In healthcare CRM is taught in simulation-based and classroom-based team training courses. Some of the classroom-based concepts have been commercialized and some are non-profit. There is a number of classroom-based teaching concepts that have been shown to improve patient safety [20, 24-27] and even return of investment by lowering frequencies of adverse events [28]. E-learning and serious games have also been used successfully for non-technical skills teaching [29, 30].

2.1.4 Patient safety challenges in surgery

2.1.4.1 Operating rooms

The development of surgical interventions is rapid and operating rooms therefore are increasingly complex in terms of staff and equipment. As advanced procedures are performed on patients with severe comorbidities, anesthetic management is also increasingly complex and demands more sophisticated monitoring and specialized staff compared to 20 years ago. The introduction of laparoscopic and especially robotic surgery has increased the physical distance between staff [31]. Altogether, the technical as well as the non-technical challenges [32] are increasing in terms of team communication and collaboration, hence flaws in collaboration is a major cause of harm to patients [11, 33].

Noise levels in OR´s have been discussed as another communication challenge and in a study by Kurmann et al.[34] noise levels positively correlated to surgical site infections although the mechanisms remain unexplained. Keller et al.[35] found that surgeons with less experience were more affected by noise peaks. The fact that noise levels are often far above the recommendations for concentrated work, with up to 80 dB generated by suction devises alone remains, however the effects on communication and patient safety is not fully understood.

2.1.4.2 Checklists for safe surgery

The use of checklists as cognitive aids is common in other high-risk industries and increasingly gaining acceptance in healthcare [36]. The WHO checklist for safe surgery [37] was developed as a measure to lower the relatively high levels of morbidity and mortality for patients undergoing surgery worldwide. For staff working in operating rooms the checklist is not only a tool to remember all the items that needs to be checked, it is also proven effective to open up communication and improve teamwork [38]. The WHO checklist has been adopted and proven valuable also for other healthcare settings than operating rooms [39, 40].

2.1.4.3 The surgical care pathway

Patient handovers have been pointed out as especially prone to error resulting in harm to patients due to loss of information and insufficient situation awareness [41, 42]. Interventions to standardize handovers aiming at reducing loss of information [43], for example the Situation Background Assessment Recommendation (SBAR) format has been proposed to structure communication [44] (chapter 10). Checklists for different clinical hand-over settings have been found valuable [45]. Introduction of a combination of checklists covering the entire care pathway for surgical patients can reduce postoperative complications [46].

Manser et al. have broadened the understanding of handovers by showing that the number of items that are correctly handed over will not necessarily correspond to a correct understanding of the situation [41, 47, 48]. Checklists are valuable but all that matters for a general understanding of the situation does not fit into checkboxes. Successful handovers are team events including an open discussion and possibilities to ask questions.

The American Heart Association (AHA) published a scientific statement “Patient safety in the cardiac OR - Human factors and teamwork” in 2013 [20, 49]. The scope was broad covering for example safety attitudes, checklists, design of OR´s, routines for handovers and team training. The AHA recommendations reaching the highest level of evidence (Class 1 level B) include: the use of preoperative checklists and briefings, team training including all OR staff and formalized handovers. The authors conclude that although there are few randomized controlled studies on human factors in cardiac OR´s not all that matters can be studied in a randomized design, there is enough evidence for these recommendations [49]. Regarding future studies, AHA recommendations include studies of the “best product” for teamwork training.

Communication over the screen between anesthesia and the sterile field.
Photo Annika E. Karlsson

2.1.5 The barrier in the OR

An operation timeline consists of a number of phases and the staff involved is most active and perform critical tasks in a sequence. Therefore all professionals need to concentrate especially at some points and can work in a more automated fashion during other parts of the procedure. Hull et al. have showed how staff experience stress and teamwork during operations [50], i.e. assistant surgeons experience most stress during and in the end of procedures and circulating nurses in the preoperative phase. In a study from Japan [51] not only patient factors but also the role in the OR was related to perceptions of stress among circulating and scrub nurses. The importance of being able to switch from an automated mode to a more effortful state is described for surgeons [52]. The ability to switch to an effortful mode of working is likely to be of importance to some extent also for other professions as all have their critical tasks to perform during a procedure.

Studies have displayed communication challenges in operating rooms related to professional hierarchies [53, 54]. Makary et al. displayed inferior perception of quality of collaboration and communication by nursing staff compared to physicians in operating rooms and similar results have been found in other contexts such as delivery [55] and intensive care units [56, 57]. Team training was found to correlate to improved perceptions of collaboration by nurses and nurse assistants [56].

In a cardiothoracic OR setting industrial engineers have studied flow disruption from a design perspective. This approach to improved safety has been fruitful in other industries, as disruptions of flow are known as precursors of errors. Researchers categorized 1000 disruptions during 10 procedures to learn more and establish a framework [58]. The professional groups displayed very different patterns with a majority of disruptions to flow relating to design, i.e. lack of space and poor equipment positioning for the perfusionist and the anesthesia team. The nursing team was prone to interruptions. The most common type of disruption to flow for surgeons was communication flaws.

2.1.6 Patient safety culture and safety attitudes

The safety culture concept was launched after the Chernobyl nuclear power plant disaster in the 1980s. Safety climate is a related concept mirroring the local safety culture at a particular workplace. Vincent defines safety climate as *"staff´s perception, attitudes and beliefs about risk and safety"* [59].

Safety climate in a workplace can be estimated using questionnaires on individual attitudes to patient safety. There are validated instruments for measuring patient safety attitudes among both medical students [60] and staff [61, 62] in different settings. Interventions such as patient safety education have been shown to increase patient safety attitudes among students [30, 63, 64].

Regarding patient safety attitudes among healthcare staff, studies have displayed positive correlations to patient safety measures such as adverse events and risk adjusted morbidity and mortality [65-67] at both hospital and department levels. Interventions including SBTT can increase patient safety attitudes among staff [56, 68, 69]. Some studies have also found a correlation between staff´s wellbeing and patient safety [70, 71]. The correlations are complex [70] but accelerating numbers of staff suffering from burnout, high staff turnover and shortage of nurses makes this area of research highly relevant.

2.2 EDUCATION AND TRAINING

2.2.1 Teaching and learning safe practice in healthcare

To become a highly skilled and knowledgeable professional in healthcare today, is quite a demanding and costly endeavor [72]. To stay up-to date and efficient providing safe care in the increasingly complex and rapidly evolving work environment of today's hospitals, is even more demanding [73].

The Flexner report from 1900 transformed medical education particularly in the US and led to integration of medical education and research at universities. At the time the Flexner report contributed to great improvements, but since then society and healthcare has evolved. Ever since, science has been promoted to an increasing extent and the practical, educational and ethical aspects of medical education have been held back [74].

In an effort to replace the Flexner report, the Lancet commission has published an overview of healthcare educational recommendations for the 2000 century [72]. The effort was international aiming to provide guidance for managers, politicians and educators. The recommendations focused on the inter-dependence between countries, looking at health care workers as one international pool, as well as the inter-dependence between the health care professions in order to provide safe and efficient care. Recommendations include breaking up professional silos, inter-professional educational efforts and education in teamwork skills for all [72].

To help universities and health care providers around the world to provide patient safety education, the WHO in 2011 launched a curriculum guide for patient safety education [73]. The guide has been embraced by the healthcare professions international organizations. The aim of the program is to provide guidance for educators in healthcare as well as students, including ready to use teaching material. Two of the 11 topics for teaching are, "why applying human factors is important for patient safety" and "being an effective team player".

2.2.2 Teamwork training in healthcare

Classroom-based teamwork training can have positive effects on participants and patient safety. Combinations of seminars and systems improvements have also been successful [74, 75] in reducing glitches. Classroom-based team training and organizational improvements such as new routines and checklists have in studies showed positive results on patient safety [76].

A resent meta-analysis by Huges et al. [77] aimed at answering the question: how effective is teamwork training in healthcare? One hundred twenty-nine publications were included, all measuring effects on at least two out of Kirkpatrick's four levels; reaction, learning, behavior and results. The analysis displayed effects of teamwork training in healthcare superior to results from other industries. A theoretical model displaying downstream effects from the learning level (Kirkpatrick 2) to behavior, transfer, organization and patient care levels (Kirkpatrick 3 and 4) was supported by the results. According to the model effects on organizations and patient care are likely also by interventions only monitoring effects at the learning level. The strengths of the review by Huges et al. [77] were the large amount of studies included and the extensive analysis. However, the variety of different team training interventions, including classroom-based education and a wide range of health care simulations, makes practical application of the results more difficult as the review did not aim to answer questions regarding the potential of each type of intervention separately.

2.2.3 Simulation-based teamwork training (SBTT) interventions

In healthcare the CRM concept and inter-professional simulation-based teamwork training has gained acceptance and is established in many healthcare systems due to studies supporting positive correlations to patient safety [78, 79].

Some studies show positive effects of SBTT on the reaction level, on learning and staff´s attitudes [56, 80, 81]. A number have also managed to show transfer of learning from SBTT to improved patient safety [82-84].

In some studies combinations of interventions have been used in order to enhance patient safety. Riley et al. performed a study on perinatal care in 14 US hospitals. The intervention included; introduction of evidence-based care bundles for a number of specific situations, didactic and simulation-based teamwork training for all staff and follow up regarding adherence to the intervention [85]. The intervention involved 1800 staff, covered 7 years and 342 000 births. The results included a 14 % reduction of adverse events. The authors concluded that a combination of interventions is more effective than a single one.

Simulation-based team training. Photo: Rickard Kilström

2.2.4 Learning in SBTT

Adult learning theory as outlined by Biggs and Tang [86] emphasizes constructive alignment as a foundation to design for learning. Constructive alignment in short is a structure in which learning activities and assessments are constructed to align with the intended learning outcome. Before the end of the process there is a reflection, assessment, of how well the learners achieved the pre-set learning outcome. The purpose of the structure is to help participants to engage in their learning and to make sure the learning objectives are addressed. This model corresponds well to the recommended structure for skills training [1]. The vocabulary is slightly different, so is the starting point in the process. Training needs analysis is the first step in which the procedure, or activity that will be trained is chosen and carefully analyzed and training objectives are outlined, this in turn is the foundation for the training activity/ simulation. After the training an assessment of how well the trainees met the pre-set training goals is performed that can guide adjustments of the training [87].

The concept “deliberate practice” for expert performance regarding skills in activities such as sports, music and surgery has put focus on structured training rather than talent to reach the highest level of expertise [88]. Effective training has to include long hours of practice at the right level of difficulty. Specific feedback targeted at predefined learning goals and willingness to practice are necessary prerequisites to reach expertise.

SBTT is commonly founded on theories on adult learning and concepts for skills training. Dieckmann [89] has outlined a widely used model of the parts that make up a simulation: Setting/ introduction were psychological fidelity is established, simulator briefing and demonstration of facilities, theory inputs where learning goals are clarified, scenario briefing containing case specific information, scenario, debriefing to ensure reflection in relation to learning goals and course ending with possibilities to discuss transfer of learning and outcome of the training. These parts make up an entity where the separate stages also represent different learning strategies.

2.2.5 Assessment of non-technical skills

In order to help clinicians assess and train non-technical skills in clinical settings and in SBTT, Fletcher et al. developed Anesthetists' Non-Technical Skills (ANTS), a behavioral marker system for anesthetists [90]. ANTS was followed by several non-technical behavior scales developed for different professionals such as Scrub Practitioners' List of Non-Technical Skills (SPLINTS) [91] and Non-Technical Skills for Surgeons (NOTSS) [92].

A program for assessment of all team members non-technical skills (ATEAMS) was developed at the Center for Advanced Medical Simulation and Training (CAMST) in Stockholm and published in 2009 [93]. The program has verbal anchors at 4 levels for each non-technical skills item and is used as a framework for training goals, and guidance for assessment of team behavior and feedback during the CAMST courses in this thesis. The aforementioned scales include similar items as non-technical skills instruments developed in aviation.

2.2.6 Inter-professional perspective

In his book on patient safety Charles Vincent points at the importance of inter-professional education to provide safer care. "*Enormous resources are rightly devoted to the training of healthcare professionals but almost all training takes place within disciplines. This is, to put it mildly, completely crazy, given that almost all the work happens in teams*" [59] (page 359).

Simulation has become an important opportunity for inter-professional under- and postgraduate education and enables a team-based, experiential learning activity [94]. For undergraduates one single episode can increase perception of inter-professional education among nursing and medical students [95].

Despite a wish to increase inter-professional training a review on team training for OR staff from 2017 [96] only found 10 studies that include more than 2 professions [97].

2.2.7 Motivation - a prerequisite for learning

Motivation is a powerful prerequisite for learning [86, 98] both on shorter and longer term. Self Determination Theory (SDT) [99] discusses the differences in motivation and engagement seen in relation to learning goals and engagement in tasks. Pursuing learning goals with a strong intrinsic learning content (i.e. personal growth, common good) is related to better wellbeing as the basic psychological needs autonomy, competence and relatedness are met to a large extent. Pursuing goals supported by extrinsic motivation (i.e. wealth and fame) is correlated to an increased risk of low self-esteem and excessive social comparison.

According to SDT [99] more than one type of motivation occur simultaneously but to different extents. To be intrinsically motivated means wanting to learn for learning's sake or performing a task out of the joy in the task itself. To be extrinsically motivated is wanting to learn for external rewards or for avoidance of negative effects.

Situational motivation is the "here and now "of motivation relating motivation or engagement to a specific task or learning experience. The different kinds of situational motivation in SDT can also be regarded as a continuum. The Situational Motivation Scale (SIMS) taps into four types of human motivation as described by self-determination theory [99, 100].

Intrinsic motivation captures participation in a task out of one's own will and interest, for its own sake. Internal regulation applies to tasks done because of a belief they will result in some sort of personal reward, the motivation coming "from within". The aforementioned types are also classified as autonomous. External regulation stimulates us to do tasks because somebody has told us to do so, the motivation coming from something/somebody else. Amotivation applies to situations when the aim and purpose of performing a task is not apparent. A review of self-determination and learning finds evidence for the relevance of self-determination theory for learning regarding several important aspects [98] both in school and university settings. Persistence was related to intrinsic motivation and identified regulation in a study on high school students. Autonomous motivation was related to better achievement, better retention of learning and greater depth of learning in university settings [101].

2.3 ASSESSMENT OF TRAINING

2.3.1 Self-efficacy

The construct self-efficacy has been used in psychology since the 1980s in a variety of settings. Bandura defines it as "*People´s judgments of their capabilities to organize and execute courses of actions acquired to attain designated types of performances"* [102]. Self-efficacy is always related to a specific situation and task. Actual performance regarding specific cognitive as well as motor skills have been found to correlate to self-efficacy beliefs regarding a wide range of specific tasks. Instruments for self-assessment of self-efficacy have been developed for different types of skills. Many factors are known to have an impact on self-efficacy regarding a task such as outcome expectations and task value to the individual. In studies on team training improved self-efficacy regarding performance of relevant tasks in relation to training have been displayed [56, 103]. A higher level of self-efficacy is correlated to willingness to pursue practicing a skill and to actual task performance and is therefore used in studies of simulation-based teamwork training.

2.3.2 Flow

Csikszentmihalyi has outlined the flow concept [104] defined as a state of concentration and joy in a task. The capacity to experience flow is even correlated to general quality of life and happiness. A climber can experience flow when climbing a difficult rock, a surgeon can experience flow when operating on a particularly demanding case. The flow experience is characterized by lost boundaries between task and self and a feeling of strength, capability, concentration and joy. The task at hand has to be enough demanding but not too challenging for a flow experience. In a study including Chinese students team working enhanced flow in more challenging tasks compared to working one by one [105]. A flow experience will make a person more willing to pursue an activity and is therefore relevant in experiential learning such as simulation.

2.3.3 Mental strain

Multitasking is a very relevant problem in modern society. As humans we all have limited working memory and split attention can increase the risk of human error [106, 107]. The multiple resource theory [108] set up a dimensional model to explain the various resource dimensions and impact on performance by split attention. In multiple resource theory the focus is demand, resource overlap and allocation policy. Mental workload theory focuses on demands. A simulation study has shown inferior performance of a newly acquired task in subjects experiencing high workload [109]. Mental strain can be estimated using the Borg CR 10 scale [110]. In an earlier study self-assessment of team leaders mental strain and flow were significantly higher compared to followers [111]. Too high mental strain might impair learning and willingness to participate in simulation as a participant or educator.

2.4 DESIGN FOR LEARNING IN SBTT

A number of studies on features of importance for design of successful SBTT have been published [112, 113]. Studies are based on a variety of theoretical foundations and practical conclusions to guide educators based on evidence is not easily obtained. This text will provide some examples.

A review on instructional design of simulation-based education by Cook et al. [112] included 289 studies on simulation for technical and non-technical skills training. The strongest correlation between instructional features and outcome (satisfaction, knowledge, skills and attitudes) were: **range of difficulty, repetitive practice, distributed practice, cognitive interactivity, multiple learning strategies, individualized learning, mastery learning,**

feedback, longer time, and clinical variation. The review was dominated by technical skills training but also included team training.

Satish and Streufert [114] have proposed a design for simulation to train decision making and information processing developed for military and aviation adjusted for medicine based on complexity theory. Salas and Burke [113] have commented on instructional features of importance for effectiveness of simulations including: **carefully crafted scenarios, assessment of performance** and **partnership** between educational/training experts and medical subject matters experts for successful design of training.

A recent review by Hughes et al. [77] found evidence for effects of team training on all Kirkpatrick levels. When analysing under which conditions team training was correlated to success one unexpected result of the review was that feedback was negatively correlated to outcome. This finding contradicts positive correlations between feedback and learning in the aforementioned review by Cook et al. and adult learning theory emphasizing **reflection** [86]. Adult learning theory further point at the importance of **building on previous experience**, **experiential learning** and **activities that make sense** to be successful [86, 115].

Dieckmann et al.[116] have described conceptual frames applicable for a deeper understanding of the social aspects of SBTT from a theoretical perspective building on concepts from sociology and psychology. The importance of creating a learning atmosphere were facilitators and participants meet on common ground is emphasised. Further, participants´ *"by in"* to the concept and willingness to act *"as-if"* the simulation was real, accepting lack of realism is highlighted. Participants and facilitators should, according to Dieckmann et al., look beyond realism and acknowledge aspects of non-realism of a simulation, such as the possibility to restart a scenario and slow down time, as possibilities for valuable learning. The frames clarified in the study can be used as guidance for further studies on best praxis of SBTT and for faculty development.

Simulations have to be put into context to enhance learning and achieve transfer of learning to clinical work. As described by Johnson [117], the **context** and the relation to reality provided by educators as well as **role-modeling** by educators are essential components that facilitators should be aware of to achieve efficient simulations.

Resent extension of the CONSORT and STROBE criteria to enhance reporting of simulation-based research [118] by Cheng et al. is a valuable contribution to enhance study design and possibilities for aggregation of results that is needed to broaden the knowledgebase regarding design of training.

2.4.1 The fidelity concept

The relevance of SBTT relies on transfer of learning from the simulated session to real healthcare situations. Students and staff have to buy into the concept and act as if the simulation was a real situation in order to benefit from the experiential learning [116, 119]. Simulated scenarios must make sense to participants and therefore manikins as well as equipment have to be “real enough” [113, 120]. The technical resemblance of the manikin to reality is called fidelity. Human patient simulators are classified as high or low fidelity referring to anatomic and physiologic resemblance to a human body.

The setting of the simulation is also classified in terms of fidelity where in situ simulation, that is simulation in the workplace for example emergency department, has been regarded as the highest fidelity [121]. A review by Paige et al. proposed a matrix to clarify the fidelity concept consisting of the dimensions physical, psychological and conceptual fidelity. The authors concluded that the literature is not uniform in the use of the fidelity concept [122].

In recent years the fidelity concept has been challenged [123]. An interview study on fiction and realism showed that participants in simulations have diverse opinions on features that enhance reality [124]. The same feature in a simulation can even be perceived as either enhancing realism or fiction. The perceived value of the training does not always relate to fidelity [123]. In recent work it has been argued that the fidelity concept should be abandoned as a number of studies have failed to find a strong correlation between simulator fidelity and perceived value of the simulation-based education and transfer of learning. To replace the fidelity concept Hamstra et al. suggest “*functional task alignment”* [125]. This construct emphasizes the realism of the simulation relative to the setting it is mimicking. Depending on the situation being simulated different items are important for a simulation to be applicable.

Facilitator close to the participants in inter-professional teamwork training for students.
Photo: Rickard Kilström

2.4.2 Facilitation in SBTT

Teaching in simulation-based teamwork training is a task quite different from medical education in more traditional settings. Participants as well as educators point at the importance of familiarity with the concept of SBTT to lead successful sessions [126-128].

In order to deliver simulation-based education with good quality a number of skills are required from the educator. Harden and Crosby published a guide outlining the 12 roles of a medical teacher [129], the roles relevant for simulation-based education were summarized as: Information provider, role model, facilitator, assessor, planner and resource developer. The efficient educator applies the different roles to the faces of a simulation session [128, 130]. Learning objectives in healthcare simulations can vary over a broad range, which demands different skillsets from the educator.

Work by Johnson displayed how simulations can be meaningful learning experiences if educators help participants by adding information from clinical work [117]. She also pointed at the importance of the educator as role model, especially for junior learners.

The debriefing, which is the part of the simulation when participants and educators reflect after a scenario, is commonly regarded of particularly importance for learning. There are a number of models published [128, 130-132] but regarding effectiveness there is no gold standard.

2.4.3 In-scenario instruction

Facilitators in healthcare simulations have to bridge the gap between the appearance of a patient simulator and the body of a sick patient. Human patient simulators can be highly sophisticated with features such as pupils that react to light, breathing sounds and exhaled carbon dioxide. However, some features are still very different from the body of a sick patient such as skin color and temperature, as well as findings of abdominal and neurological examinations.

This gap in bodily appearance has to be filled out by facilitators to enable assessment and decision-making by participants. In some texts this information is called cues [122]. Reality cues are bits of information necessary for understanding of the clinical case. Conceptual cues on the other hand are clues to help participants to reach the learning objectives of the session, for example help to clarify the steps of a procedure or algorithm. In order to create meaningful learning activities facilitators have to provide reality cues regarding bodily features that simulators do not display. The necessary amount of supplementary information is dependent on the fidelity of the simulator and the scenario that it is mimicking [119].

One possibility to deliver supplementary information is by an actor or member of faculty roleplaying during simulations, a so-called confederate. This practice, besides adding information, offers possibilities for roleplaying for example difficult behavior of a team member and tuning the level of stress in the scenario. Nestel et al. concludes that successful use of confederates in simulation demands scripted roles and educators with some acting skills [133, 134]. The use of confederates enables the use of SBTT for a broader set of learning objectives such as speaking up to a team member and informing a relative.

3 AIMS

The general aims were:

- firstly, to study aspects of participants´ reactions to simulation-based teamwork training in a number of settings and
- secondly, to investigate instructional and design features important for successful simulation-based teamwork training.

Paper 1: Third year medical students took part in a simulation-based teamwork training study during their surgical rotation. The hypotheses were:

1. Attitudes to patient safety are positively correlated to situational motivation to training.

2. Situational motivation in terms of intrinsic motivation and identified regulation increase after training.

Paper 2: Professional operating room staff participated in a simulation-based teamwork training study with a mixed methods design. The hypotheses of the quantitative part were:

1. Self-efficacy and situational motivation in terms of intrinsic motivation increase after training.

2. Staff from the OR professions react in a similar pattern regarding development of self-efficacy and situational motivation in relation to the training.

Analysis of qualitative data expands knowledge regarding design features of relevance for successful training and transfer of learning.

Paper 3: Professional pediatric emergency staff took part in a simulation-based teamwork training study using low and higher fidelity simulators. The hypotheses were:

1. Participants´ reactions to simulation-based teamwork training will be more positive and the experience of realism better when training with a high-fidelity simulator.

2. Facilitators´ tasks are less demanding when using a high-fidelity simulator.

Paper 4: Simulated scenarios from three different centers were video-recorded and analyzed in terms of in-scenario instruction of essential information in a qualitative study. The research questions were:

1. What characterizes the observed methods to convey extra scenario information?

2. What triggers facilitators to provide extra scenario information?

3. What visible impact do the methods for providing extra scenario information have on participants´ activities in the scenario?

4 METHODOLOGICAL CONSIDERATIONS

Research in the healthcare field is always striving for better outcome for patients. However medical intervention studies often have to rely on surrogate measures, since better survival or improved function of life for patients for a number of reasons is not always feasible to assess. Simulation-based teamwork training courses aim at training a number of qualities of professional competence. Knowledge, skills and attitudes in a number of areas including emergency treatment, non-technical skills and inter-professional skills are addressed.

In simulation-based research risk adjusted mortality and morbidity have been used as outcome measure in large bundle interventions including introduction of evidenced based protocols for specific situations in combination with teamwork training [83, 85]. These studies are very costly and the impact of the teamwork training itself is not always defined since bias cannot be excluded.

Studies on healthcare simulation-based teamwork training uses a variety of surrogate measures in order to gain understanding of the impact of interventions. As simulation interventions primarily has an effect on participating students and staff and, if successful, can lead to benefits for patients and organizations a number of methods are used to assess outcome at the individual, patient and organizational levels [18].

	Study 1	Study 2	Study 3	Study 4
Reaction	PCQ, SIMS	PCQ, SIMS	PCQ, flow, mental strain	
Learning		Self-efficacy		
Behavior		Interview	Video analysis	Video analysis
Results		Interview		

Figure 1. Assessment of training in relation to Kirkpatrick´s framework.
PCQ- post course questionnaire, SIMS- Situational Motivation Scale

Kirkpatrick has published a widely used scale for assessment of training outcomes on four levels; the reaction, learning, behavior and results levels [135]. This thesis includes studies on all levels using a variety of methods for assessment (figure 1). Study 1, 2 and 3 includes assessment on the reaction level using psychometric instruments and post-course questionnaires. Study 2 also uses psychometric instruments for assessment on the learning levels. Study 2 uses focus groups interviews for assessment at the behavior and results levels. Study 3 uses quantitative video analysis to assess at the behavior level. In study 4 aspects of behavior in relation to instruction is studied.

4.1 ASSESSMENT OF TRAINING – OVERVIEW

In this thesis training was assessed from multiple perspectives (figure 2). Looking at the courses in a time-line like model assessment included individual self-assessed measures of prerequisites for training such as situational motivation and attitudes to patient safety. Assessment of training related to simulator fidelity, in-scenario instruction and facilitators´ reactions such as flow and mental strain. Individual self-assessed effects of training such as self-efficacy and situational motivation and perceptions of possibilities for transfer of learning from the training to the workplace.

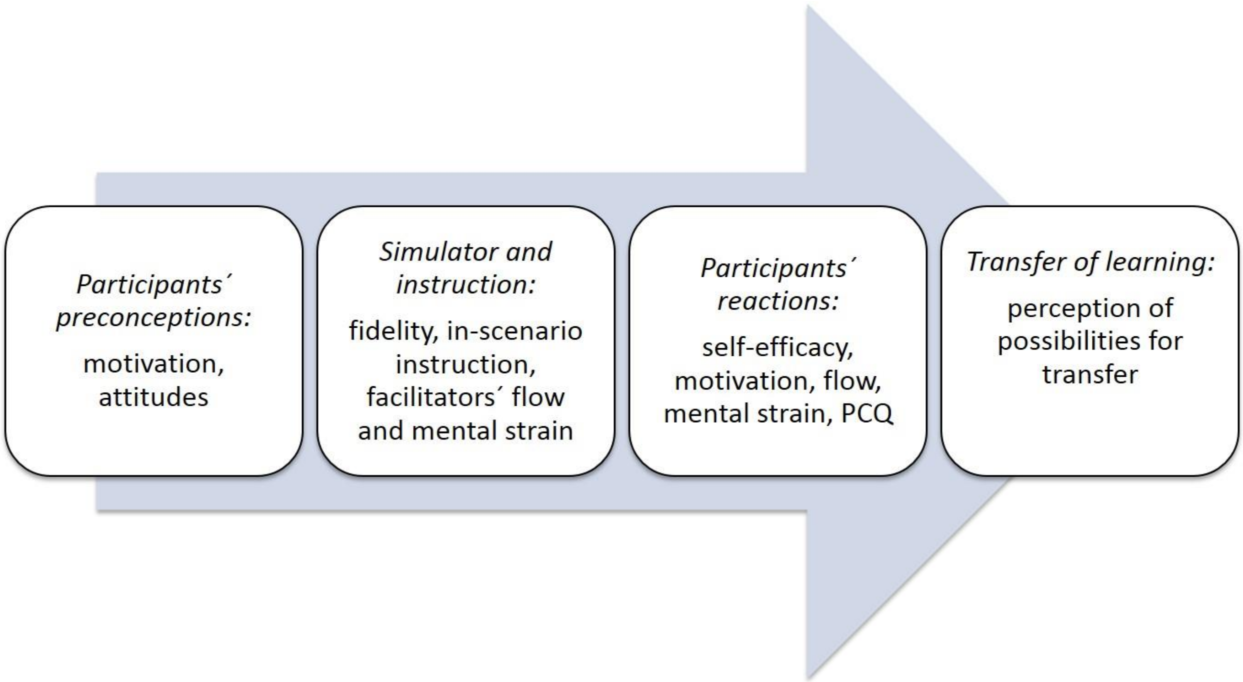

Figure 2. Overview of assessment in relation to the SBTT process.
PCQ- post course questionnaire

Individual assessment of the types of situational motivation was scored before and after training in the first two studies. Post course questionnaires with open and closed ended questions were used in the studies. In order to deepen the understanding of how aspects of training were perceived by participants´ beyond the information obtained through questionnaires focus group interviews were used in study 2.

To study participants´ behavior during scenarios videos were quantitatively analyzed in terms of time to perform key emergency treatment of the simulated patient in study 3.

Study 4 took a quite different perspective focusing on actions and interactions during scenarios and how facilitators´ interventions influenced participants´ actions and interactions using qualitative video analysis. This perspective was aimed at a more detailed understanding regarding the specific issue of in-scenario instruction.

Table 1. Overview of studies and participants:

Study and type	Subjects	Type of data
1. Prospective cohort Intervention	56 medical students	Attitudes to patient safety, Situational motivation, Post course questionnaire
2. Mixed –methods cohort Intervention	71 operating room staff: 11 surgeons, 10 anesthetists, 20 nurse anesthetists, 17 scrub nurses, 13 nurse assistants	Situational motivation, Self-efficacy, Focus group interviews
3. Quasi experimental Intervention	163 staff: 60 physicians, 82 nurses, 21 nurse assistants 5 facilitators	Staff: Flow, Mental strain, Time to key treatment Facilitators: Flow, Mental strain, Frequency of interventions
4. Qualitative video analysis	85 nursing and medical students 35 physicians and nurses. 10 facilitators	Video filmed scenarios

4.2 PARTICIPANTS

The students and staff included in the studies all took part in regular courses as a part of their regular training or work. The students in study 1 were all in their 4th year and the course was compulsory. The female/ male ratio displayed a slight female dominance that mirrors the situation at Swedish medical schools.

In study 2 staff from the two hospitals participated during working hours. Some volunteered, some were scheduled by the employer. The female dominance was large, mirroring the situation at Swedish operating departments.

Participants in study 3 were all scheduled by the employer and participated in the training as a part of regular work shifts. As the training was undertaken on a regular basis, every other week, many participants took part in the training more than once. They were included in the study only on their first occasion.

In study 4 participating staff and students from the three centers were heterogeneous regarding experience and settings. All courses were regular, but some participants were scheduled and some volunteered to participate.

The regional ethics committee in Stockholm (nr 358/02 with amendment 2007/1517-32 and 2010/0005-32 and nr 2017/2456-31/5) and the regional ethics committee in Linköping (nr 2012/439-31) regarding the multicenter study, approved of the studies. All participants could deny participation in the studies still participating in the courses on equal conditions. Participants were included after written informed consent.

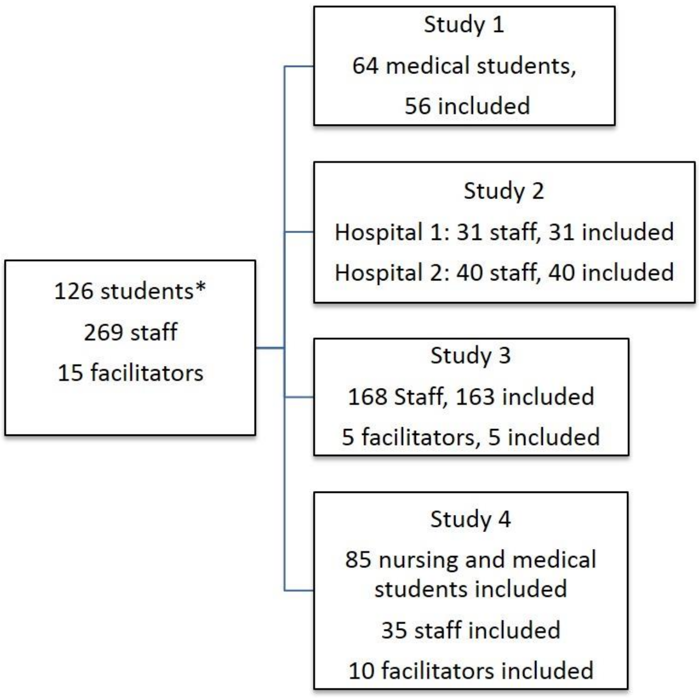

Figure 3. Studies and participants. * 15 students participated both in study 1 and 4

4.3 THE TRAINING

Study 1 and 2 was conducted at the Center for Advanced Medical Simulation and Training (CAMST) and data was collected during regular simulation-based teamwork training courses. Study 3 was conducted by CAMST in collaboration with the pediatric emergency department and data was collected during in situ simulation at the pediatric emergency department at Karolinska University Hospital in Huddinge. The fourth study was conducted as a part of the SimIPL research collaboration with data collected at Simulatorcentrum West in Gothenburg, at Clinicum in Linköping and at CAMST.

4.3.1 Courses at the Center for Advanced Medical Simulation and Training (CAMST)

The Center for Advanced Medical Simulation and Training was founded in 2002 and has extensive experience delivering courses and performing studies on simulation-based learning [136]. The courses had non-technical skills learning objectives derived from the Crew resource management concept refined and clarified in the ATEAMS program [19, 93]. The program includes verbally anchored non-technical skills items that serve as learning objectives and basis for goal directed debriefing. Data for study 1 and 2 were all collected during full day courses.

The facilitators involved were all clinically active and experienced in simulation and debriefing. Regular courses included three facilitators, a technician also acting as the patient´s voice, a confederate and debriefer and a main facilitator and debriefer. In the OR team courses an even larger team of facilitators was engaged including; a surgeon, an anesthetist, an OR nurse and a nurse anesthetist. During the introduction care was taken to allow all participants to air their expectations and worries regarding the training. A discussion guided by a prepared set of questions on non-technical skills purposefully involving all participants and clarification of the ATEAMS items serving as training goals took place before familiarization with the studio and simulators.

The full body manikins used were SimMan 3G (Laerdal, Stavanger, Norway) and HPS, (CAE, Sarasota, Florida, USA). The laparoscopic simulators used in study 2 were Lap Mentor and Lap Mentor express from (Simbionix, Airport city, Israel).

Scenarios were usually 4 emergency scenarios, in the OR course parts of operations i.e. not the whole surgical procedures were chosen. The reason for simulating parts of procedures rather than entire operations was to minimize the time when one or more profession was less active and to enable more scenarios in a limited timeframe. During scenarios 1-3 participants were observing and 3-6 were active. A facilitator was always acting as a confederate with the main tasks of helping out to find equipment and to provide essential information that could not be provided by the simulators.

Each scenario was followed by a video enhanced debriefing guided by the ATEAMS training goals following a structure where active participants reflected on their performance, thereafter peers and finally facilitators. Relevant clips of the videos were displayed, and the team effort was always in focus. The last part of the course day was dedicated to a general discussion regarding lessons learned, applicability and possibilities for transfer of knowledge and skills.

4.3.2 In situ simulation

For study 3 data was collected during scenario training taking place in one out of two of emergency rooms in the Emergency Department at Karolinska University Hospital in Huddinge. The training was established before the study commenced using a doll to represent the patient, this model later served as the control model in the study. During the study equipment for video recording, simulator and screens were temporally installed. Sessions were 90 minutes including demonstration of emergency equipment accessible in the emergency room such as intraosseus drill and defibrillator. The staff scheduled to take part in the training performed one scenario followed by a brief debriefing. Alternating scenarios were an infant with septic shock and a child with severe asthma. Questionnaires were filled out directly after the training. There were occasions when the training was interrupted due to high workload and need to use the room for critical patients and therefore data collection was prolonged. The simulators used were PediaSIM ECS and BabySIM ECS (CAE, Sarasota, Florida, USA).

4.4 ASSESSMENT INSTRUMENTS AND CONSIDERATIONS

4.4.1 Patient safety culture and safety attitudes

Safety climate in a workplace can be estimated using questionnaires on individual attitudes to patient safety. The Attitudes to patient safety questionnaire (APSQ) for medical students has 26 questions, 2-5 questions for each of the nine sub-scores. The sub-scores are: Patient safety training received, Error reporting confidence, Working hours as error cause, Error inevitability, Professional incompetence as error cause, Disclosure responsibility, Team functioning, Patient role in reducing error and Importance of patient safety in the curriculum [60].

Safety attitudes among students mirror the situation at medical school, as the students do not belong to a particular workplace but rotate between departments for the practical part of the education. Participants in study 1 filled out the APSQ before the introduction of the course.

This questionnaire was chosen, as it was the only validated instrument for assessment of safety attitudes among students. A pilot study was performed before data collection commenced and found the questionnaire feasible to use in the original English version with permission from the authors [60].

The safety attitudes questionnaire for operating room staff (SAQ-OR) is derived from the original published by Sexton et al. [62]. The SAQ has been adjusted to operating room settings and translated into Swedish by Göras et al. [61], it was used with permission from the authors. SAQ-OR includes 57 questions, 30 of them are included in the six factors: Safety climate, Teamwork climate, Job satisfaction, Stress recognition, Perception of management and Working conditions. Participants in study 2 filled out the SAQ-OR before the introduction of the course.

4.4.2 Situational motivation

Situational motivation reflects motivation in relation to a specific situation or task. The Situational Motivation Scale (SIMS) taps into four types of human motivation as described in the self-determination theory [99, 100]. Intrinsic motivation captures participation in a task out of one's own will and interest, for its own sake. Internal regulation applies to tasks done because of a belief they will result in some sort of personal reward, the motivation coming "from within". External regulation applies to tasks somebody has told us to do, the motivation coming from something/somebody else. Amotivation applies to tasks the aim and purpose of which we do not understand.

The scale was developed and validated by Guay, Vallerand and Blanchard [100] and translated to Swedish by L. Hedman. SIMS includes 4 questions regarding each type of motivation, altogether 16 questions. Each question is scored on a 7- graded Likert like scale and a mean score is calculated for each type of motivation. Participants in study 1 and 2 filled out the SIMS at two occasions, the first time after the introduction, before the first scenario and the second time at the course ending.

The SIMS was chosen because it is a relatively short validated instrument assessing the, for learning important motivation in relation to a specific situation.

4.4.3 Self-efficacy

Self-efficacy reflects the belief in your own capabilities. The Self-efficacy questionnaire used in study 2 was derived from Pintrich et al. [137] and translated into Swedish by L. Hedman. The questionnaire includes 5 questions each with a 7-graded Likert like scale. A mean score is calculated. Participants in study 2 filled out the questionnaire before the first scenario, after the introduction and at the course ending.

The questionnaire was chosen, as it is validated and short and therefore feasible. Self-efficacy has been used in previous studies of teamwork training [56, 111].

4.4.4 Flow

Flow is defined as a state of concentration and joy in a task. The flow experience is a strong motivator for training and persistence in a task and was therefore assessed. Jackson et al [138] developed an instrument for self-assessment of flow. The questionnaire used in the third study was a short version of the scale translated into Swedish by L. Hedman and include nine items each scored on a 10-graded visual analog scale. The answers were calculated into a mean score. Participants and facilitators in study 3 scored flow directly after the scenario. The

Jackson short scale was chosen, as it is short enough to be feasible in an in-situ training setting.

4.4.5 Mental strain

The Borg CR-10 scale was used to score participants´ and facilitators mental strain in study 3. The scale is non-linear to better distinguish the most used part of the scale and it has verbal anchors [110]. Participants and facilitators in study 3 scored mental strain directly after the scenario.

4.4.6 Performance measured on video filmed scenarios

Time to key treatment was measured on filmed scenarios in study 3. Assessing time to key treatment is a possibility to measure clinical performance in emergency scenarios. Two independent raters measured the time from start of the scenario until the treatment was prescribed and delivered to the simulated pediatric patients.

4.4.7 Post course questionnaires

The questionnaires in study 1 were the standard questionnaires with closed and open-ended questions used at Karolinska Institutet with additional questions to give specific information regarding the simulation. Closed ended questions were answered on a Likert like scale. In study 3 open-ended questions were used to obtain additional information regarding participants reactions in relation to the two simulators. Participants stated the three best elements of the training and the three elements in most need of improvement. The number of statements related to the simulators and perception of realism was calculated for the respective simulator fidelities.

4.5 STATISTICS

Study 1

Parametric statistics were used to analyze the data from the Likert like scales in APSQ and SIMS [139]. Statistical comparisons to identify the differences between two independent groups, SIMS scores before and after training, were performed by using the Student's t-test for uncorrelated means, confirmation of normal distribution using the Shapiro Wilk test. The Pearson correlation coefficient was used in order to test independence between variables. In addition to that, descriptive statistics were used to characterize the data. All analyses were carried out using the statistical software SAS. The 5% level of significance was considered and in the case of a statistically significant result the probability value (p-value) has been given.

Study 2

Comparisons of continuous data were performed by analysis of variance, ANOVA in the comparison of the three professions. Statistical comparisons in order to test differences between two independent groups, SIMS and SE scores before and after training, hospitals and team belonging, were done by use of the Student's t-test for uncorrelated means [139]. The Pearson correlation coefficient was used in order to test independence between variables. In addition to that descriptive statistics was used to characterize the data. All analyses were carried out by use of the SAS statistical software and the 5% level of significance was considered.

Study 3

Regarding the individual measurements of flow experience and mental strain ANOVA was used with the factors roles and manikin fidelity. The statistical unit regarding time to key treatment was the team and independent t-test was used for comparison of the two manikin fidelities. When controlling for the two patient cases, asthma and sepsis ANOVA was used.

To evaluate the extent to which variations in mental strain and flow could be explained by age, sex, profession, previous simulation and role forward regression analysis was performed. To compare fidelities for the trainers with respect to mental strain, experience of flow and frequency of interventions a mixed linear model was used. Software used was Statistica 10.0, StatSoft and SAS System 9.1.

4.6 QUALITATIVE DATA AND ANALYSIS

4.6.1 Focus group interviews and analysis

4.6.1.1 Focus group interviews

Semi-structured interviews were used to gather data regarding staff´s perceptions of the simulation-based teamwork training in study 2. Focus groups are used to gather large amount of data in a limited time, often for marketing purposes [140]. In the OR team training study data was collected during focus group interviews consisting of teams of staff. The interview guide included open-ended questions regarding development of engagement in the simulation, how aspects of the training contributed to motivation to the training, what made it more difficult to immerse? Questions regarding possibilities and barriers for transfer of skills from the course to the workplace were also discussed.

The interviews took place in the simulation center after the course ending and were video and audio recorded. One researcher took part in all the 5 interviews and nobody, but the participants and the researcher were present. The discussions were open and all participants were encouraged to share a variety of opinions. Participants were especially encouraged to share critical opinions regarding the training, a measure aiming to reducing risk of bias, as the interviewer was also a facilitator in the training. Although the questions were targeted toward the simulation the participants in all groups also discussed their work in the operating room and related the content of the training to their workplace.

4.6.1.2 Thematic analysis of focus groups

The research questions were to obtain a broader understanding of how participants´ self-efficacy and engagement developed during the course and how participants perceived aspects of design of the course in relation to their engagement. Therefore, a theoretical or deductive approach, guided by the researchers´ preconceptions was applied [141]. Interviews were transcribed by two assistants and checked and labeled according to who said what by the researchers [140]. The labels included interview, sex and profession and were kept throughout the process to allow for detection of patterns relative to professional group. Two researchers analyzed the data starting with reading of the transcripts and individual coding of preliminary themes. Themes and sub-themes were later negotiated until consensus. Although the themes that were chosen appeared close to the original research questions the subthemes were formed in an inductive process entirely derived from the data. After the preliminary results were written, one of the interviewees read the text to check for general understanding.

4.6.2 Video data and analysis

To collect data on video film is increasingly common in qualitative research [142]. Possibilities to study behavior and interactions occurring in all kinds of environments in detail without the need of a researcher present possibly affecting the course of actions are some of the advantages. Another advantage is the possibility to preserve raw data and look back at the material an infinite number of times.

4.6.2.1 The SimIPL dataset of filmed simulations

The data for study 4 was exclusively based on the analysis of video filmed scenarios. The dataset was collected as a part of the SimIPL multicenter study including (and managed) from the department of Medical Education at Linköping University, department of Education, Communication and Learning at Gothenburg University and CAMST at Karolinska Institutet. Researchers from Gothenburg with extensive experience regarding video analysis provided the project with guidelines for camera equipment, angels and microphones. At CAMST the researchers assisted by technicians collected data during regular courses, after informed consent from the participants and facilitators. A number of technical challenges prolonged the data gathering. 10 scenarios including introduction, briefing and debriefing from each center were collected and exchanged, and formed the common dataset for a number of studies[143-146] including study 4.

4.6.2.2 Collaborative video analysis

One part of the analysis for study 4 consisted of a multidisciplinary workshop where selected video clips were analyzed in depth. The Linköping research team developed the methodology [144] with inspiration from Boijes [147] constant comparison and video analysis by

Heath [142] et al. The data of interest was perception of actions and interactions both between the participants and their interactions with the environment, the simulator, the facilitators and the equipment in the studio.

Analysis was performed in phases, first individual perceptions were written down by each researcher. Thereafter observations were discussed together with the individual field notes. Films were revisited a number of times and findings were negotiated until a common understanding was achieved. A strength analyzing filmed scenarios in a multidisciplinary team with different professional and research backgrounds was that the variety of preconceptions and understandings makes the analysis richer and decreases the risk of bias from one research paradigm alone. For study 4 we divided the research team into 2 for the first phases of analysis of the same films. Later the 2 sub teams merged to further enable a variety of perceptions before consensus was sought. After the collaborative analysis workshop films, field notes and transcripts of the clips were revisited and anchored in the entire dataset of 31filmed scenarios (figure 4).

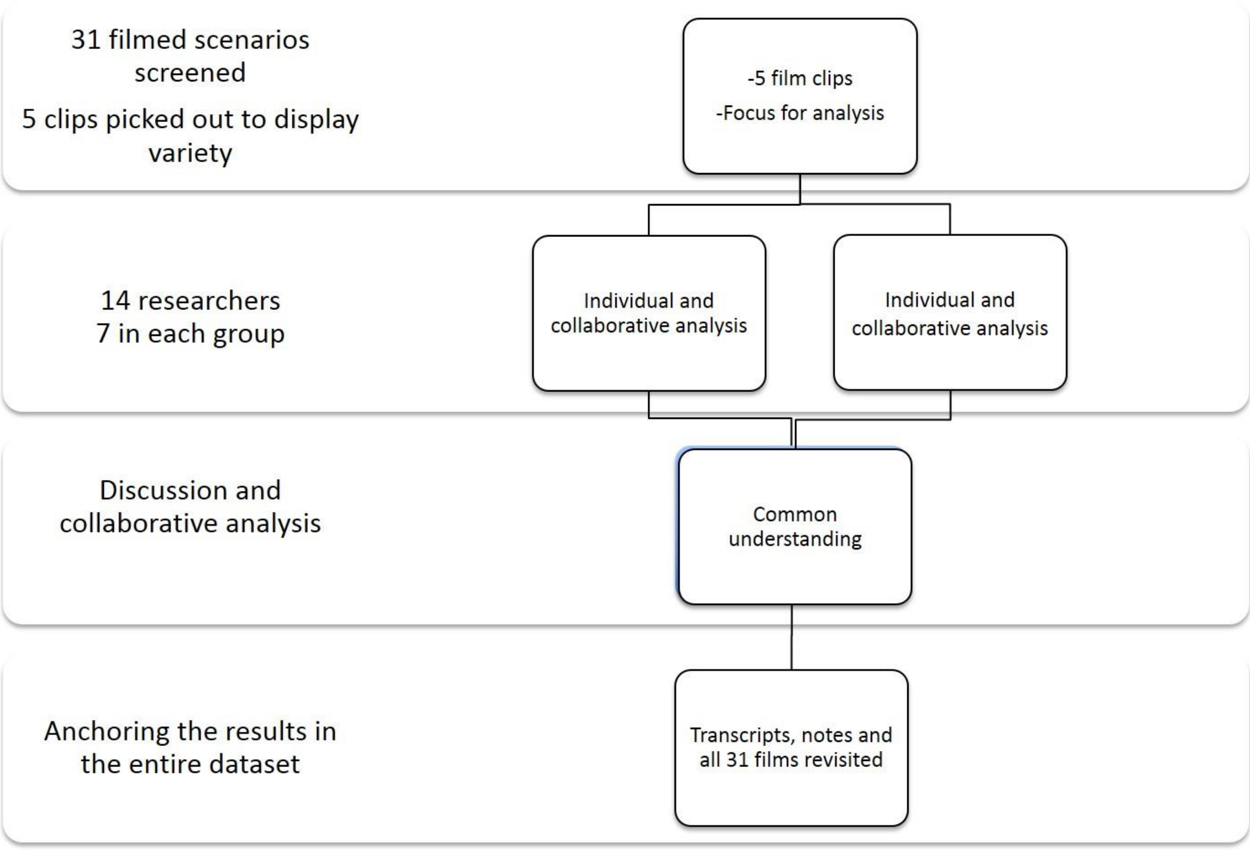

Figure 4. Process for video analysis.

4.7 ETHICAL CONSIDERATIONS

The medical ethical codex to "do no harm" is highly relevant in team training research. To provide opportunities for staff and students to practice, reflect and learn in a synthetic environment without risks has the potential to reduce unintentional harm to patients. The second ethical reason to research the field of healthcare simulation is the excessive costs of simulators and faculty that makes simulation-based team training a scarce resource that must be used wisely. If the wrong behavior is taught or if resources are used for useless training it is unethical.

The studies included in this thesis were performed in established centers. The risks to participants were generally considered small. All participants and facilitators included received oral and written information prior to the study and provided written consent. Participants who declined participation in the study took part in the training on the same conditions.

4.7.1 Ethical approval

Study 1: The regional ethics committee in Stockholm nr 358/02 with amendment 2007/1517-32

Study 2: The regional ethics committee in Stockholm nr 358/02 and 2017/2456-31/5. The regional ethics committee in Linköping 2012/439-31 (Regarding the multicenter study)

Study 3: The regional ethics committee in Stockholm nr 358/02 with amendment 2010/0005-32

Study 4: The regional ethics committee in Linköping 2012/439-31 (Regarding the multicenter study)

4.7.2 Data management

Data were coded to avoid identification of individuals. Questionnaires and codes were stored in a locked room, code lists separated from questionnaires. When data was transferred to computer files they were coded. Film files were stored on a hard drive in a safe.

5 RESULTS

5.1 FIDELTITY AND INSTRUCTION

In the third study, on pediatric emergency teams, training with a low fidelity manikin was compared to a high fidelity simulator. Regarding participants´ flow experience and mental strain no significant differences were found relating to the two simulator fidelities. Clinical performance was measured as time to key treatment on filmed scenarios and differences were found when comparing the two fidelities. The teams training with a high fidelity manikin were significantly slower in delivering oxygen (mean 105 seconds) compared to teams training with the low fidelity doll (mean 67 seconds) $p=0.014$. Analysis of post course questionnaires also revealed differences with more positive comments regarding realism when using the high fidelity manikin compared to the low fidelity manikin represented by a doll.

When analyzing facilitators' reactions significant differences were found regarding flow experience, mental strain and frequency of interventions when comparing the two types of manikins. Frequency of intervention was twice as high when using the low fidelity manikin, 1.3 (0.1) interventions/minute, mean (SEm) with the high fidelity simulator compared to 2.4 (0.1) interventions/minute with the doll. Facilitators´ flow experience was significantly higher with the high fidelity simulator and mental strain significantly lower with the high fidelity manikin.

5.2 IN-SCENARIO INSTRUCTION

In the study on pediatric emergency training, participants´ reactions were not correlated to simulator fidelity but facilitators´ reactions were significantly correlated in terms of more interventions, higher mental strain and lower flow experience when using the low fidelity manikin.

The fourth study built on these results exploring in-scenario instruction and the interaction between facilitators´ actions and participants´ actions and interaction. When studying the common dataset of filmed scenarios in the SimIPL project variations were found regarding in-scenario instruction. The three centers used four different methods to provide participants with essential information regarding clinical finding impossible to provide by the simulators, for example skin color and abdominal examination in this work called "*extra scenario information*". The facilitators were present in the simulation studio acting in the scenario or passive or the facilitators were situated in an adjacent room supplying extra scenario information via an earpiece or a speaker. There were also significant differences in the language style used and the timing of information conveyed by facilitators. The method used had visible effects on participants' actions and interactions and had the potential to interrupt and even disrupt participants´ teamwork. Facilitators present in the simulation studio timed extra scenario information better and instruction was less disturbing to participants´ teamwork compared information from facilitators in an adjacent room.

5.3 SITUATIONAL MOTIVATION

In study 1 and 2 situational motivation increased when assessed after training in terms of intrinsic motivation and identified regulation. External regulation and amotivation decreased correspondingly (table 2). The SIMS scores were similar when comparing the students in study 1 to the operating room staff in study 2 and did not differ when comparing professional groups, the 2 hospitals or staff´s on the job experience.

Table 2. Intrinsic motivation (IM), Identified regulation (IR), External regulation (ER) and Amotivation (AM) scores before and after training from study 1 (students) and study 2 (staff).

	IM before Mean (SD)	IM after Mean (SD)	IR before Mean (SD)	IR after Mean (SD)
Students (n=56)	5.0 (1.0)	5.5 (1.0)	5.6 (0.8)	5.9 (0.8)
Staff (n=71)	5.2 (0.9)	5.8 (0.9)	5.6 (0.8)	5.8 (0.8)

	ER before Mean (SD)	ER after Mean (SD)	AM before Mean (SD)	AM after Mean (SD)
Students (n=56)	3.6 (1.4)	3.2 (1.6)	1.4 (0.7)	1.2 (0.6)
Staff (n=71)	3.2 (1.6)	2.9 (1.6)	1.9 (1.1)	1.7 (1.2)

5.4 DESIGN FEATURES OF IMPORTANCE FOR REACTIONS AND TRANSFER OF LEARNING

In the operating room team training study qualitative focus group interviews were included to gather more detailed information on participants´ perception of the training. Analysis revealed a number of sub-themes related to features of relevance. Training in one’s own professional role with an entire professional team from the workplace was mentioned as particularly important for motivation and possibilities for transfer of learning. New knowledge regarding non-technical skills and tools for teamwork was also highly appreciated as was receiving feedback and reflecting after action.

The inter-professional discussions during debriefings and interviews were highly appreciated and staff expressed how rare opportunities were to discuss with colleagues from the OR professions outside the operating room. The recurrent theme of communication barriers in the OR related to as the physical screen between the sterile operating field and anesthesia was unexpected.

5.5 ATTITUDES TO PATIENT SAFETY AND MOTIVATION

In the first and second study one of the hypotheses was that attitude to patient safety as measured with the Attitudes to patient safety questionnaire (APSQ) [60] for medical students and the Safety attitudes questionnaire for the operating room (SAQ-OR) [61] for staff would correlate to situational motivation scores. In the study on medical students a positive correlation regarding identified regulation and total APSQ scores was found ($r=0.33$, $p=0.014$). In the second study no significant positive correlation to any of the four types of situational motivation to patient safety attitudes was found.

6 DISCUSSION AND IMPLICATIONS

6.1 TO STUDY REGULAR TRAINING

The field studies in this thesis all occurred during regular simulation-based team training courses that were established prior to the studies. As SBTT is a relatively new field few researchers have had the possibility to study established courses provided on a regular basis before. The research approach was adjusted to minimize intrusion to the courses and thereby allow a relatively large number of facilitators and participants to take part. By studying established courses, the risk that the research itself influenced participants and facilitators is likely to be smaller compared to novel courses set up specifically for research purpose. The challenges to study regular courses were that the training could not be fully standardized, and assessment had to be feasible.

6.2 INSTRUCTION AND FIDELITY

In the 3rd study on pediatric emergency team training the facilitators intervened a lot more when using a low fidelity manikin compared to the high-fidelity simulator. Correspondingly facilitators experienced a significantly higher mental strain and a lower flow experience with the low fidelity manikin. The findings of high mental strain were in line with studies showing high stress levels for simulation facilitators and a number of roles to fulfill in order to be a successful educator [127, 148]. The difference in workload for facilitators relating to simulator fidelity has not been studied before and was particularly interesting as the participants displayed a very different pattern.

Participants´ reactions were similar using the two manikins. The shorter time to provide oxygen when training with the low fidelity manikin was interpreted as a lower degree of realism. Verbal information delivered by the facilitator regarding skin color and breathing when using the low fidelity manikin being processed and readily usable for participants. In contrast to performing assessment of the respiratory pattern and oxygen saturation on the manikin and patient monitor to obtain the same information from the high-fidelity manikin.

The finding that participants´ reactions displayed only minor differences in relation to the fidelity of the simulator was unexpected. However, it is in line with a study by Dieckmann et al. on professional participants´ perception of realism in simulated scenarios revealing individual non-consistent perceptions of cues of reality and fiction [124]. The participating anesthetists in Dieckmann's work took part in scenarios together with facilitators role-playing the other members of the OR team. The anesthetists in the study perceived the same features as a reality cue in one and fiction in another scenario. Dieckmann and colleagues came to the conclusion that perception of realism relies on a number of features, one being the role-play another the possibility to get clarification and ask questions during scenarios. Results from the 3rd study and Dieckmann's work both suggest that participants´ perception of realism is related to facilitators´ actions during scenarios.

A possible mechanism for the small differences regarding participants´ reactions when training with a lower or higher fidelity manikin in our study could be facilitators´ actions. By skillfully adding missing information facilitators can compensate for the shortcomings of the simulator. Lower fidelity simulators display fewer of the essential signs necessary for assessment and treatment and in-scenario instruction is therefore more demanding for facilitators but not necessarily of less value for the participants. The results are in the same vein as the ongoing discussion questioning the importance of simulator fidelity for learning [123, 149].

In the 4th study on in-scenario instruction *extra scenario information* as a notion is described for the first time. Extra scenario information represents a subset of in-scenario instruction. The notion includes transfer of information necessary to bridge the gap between the appearance of the simulator and a sick patient for example skin color and temperature, facial expression, movements, muscle tone and abdominal examination.

A variety of methods to provide extra scenario information during scenario training were found. The facilitators were located in the simulation suite or in an adjacent room and used a variety of language styles, tempo and timing when providing information. Most importantly it was demonstrated that attributes of the extra scenario information influenced the participants´ actions and interaction and that facilitators working closer to the participants were superior in terms of timing of extra scenario information.

The variation regarding participants´ behavior in relation to attributes of in-scenario instruction could be a link explaining the failure to correlate simulator fidelity to learning [123, 125, 149]. If facilitators skillfully provide extra scenario information, participants might not experience any disadvantage when training with a simulator of lower fidelity. On the other hand, inferior timing of instruction and lack of necessary information could make scenario training unrealistic even with a very sophisticated manikin.

In-scenario instruction had a visible impact on participants in the 4th study and variations in instruction have the potential to be as important for participants as simulator and setting fidelity (figure 5). Rystedt and Sjöblom argue that a simulation is a dynamic process where participants by deliberately ignoring irrelevant features of the setting and by relating to real life experience create valuable learning opportunities [119]. The results from study 3 and 4 add the importance of instruction to help participants to bridge the gap between the simulated setting and reality to enhance the relevance of the simulation.

Based on this knowledge there are reasons to recommend that:

1. Educators shift focus from the fidelity of the simulator to instruction in order to bridge the gap to reality that is inevitable.
2. Studies comparing methods for in-scenario instruction including participants and facilitators should be performed. If possible including outcomes on all Kirkpatrick´s levels.

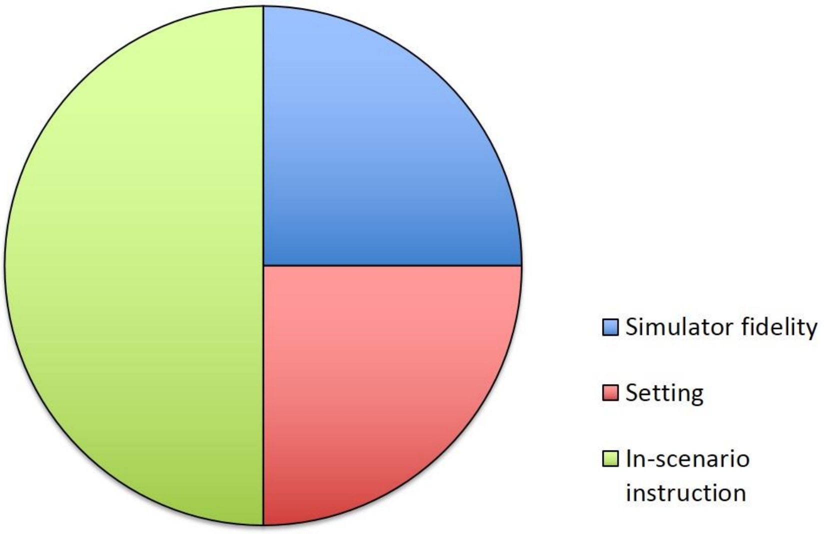

Figure 5. Model of aspects of importance for perceived realism of a scenario given that the clinical case is relevant to the participants.

6.3 STAFF AND STUDENTS

Both students and staff were included in this thesis; in study 1 all participants were medical students. In study 2 and 3 all were staff and in study 4 both staff and students were included.

6.3.1 Similarities between students and staff

In study 1 and 2 the development of different kinds of situational motivation in relation to simulation-based team training courses was monitored. Very similar patterns displaying increased intrinsic motivation and identified regulation after training was found for both students and staff (table 2 and figure 6).

Increasing intrinsic motivation was expected in the student cohort as most of the participants had their first team training experience allowing them to practice the role of graduated physicians. The pattern displayed by the experienced staff was more unexpected.

Regarding the OR professions, earlier work has displayed higher levels of flow experience by team leaders [111] compared to followers and as the physicians more often take the team leaders role a higher level of intrinsic motivation was expected in the physicians' cohort. A reason for not finding differences in intrinsic motivation could be that the study was underpowered; another possibility is that the training allowed all participants to practice valuable skills.

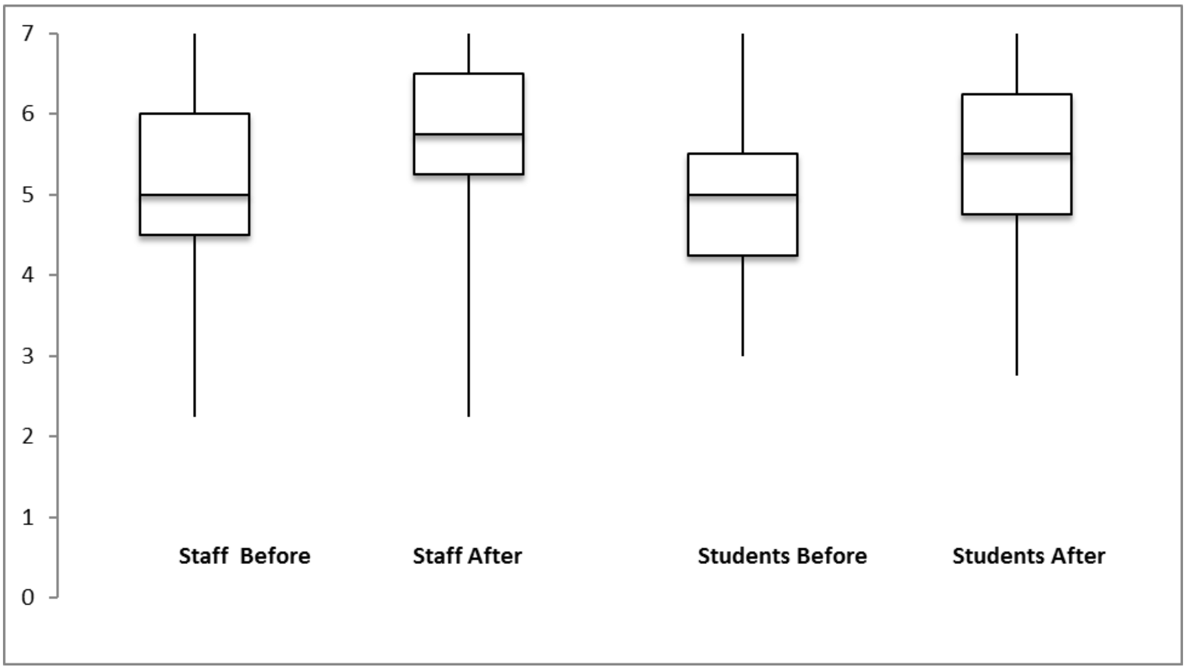

Figure 6. Staff´s and students´ intrinsic motivation before and after training.

In the same vein we expected junior staff in study 2 to be more motivated for training compared to senior staff but no positive correlation was found regarding on the job experience. A possible explanation to similar scores of intrinsic motivation could be that staff regardless of on the job experience and profession feels the need to practice and improve. A study on circulating and scrub nurses work stress and work satisfaction [51] found differences regarding sense of teamwork in relation to role in the operating room. Another study on teamwork and stress in the OR revealed that different members of the OR team experience stress during different parts of the procedure [50]. The complexity of the OR team can be the reason for the high levels of intrinsic motivation to practice teamwork even for experienced staff of all professions.

Studies have correlated situational motivation to autonomy supportive contexts and intrinsic goal content [101]. Regarding goal content one can assume that both students and staff find the non-technical skills goals aiming for enhanced patient safety valuable, Vansteenkiste et al. [101] argue that framing of the learning objectives also play a key role. I argue that the training at CAMST is well designed and that the credibility of training and debriefing with experienced facilitators representing each profession is one reason for increasing intrinsic motivation. Qualitative data from study 2 offers some support to this interpretation.

Scholars agree that participating in teamwork training once is unlikely to have a large effect on long term performance and safety culture although the amount and frequency of training needed is not yet known [18, 150, 151]. The duration of motivation to training is unknown, but students in the healthcare professions will graduate and a motivating simulation experience is likely to be of benefit for further training. Further studies on decline of skills and motivation would be valuable to support planning of sustainable long-term interventions.

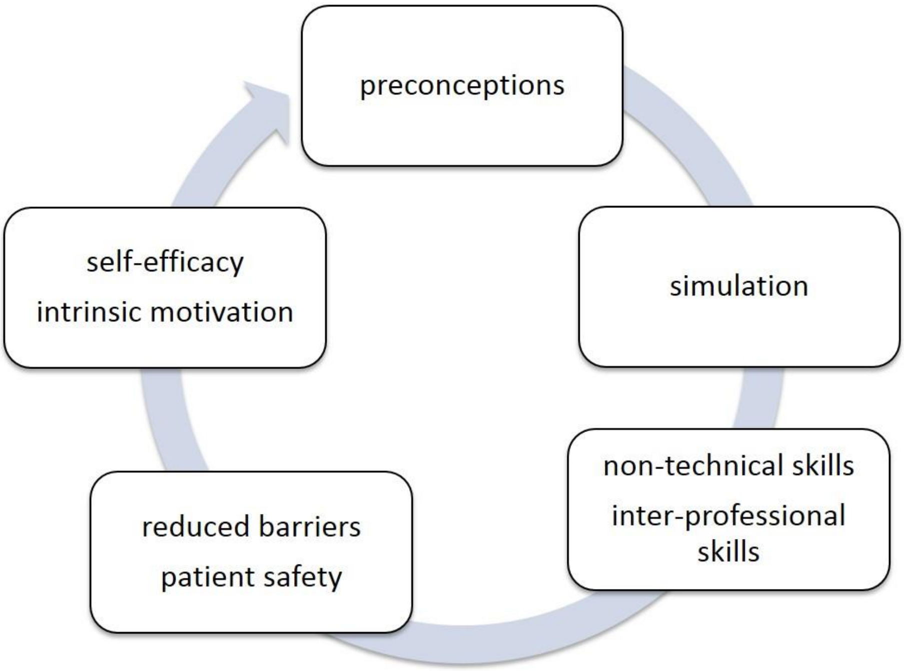

Figure 7. Model of repetitive SBTT.

6.3.2 Differences between students and staff

In the 4th study in-scenario instruction using different methods was explored. One center used a facilitator acting as a confederate in the scenario when training both staff and students. Although the focus of analysis was not to look at differences in instruction in relation to participants´ experience there was a tendency to a more active role of the facilitator when training students, for example by asking clarifying questions and providing hints as guidance.

6.3.3 Safety attitudes and motivation

Regarding students there was a positive correlation regarding identified regulation before training and attitudes to patient safety (APSQ) total scores. No positive correlation in terms of any kind of situational motivation to safety attitudes (SAQ-OR) scores was found in the staff cohort. The reasons for the weak and non-existing correlations could be that patient safety attitudes is a concept containing many different aspects including stress recognition and limitations to human behavior and others related to the workplace such as confidence in colleagues and management.

Both the APSQ and the SAQ-OR questionnaires are constructed for monitoring of safety climate at medical schools and departments. Both students and staff in these studies were generally highly motivated to the team training for reasons only to a minor extent explained by safety attitudes. The patient safety curriculum for students at KI is not yet very well defined and integrated. Measuring safety attitudes after the introduction of a new structure of the curriculum integrated with the SBTT would be of value.

6.4 TO UNDERSTAND HEALTH CARE PRAXIS THROUGH SBTT STUDIES

Simulation has been used as a substitute for reality to understand teamwork in operating rooms [152-154]. One of the advantages is that emergencies that are relatively rare and difficult to study can safely be explored in the synthetic environment. Another advantage is that both settings and behavior, by roleplaying parts of the team, can be standardized.

The 2nd study did not initially aim at analyzing actual teamwork in operating rooms but during focus group interviews the participating staff also discussed inter-professional teamwork at their workplace. As the authentic multi-professional teams had spent a day together including a lot of interaction and feedback before the interviews they were eager to discuss strengths and weaknesses not only regarding the training but also regarding teamwork at their workplace.

The fruitful discussions regarding teamwork in OR´s that took place were unplanned, but the setting can offer possibilities to collect data for research and improvements of working conditions in OR´s in the future. Staff´s burnout, patient safety and staff´s turnover are topics at the top of the agenda in many health care organizations worldwide. The importance of good working conditions in OR´s is further emphasized by studies displaying a positive correlation between staff´s wellbeing and patient safety [70, 71].

6.4.1 The barrier in the OR

Unexpectedly the perception of communication barriers in the OR team was mentioned to some extent during all five interviews in study 2. In a much discussed paper by Makary et al.[54] perceptions of the quality of teamwork in operating rooms was related to staff status with doctors perceptions of teamwork significantly superior (particularly so surgeons) to nurses views. Results from intensive care and delivery units display similar patterns [56 57].

In our second study OR staff related to the screen between anesthesia and the sterile field as a barrier. This perception could reflect the same phenomena, i.e. staff of lower status in the OR perceiving inferior quality of collaboration compared to staff of higher rank. What this study adds is that participants aired that the training "*lowered the barrier*". Team tools, such as a time-out, were perceived as a help to "*break down the barrier"* and "*level the communication".*

The discussion regarding the barrier could also be a reflection regarding physical and organizational constraints to communication and collaboration in the OR. It is known that noise levels are high [34, 35] and increasing amounts of technical devises and screens also impair visibility. Communication is further challenged by rotation off staff, nameplates invisible behind the sterile gowns and surgical masks. The organization of staff in different departments was also mentioned as an obstacle to meet and collaborate by participants in this study.

Inter-professional discussions facilitated by a common team training experience could offer possibilities to understand and improve conditions for teamwork. This discussion is in the same vein as successful patient safety intervention studies applying a combination of team training and organizational changes or/and new routines [85, 150]. One possible reason for the success of bundle interventions could be synergistic effects of training and implementation of new routines. Fruitful inter-professional discussions facilitated by the teamwork training have the potential to enhance acceptance of new routines and also improve working climate.

6.5 STRENGTHS AND LIMITATIONS

The team training interventions studied in this thesis aim at improving participants´ non-technical skills and thereby enhancing patient safety. As the studied team training courses were regular and not experimental settings all factors could not be fully standardized, for example the number of participants varied, their level of experience varied and a number of facilitators were involved. Assessment methods used were for feasibility reasons surrogate measures, not morbidity and mortality data and instruments were chosen to be reasonably short and easy to fill out for the same reasons.

Studying regular courses had a number of advantages. One was that a relatively large number of students, staff and facilitators from different settings could be included. Another was that the impact of the research on the training is likely to be less compared to training set up specifically for research purposes.

Regarding data derived from psychometric instruments results rely on the validity, sensitivity and specificity of the instruments and also on thorough work to fill them out by each participant. Validated questionnaires were used and the main perception was that participants generally made an effort to fill out scales well and truly, the low number of missing values points in this direction.

Data derived from analysis of videos rely on the representative selection of films and a proper interpretation of content. The SimIPL database consists of recordings collected at three centers during regular courses. This implies a greater generalizability, however the representativeness in a wider perspective is unknown. It is likely that a larger dataset would have displayed even wider variations.

The research group performing these studies consisted of experienced physicians and simulation facilitators and experts in behavior- and education sciences. The perspective of the simulation experts allowed for deep understanding of teamwork training both from a facilitator´s and participant´s perspective. The experts in education sciences, video analysis and behavior sciences allowed for a broader perspective and ensured that data was interpreted in a wider context. Having a team of researchers representing a number of relevant fields is one of the strengths of the studies included in this thesis.

Study 1: Data was collected during a limited time frame and the course was established at least 12 years prior to the study. Situational motivation is a construct relevant in higher education that has to our knowledge rarely been monitored in SBTT contexts before.

Limitations were that the study was conducted in a single center, which reduces possibilities to generalize the conclusions of the results. Twelve percent of the students did not consent to participate which may have influenced the results as the students who declined might have been less motivated compared to the included cohort.

Study 2: Inter-professional teamwork training for authentic OR teams is rare as organizational structures often imped staff from all professions to gather for training. One of the strengths of this study was the possibility to include complete authentic teams from two hospitals. Another strength was that data from psychometric instruments could be triangulated with qualitative data from interviews to allow for a broader understanding of participants´ perception of the training.

There are also a number of limitations. One is that the moderate number of participants of five professions made the sub-group analysis difficult due to small numbers. Real differences between groups could therefore have been missed. Another limitation was that the included staff was not homogenous in terms of on the job experience or prior teamwork training. Included nurses were more senior compared to the doctors. It is hard to know how these differences might influence the results. Finally, the qualitative data was derived from a single center, which can limit the possibilities to draw general conclusions.

Study 3: The strengths of the study on pediatric emergency teamwork training are firstly that both participating staff and facilitators were included in the comparison of training with the low and higher fidelity manikins. Secondly the study included measures of clinical performance as well as participants´ and facilitators´ reactions. Thirdly, a large number of staff was included in the established in situ training. Finally, the analysis included several measures to minimize the influence of other explanations to the results than simulator fidelity.

Limitations of the study was the long time spent for data collection and the different facilitators responsible for the training that could have influenced the training and thereby the results. Six out of 34 video filmed scenarios could not be analyzed as participants did not give consent, it is unknown if the excluded scenarios differed from the included.

Study 4: The novelty of describing the notion extra scenario information in SBTT is a strength of this multi-professional, multicenter study. The diversity of competences in the research team allowed for multiple perspectives of how facilitators´ transfer of information influence teams in simulated scenarios.

The exploratory nature of the study is however to be taken into account for then drawing conclusions based on the results. The data was derived from three Swedish simulation centers and restricted to phenomena visible to the researchers.

7 CONCLUSIONS AND FUTURE DIRECTIONS

The general aims of this thesis were firstly to study aspects of participants´ reactions to simulation-based teamwork training in a number of settings and secondly to learn more about instructional and design features of importance for successful training.

- Both medical students and experienced staff increased their intrinsic motivation after a full day of simulation-based teamwork training pointing at the possibility for a well-crafted team training course to serve as a motivator for further training. **Paper 1 and 2**
- The team training course for entire operating room teams was equally well received by all professional groups and can answer the call for inter-professional team training for operating room teams which has so far been rare. **Paper 2**
- Operating room staff described professional barriers enhanced by organizational and physical obstacles. Simulation-based teamwork training hosts possibilities to understand and improve teamwork conditions in the OR. **Paper 2**
- Pediatric emergency teams reacted in a similar pattern to training with a higher and a lower fidelity manikin. Facilitators mental strain was higher with the lower fidelity manikin, but their behavior seemed to bridge most of the difference in simulator fidelity in the eyes of the participants. **Paper 3**
- A large variation regarding in-scenario instruction was found. Methods used by facilitators influenced participants´ actions and interactions and lack of timing could interfere with team communication. **Paper 4**

Instruction and design of training deserves further studies, preferably multicenter studies including both facilitators and participants. In order to enhance research and aggregation of data the extension of the CONSORT and STROBE criteria for simulation-based research [118] could be further extended to include more details regarding instruction.

8 POPULÄRVETENSKAPLIG SAMMANFATTNING

Bakgrund:

Förutom kunskaper och teknisk skicklighet behövs samarbetsfärdigheter för att kunna ge säker vård, särskilt när tiden är knapp och utrymmet för felhandlingar små vid akuta situationer. Samarbetsfärdigheter kan läras ut på flera sätt men för att träna beteenden är simulering en möjlig metod som används för utbildning av såväl studenter som sjukvårdspersonal. Studier har visat att simulatorbaserad träning kan öka förmågan att samarbeta och även förbättra patientsäkerheten. Vid simulatorbaserad samarbetsträning används simulatorer som liknar människor och har flera avancerade funktioner såsom puls som kan kännas, pupiller som reagerar för ljus och bröstkorg som har andningsrörelser. Flera instruktörer behövs för att genomföra simulatorbaserad samarbetsträning, dels för att styra tekniken, dels för att ge information till deltagarna om undersökningsfynd som inte kan ses på simulatorn, t ex om huden är blek eller kall och hur patienten rör sig.

En träningsdag består ofta av 3–5 simulerade patientfall som akutteamen behandlar. Efter varje patientfall ser deltagarna scenariet på film tillsammans med instruktörer för att utvärdera och lära. Simulatorer är mycket dyra liksom löner till deltagare och instruktörer och ekonomiska faktorer begränsar ofta hur mycket personal och studenter får möjlighet att träna. Därför är det viktigt att undersöka hur träning fungerar och hur den ska utformas för att ge önskat resultat.

I det här arbetet har följande aspekter undersökts:

1. Hur personal och studenter påverkas av träningen vad gäller motivation och tro på sin egen förmåga.
2. Hur akutsjukvårdspersonal och instruktörer upplever träning med en enkel docka jämfört med en avancerad simulator och hur olika metoder att ge information under scenarierna påverkar deltagarna.
3. Hur operationslag bestående av kirurg, narkosläkare, narkossjuksköterska, operationssjuksköterska och undersköterska upplever träningen samt möjligheter och svårigheter att ta med sig det man lärt sig under träningen och använda i arbetet på operation.

Metoder:

Studierna i avhandlingen är gjorda vid ordinarie träningstillfällen vilket har gett möjligheter att samla mycket information från den verkliga praktiken. En svårighet är att träningstillfällen inte kan standardiseras helt och att forskningen måste gå att genomföra utan att störa träningen. Ca 270 anställda och 160 studenter har gett sina medgivanden att delta i studierna.

För att få veta hur deltagande studenter och personal upplever träningen har beteendevetenskapliga frågeformulär där deltagarna själva skattar sin motivation att träna, tro på sin egen förmåga att klara av en uppgift, attityder till patientsäkerhet och mental ansträngning använts. För att få mer information om hur deltagare upplever träningen och hur de ser på möjligheter och svårigheter att använda lärdomarna från träningen på jobbet har deltagare också intervjuats i grupp. För att studera hur snabbt den simulerade patienten får behandling och hur instruktörens information påverkar simuleringen och deltagarna har filmade scenarier från tre svenska simulatorcentra analyserats.

Resultat:

Både studenter och personal är motiverade till träning och motivationen ökar lika mycket vid mätning efter träning bland studenter som i yrkesgrupperna, läkare, sjuksköterskor och undersköterskor. Personal från operationsavdelningar upplever att det finns goda möjligheter att lära sig samarbetsfärdigheter vid simulering och även att ta med det man lärt sig till arbetsplatsen, särskilt uppskattas att få träna i fullständiga operationslag. Vid träning på barnakuten upplever akutteamen små skillnader i att träna med en enkel docka jämfört med en avancerad simulator men för instruktören är det mycket mer krävande när en enkel docka används. Det förefaller som att instruktören kan kompensera för skillnaderna vad gäller simulatorn. Det sätt instruktören använder för att ge information har betydelse för deltagarna och en instruktör som står nära deltagarna kan "tima" informationen bättre jämfört med de som arbetar från ett intilliggande rum och ger information via högtalare eller hörsnäcka.

Konklusion:

Resultaten visar att såväl studenter som personal motiveras av träningen och att lärdomar från träningen är användbar i akutsjukvårdsarbetet. Att träna tillsammans med dem man arbetar med bedöms som särskilt betydelsefullt.

Instruktörens arbete har stor betydelse för hur deltagare upplever simulering, sannolikt större än vilken typ av simulator som används.

En begränsning är att påverkan på patientvården inte studerats. Effektiv träning kan förbättra samarbetet som i sin tur kan förbättra patientsäkerheten men många olika faktorer förutom tränad personal påverkar vården av patienter. Större studier behövs för att klarlägga hur mycket och hur ofta och exakt på vilket sätt akutsjukvårdpersonal bör träna för att uppnå bästa resultat för patienterna.

Vad detta arbete kan bidra med är att den pedagogiska utformningen av träningen sannolikt är viktigare för resultatet än vilken typ av simulator som används. Personal och studenter motiveras av att träna i de team de arbetar och efterfrågar mer träning.

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