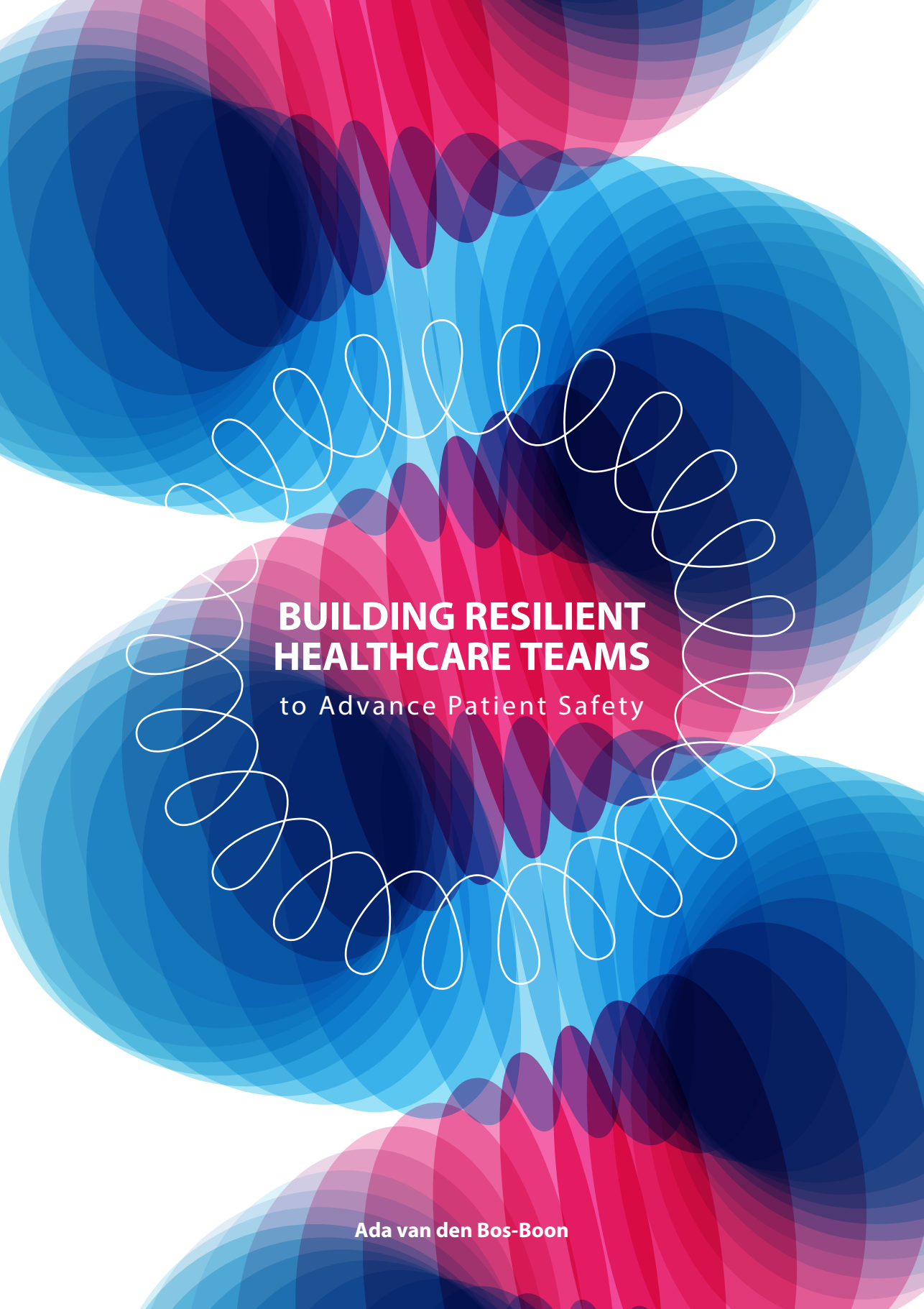
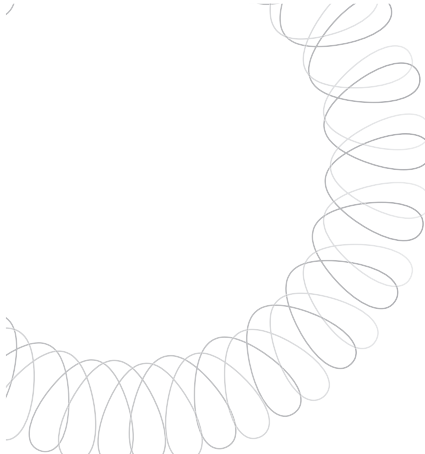




BUILDING RESILIENT HEALTHCARE TEAMS

to Advance Patient Safety

Ada van den Bos-Boon

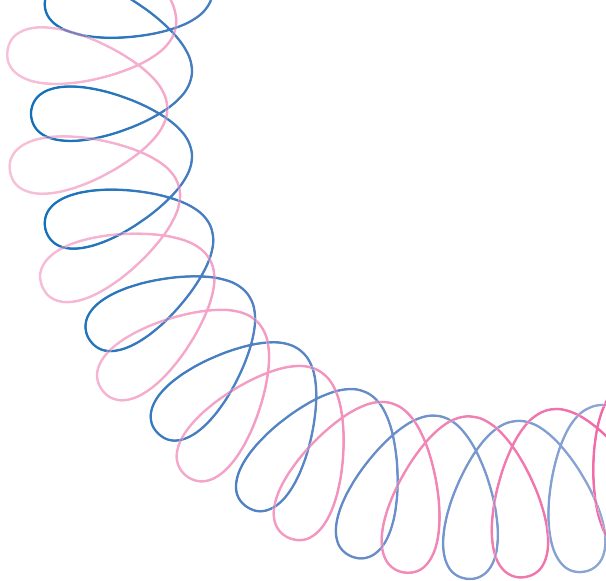


STELLINGEN
behorend bij het proefschrift:

BUILDING RESILIENT HEALTHCARE TEAMS

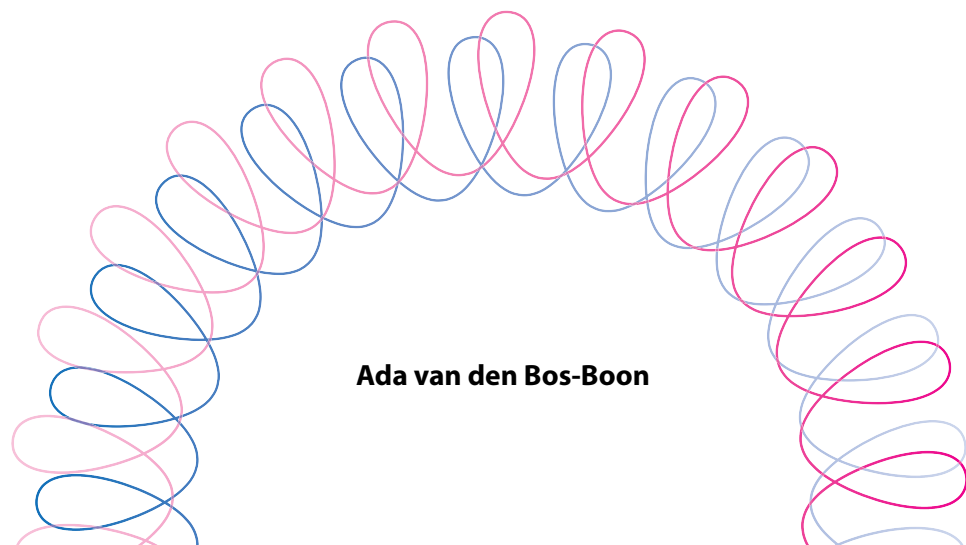
to Advance Patient Safety

1. The sustainable implementation of CRM training in health care depends on strong leadership and continuous adaptation to specific organizational contexts. (This thesis)
2. Psychological safety within healthcare teams can only be fully achieved when leaders actively promote collaboration and open communication. (This thesis)
3. The value of the Safety Attitudes Questionnaire lies not in its scores but in how teams use the results. (This thesis)
4. Integrating simulation-based exercises into CRM training sessions helps improve team members' technical and non-technical skills. (This thesis)
5. The adaptability displayed by healthcare teams during the COVID-19 pandemic deserves top priority in a new crisis. (This thesis)
6. Assessing healthcare workers' non-technical skills in acute should become as routine as assessing their technical skills. (Bartman et al., 2021)
7. Team training that considers the interplay between national cultural and team dynamics is more likely to be effective. (Rice et al., 2021)
8. Sustainable healthcare requires strategic investment in teamwork and interprofessional collaboration. (Integraal Zorgakkoord. Ministerie VWS, 2022)
9. Without a strategic focus on retaining nurses and improving their working conditions, the sustainability of healthcare systems is at serious risk. (Berenschot, Aan het werk voor een betere arbeidsmarkt in de zorg, 2017)
10. To improve patient safety, healthcare systems must analyze everyday successes with the same rigor as failures. (Lakissian et al., 2020)
11. One's best ideas often emerge during a walk - ideally in nature and with inspiring company.



BUILDING RESILIENT HEALTHCARE TEAMS

to Advance Patient Safety



Ada van den Bos-Boon

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Bouwen aan veerkrachtige zorgteams ter bevordering van patiëntveiligheid

BUILDING RESILIENT HEALTHCARE TEAMS

to Advance Patient Safety

Proefschrift

ter verkrijging van de graad van doctor aan de
Erasmus Universiteit Rotterdam
op gezag van de
rector magnificus

Prof.dr.ir. A.J. Schuit

en volgens besluit van het College voor Promoties.
De openbare verdediging zal plaatsvinden op
dinsdag 4 november om 13.00 uur

door

Aartje Boon
geboren te Leiderdorp

Promotiecommissie:

Promotor: Prof. dr. M. van Dijk

Overige leden: Prof. Dr. I. Leistikow
Prof. Dr. M.C. de Bruijne
Prof. Dr. R.M.H. Wijnen

Copromotoren: Dr. C. van der Starre
Dr. R.J.M. Houmes

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Proloog:

Hoe te leren, te reflecteren en te blijven ontwikkelen.

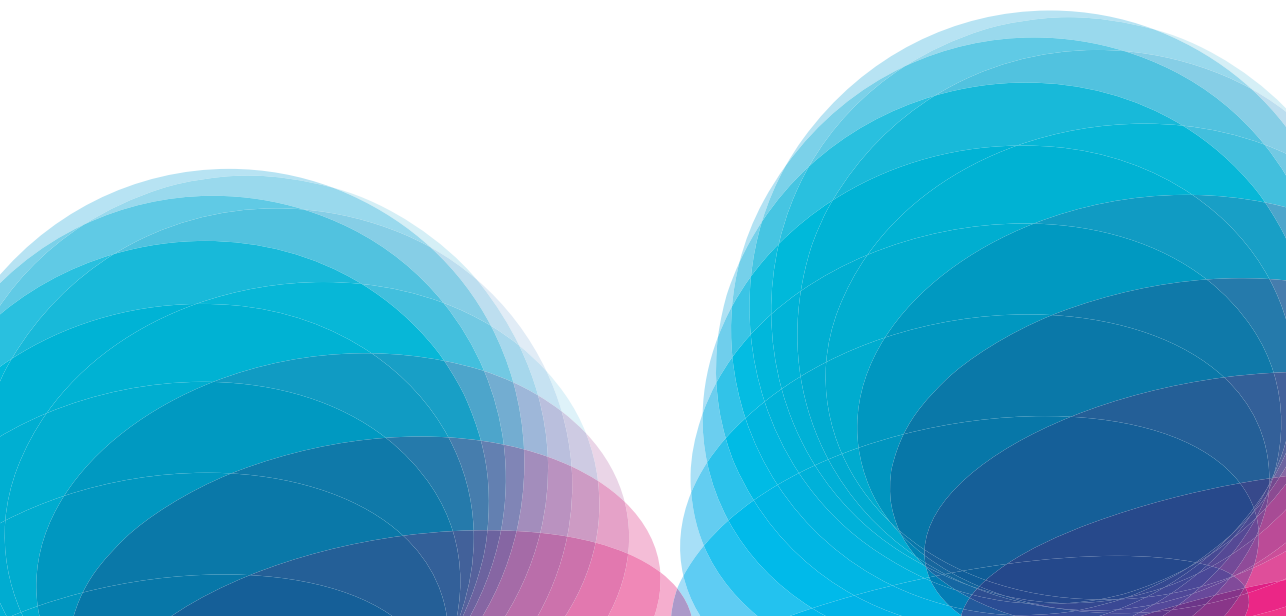
Mijn reis in de gezondheidszorg begon als verpleegkundige, waar ik werd geraakt door de manier waarop mensen samenwerken en hoe dat de zorg beïnvloedt. In 2005 maakte ik kennis met Crew Resource Management (CRM)-trainingen, die mijn passie voor teamwork en patiëntveiligheid aanwakkerde. Dankzij de visie van de afdelingsleiding kregen deze thema's een structurele plek, eerst op de Kinder-IC en later breder binnen het Sophia Kinderziekenhuis.

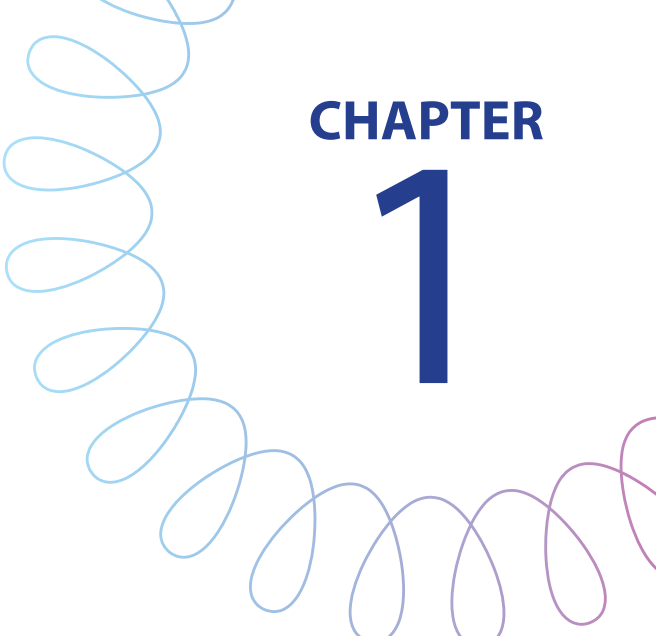
Een keerpunt kwam in 2007, toen ik betrokken was bij een calamiteit op de kinder- IC. Het liet diepe sporen na en stelde mijn vertrouwen op de proef. Maar het leerde me ook een essentiële les: veilige zorg draait niet alleen om protocollen en systemen, maar vooral om mensen. Hoe we samenwerken, communiceren en elkaar steunen bepaalt de kwaliteit en veiligheid van zorg. Deze ervaring gaf me een diepgewortelde motivatie: ik wilde bijdragen aan een werkomgeving waarin zorgprofessionals zich gesteund voelen, waarin teamwork niet vrijblijvend is, maar een integraal onderdeel van veilige en effectieve zorg.

Wat begon als een persoonlijke zoektocht, groeide uit tot een bredere visie op structurele verandering. Dit proefschrift is geworteld in die overtuiging: veiligheid gaat niet alleen over het voorkomen van fouten, maar ook over nieuwsgierigheid naar wat goed gaat. Over het lef om te leren, te reflecteren en te blijven ontwikkelen.

Mijn wens is dat dit proefschrift niet alleen wetenschappelijke inzichten biedt, maar ook praktische inspiratie voor zorgprofessionals en leiders. Dat het bijdraagt aan zorg die niet alleen veilig en duurzaam is, maar ook menselijk en veerkrachtig, gedreven door vakmanschap, samenwerking en het hart voor de patiënt en elkaar.

Ada van den Bos-Boon

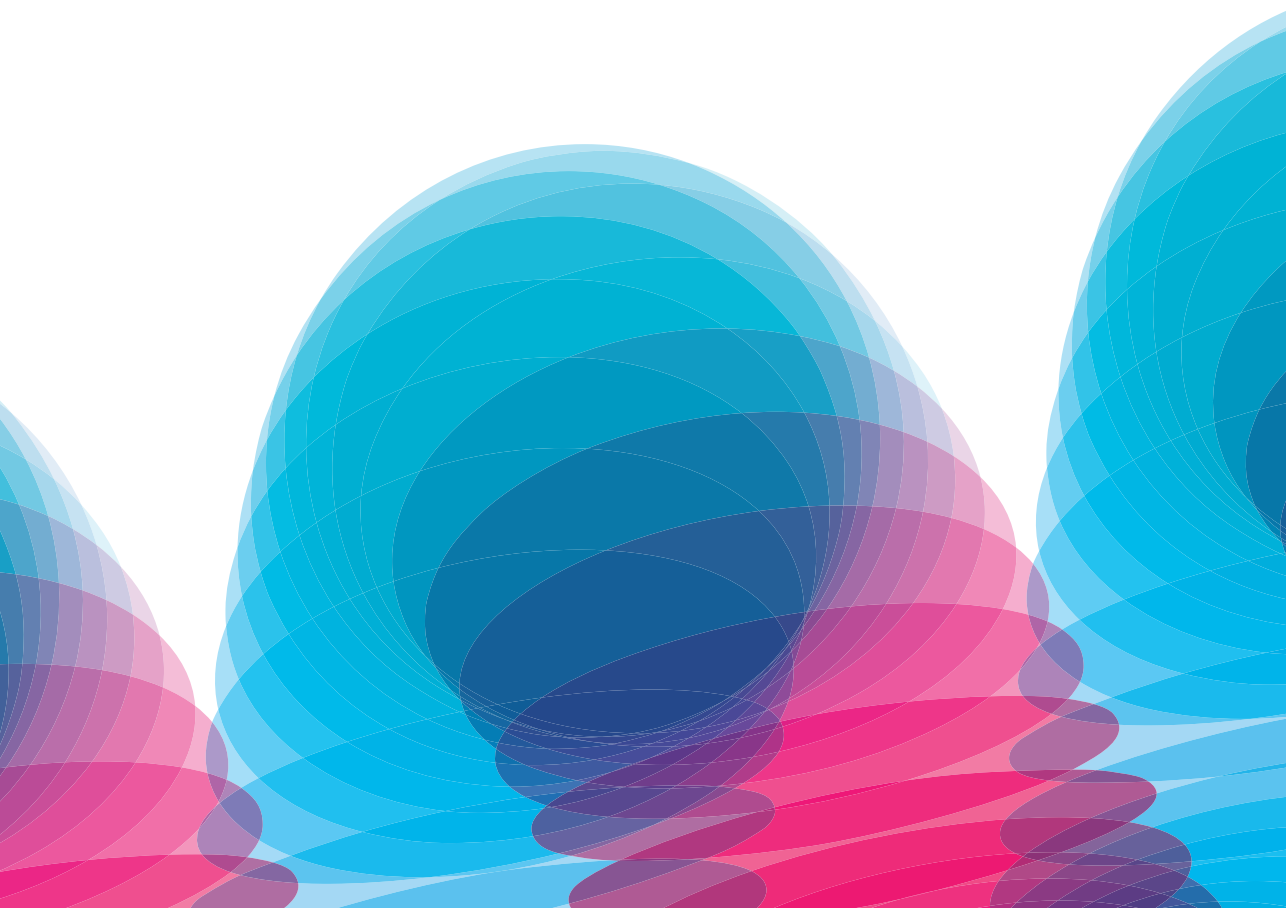




CHAPTER

1

GENERAL INTRODUCTION



The increasing complexity of care requires a multidisciplinary approach in which healthcare professionals work effectively together.¹ This does not merely entail working side by side, but rather structured teamwork with clearly delineated roles and responsibilities, open communication, and active engagement in shared decision-making. Such an approach is essential for providing high-quality, patient-centered care that adapts to each patient's unique needs. In this context, it is essential to have a culture of open communication and continuous learning from daily practice. Such a culture fosters not only the ability to learn from mistakes and provide constructive feedback but also strengthens team members' resilience, enabling them to better manage work pressure and unexpected situations.²

This thesis explores how teamwork can be systematically strengthened to improve both the quality of care and the resilience of healthcare teams. By integrating theoretical frameworks with practical insights, it aims to bridge the gap between conceptual understanding and actionable strategies for fostering sustainable teamwork in healthcare.

Furthermore, there is growing recognition that teamwork is indispensable for addressing many of today's healthcare challenges. However, despite this awareness, strategic efforts to foster effective teamwork remain fragmented across healthcare settings.³ Establishing a constructive work climate with strong collaboration can help retain healthcare professionals by promoting engagement, job satisfaction, and a sense of purpose.⁴ Additionally, close collaboration between professionals and management, along with increased participation at the institutional level, can contribute to a sustainable and resilient work environment, improving both staff retention and the quality of care.⁵

Overarching research question:

How can teamwork in (pediatric) health care be supported, assessed and sustainably embedded to ensure safe, high-quality care?

Professional relevance

In 2001, the report 'To Err is Human' from the Institute of Medicine Committee on Quality of Health Care in America stirred the healthcare community by revealing the alarming extent of preventable medical errors and calling for a system-wide approach to improve patient safety.⁶ In the same year, this committee's report 'Crossing the Quality Chasm: A New Health System for the 21st Century' identified teamwork as essential to quality and safety improvements in healthcare and proposed it as a pillar of a modern, patient-centered system of care.⁷ More recent initiatives, such as the Global Patient Safety Action Plan 2021-2030 from the World Health Organization, emphasize teamwork –characterized

by collaboration, transparency and learning from daily practice – as indispensable for a resilient and safe healthcare culture.⁸ In line with this, Hollnagel et al.'s white paper 'From Safety-I to Safety-II' encourages teams to learn together from daily successes, respond flexibly to variations, and communicate openly to remain resilient and adaptable within complex healthcare systems.⁹

- In the Netherlands, teamwork has become increasingly central to discussions on healthcare quality. The Nivel Monitor Care-Related Injury 2015/2016 report emphasized the value of multidisciplinary collaboration and improved communication among healthcare professionals to enhance patient safety.¹⁰ Likewise, the 2018 NFU Whitepaper *Together for Better Care*¹¹ advocated for interprofessional learning and team training in academic hospitals. The same year, the 'Time to Connect' report from the Federation of Medical Specialists highlighted the importance of multidisciplinary conversations, collaborative training, open communication, along with involving patients as equal team members to foster continuous improvement and patient safety.¹² Subsequently, the report 'Working Together on Appropriate Care: The Future is Now'¹³ from the National Health Care Institute in the Netherlands promoted interdisciplinary collaboration focusing on shared decision-making and clear delineation of roles. Most recently, the Scientific Council for Government Policy's report *Choosing Sustainable Care*¹⁴ argued for collaboration and integration across disciplines to ensure sustainable, future-proof healthcare.

Team interventions:

Team training has been found effective in promoting collaboration and communication, as well as exerting a positive effect on both organizational and patient outcomes.^{15,16} Several team training programs have been developed, including Crew Resource Management (CRM) and TeamSTEPPS.¹⁷ Standardized approaches are lacking however, which makes it challenging to compare interventions, ensure quality, and establish best practices across different healthcare settings.^{18,19}

Non-technical skills (NTS) assessments complement team training programs by enhancing cognitive, social, and personal resource skills essential for safe and efficient task performance. By evaluating communication, decision-making, leadership, and situational awareness, these assessments provide valuable feedback, identify collaboration errors, and support structured non-technical skill development, helping teams adapt in high-risk environments.²⁰

Additionally, a validated tool to measure safety culture in healthcare teams is the Safety Attitudes Questionnaire (SAQ), which includes teamwork among its elements. Administering this tool to team members provides targeted feedback, enables

benchmarking, and identifies potential risks in a timely manner, thereby offering actionable strategies for enhancing patient safety culture.²¹

Knowledge gaps

While the importance of teamwork in healthcare is widely recognized, several knowledge gaps remain:

- **Sustaining teamwork interventions**

The mechanisms essential for sustaining the long-term positive impact of teamwork interventions such as CRM training are not fully understood in hospital settings. This gap highlights the need to identify strategies and support mechanisms required to sustainably embed teamwork practices in healthcare teams. (Chapter 2)

- **Assessment of technical and non-technical skills**

A robust, validated tool to assess healthcare professionals' technical and non-technical skills is urgently needed. Technical skills refer to the clinical and procedural expertise required to perform specific healthcare tasks, while non-technical skills address cognitive and interpersonal competencies. The perceived need underscores the importance of developing tools like the Professional Assessment Tool for Team Improvement (PATTI[®]) for a structured assessment of these competencies. (Chapter 3)

- **Translating safety culture insights into practice**

While patient safety culture assessments, such as with the SAQ, are widely used, translating the gained insights into practical improvements in safety culture within pediatric intensive care settings. Addressing this gap requires developing tailored implementation strategies to enhance communication, foster teamwork, and integrate feedback into daily practices. (Chapter 4)

- **Effectiveness of simulation-based assessment**

More insight is required into the effectiveness of simulation-based assessment of both technical and non-technical skills, particularly in acute care situations where team functionality is critical. Research into the effects of structured simulation-based assessments, such as the "proficiency check," is essential for refining training and building team resilience. (Chapter 5)

- **Teamwork during crises**

The COVID-19 pandemic underscored the importance of teamwork during crises, but ways to optimize team functioning in future crises remain unclear. This gap calls for an exploration of lessons learned from pandemic responses to prepare healthcare teams for resilience in similar future scenarios. (Chapter 6)

Context

Most of the research for this thesis has been conducted in the unique setting of Erasmus MC- Sophia Children's Hospital. Here, the complexity of patient care, interdisciplinary collaboration, and a culture of continuous education and research amplify the impact of teamwork interventions, especially in high-stake intensive care environments where collaboration is crucial to patient safety and care quality.

Outline

Chapter 2: Sustaining the Long-Term Effects of CRM Training in Pediatric Intensive Care

Research Question: What strategies and support mechanisms are needed to sustain the long-term effects of Crew Resource Management (CRM) training in a pediatric hospital setting?

This chapter examines the lasting impact of aviation-derived CRM training on teamwork, communication, and patient safety in pediatric healthcare. While its immediate benefits are well-documented, sustaining them remains less clear. Using focus groups, observations, and individual interviews, this study explores barriers and enablers to long-term CRM integration, emphasizing ongoing training, organizational support, and cultural alignment.

Chapter 3: Developing and Validating the Professional Assessment Tool for Team Improvement (PATTI®)

Research Question: How can the Professional Assessment Tool for Team Improvement (PATTI®) be developed and validated to assess technical and non-technical skills among pediatric intensive care nurses?

This chapter introduces and validates the PATTI®, a tool designed to measure the technical and non-technical skills of PICU nurses. Addressing a critical gap, PATTI® provides a reliable measure of these skills in emergency care. The chapter outlines its development, validation, and role in ongoing assessment and skill improvement in pediatric intensive care.

Chapter 4: Exploring Patient Safety Improvement areas in the PICU: Insights from the Safety Attitudes Questionnaire (SAQ)

Research Question: What patient safety improvement areas can be identified in the Pediatric Intensive Care Unit based on the Safety Attitudes Questionnaire (SAQ), and what implementation strategies are recommended?

This chapter uses the SAQ to assess patient safety culture in the PICU, identifying areas for improvement and practical interventions. Through a mixed-methods approach, it develops strategies to enhance communication, safety protocols, and teamwork, fostering a proactive patient safety culture.

Chapter 5: Evaluating Simulation-Based assessments on PICU Nurses' Skills

Research Question: What is the effect of simulation-based assessments on PICU nurses' technical and non-technical skills during cardiopulmonary resuscitation (CPR), and how do nurses perceive this training?

This chapter evaluates the impact of simulation-based *proficiency checks* on nurses' CPR and non-technical skills in high-stake situations. Using PATTI® in a pre- and post-assessment design, skill improvement is measured, and nurses' experiences are captured through semi-structured interviews.

Chapter 6: Reflections on Teamwork Training During the COVID-19 Pandemic

Research Question: What adjustments were made to teamwork training during the COVID-19 pandemic in Dutch hospitals, and what lessons can be learned for future crises?

This chapter examines how teamwork training evolved in Dutch hospitals during the COVID-19 pandemic. Using expert surveys, it highlights the resilience, flexibility, and key adjustments that enhance team functionality, offering insights for future crisis preparedness.

Chapter 7: General Discussion

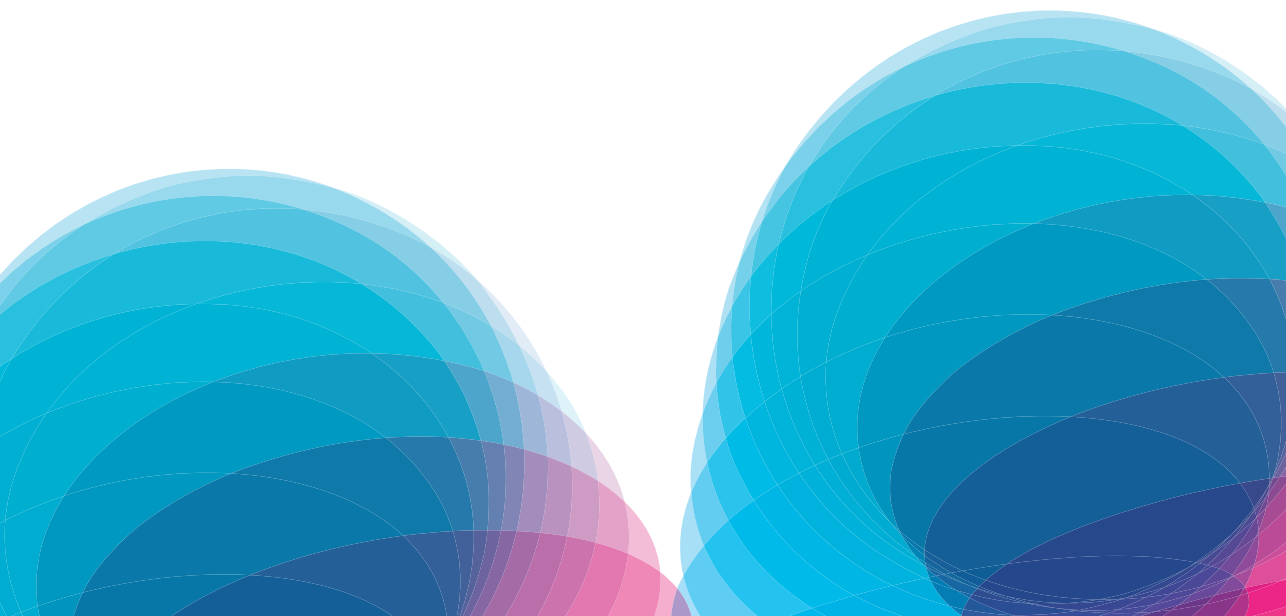
This thesis explores how to support, assess, and sustain teamwork to ensure safe, high-quality care. The research findings are situated within existing literature and policy, emphasizing leadership role in fostering sustainable team interventions, psychological safety, and team resilience. Crew Resource Management (CRM) principles are highlighted, along with structured reflection (briefings and debriefings) and measurement tools like the SAQ and the PATTI® for monitoring and improvement. The COVID-19 pandemic underlined the need for adaptability, structured communication, and reflection in crisis situations.

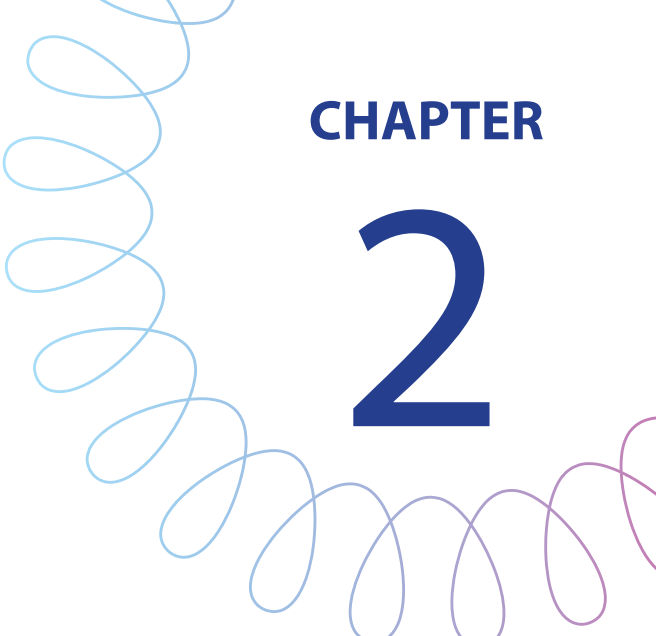
Ultimately, the thesis argues for embedding teamwork into policy, leadership development, and education as a core strategy for healthcare quality and safety.

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CHAPTER

2

EXPLORING SUSTAINABLE CREW RESOURCE MANAGEMENT (CRM) TRAINING AND TOOLS IN PEDIATRIC HOSPITAL CARE: A MULTI-METHOD APPROACH

Ada van den Bos-Boon, Cynthia van der Starre, Robert-Jan Houmes,
Saskia Gischler, Monique van Dijk, Martina Buljac-Samardzic

Submitted



Introduction:

This study deals with the long-term sustainability of Crew Resource Management (CRM) practices in pediatric hospital care, focusing on facilitators and barriers to the adoption and maintenance of these practices. The primary research question explored how CRM practices evolve and are sustained across departments with different levels of CRM experience.

Methods:

A multi-method qualitative study was conducted in three departments of a tertiary children's hospital, namely the pediatric intensive care unit and two medium care units, with respectively 17-, 5-, and 6-years' experience with CRM. Data were collected from 44 participants through focus groups (n=20), observations, and interviews (n=24). Themes emerging from the data analysis were structured using the Consolidated Framework for Sustainability Constructs in Healthcare.

Results:

CRM practices evolved differently across departments, shaped by contextual factors. Sustainability was facilitated by strong leadership support, tailored implementation, team ownership, and active feedback mechanisms. Key barriers included unclear procedures, lack of formal follow up agreements and uneven psychological safety. These could be mitigated by department-specific adaptations and continuous reinforcement of CRM principles in daily practice.

Conclusion:

CRM practices are sustained when tailored to the specific needs and dynamics of each department, supported by engaged leadership at all levels, and embedded through structured follow-up strategies. Addressing local barriers and strengthening shared responsibility among team members are essential to the long-term success of CRM training and tools. Future research should assess the impact of leadership models and tailored strategies on CRM sustainability.

Keywords: Crew Resource Management, teamwork, sustainable mechanisms, pediatric care, team training.

Introduction

Crew Resource Management (CRM) training is a well-established intervention aimed at improving teamwork and patient safety in high-risk environments like the healthcare sector.¹ Originating from aviation, CRM training combines theory-based methods (e.g., lectures), demonstration-based methods (e.g., videos), and practice-based methods (e.g., simulation training) to equip healthcare professionals with the necessary competencies and tools to optimize teamwork and minimize errors. These tools include briefings, huddles, and debriefings, and structured communication methods such as SBARR (Situation, Background, Assessment, Recommendation, Repeat), which have been found essential for effective communication and collaborative decision-making.²⁻⁵

While the short-term benefits of CRM training in healthcare are well-documented, less is known about how CRM practices can be sustained over time. Studies have shown that CRM training can improve teamwork, communication, and patient safety,^{1,6} but the mechanisms for ensuring its long-term sustainability remain underexplored. Previous research suggests that leadership support, organizational culture, and continuous adaptation are key to sustaining CRM training in healthcare settings.⁷⁻⁹ Only few studies, however, have delved into potential factors that facilitate or hinder the ongoing success of CRM interventions beyond their initial implementation.¹⁰

Background

This study focuses on the sustainability of CRM training in our pediatric hospital, namely in the pediatric intensive care unit (PICU) and two medium care units, with respectively 17-, 6-, and 5-years' experience with CRM training. Studying three departments with varying CRM experience within the same hospital allowed us to explore how local context (e.g. leadership and culture) shapes sustainability, offering practical insights often missing in CRM research.

While many studies emphasize the initial implementation of CRM, this study offers empirical insights into the long-term retention of CRM practices across varied clinical settings. Drawing on experiences of healthcare providers involved in CRM training, we explored mechanisms, facilitators, and barriers that in clinical practice potentially influence the sustainability of CRM training.

Methods

Study context

This study was conducted in 2022 at a Dutch academic tertiary hospital in an urban setting, focusing on three departments with varying experiences in CRM training. The 27-beds PICU pioneered CRM training in collaboration with aviation experts, and PICU staff have participated in CRM refresher training every two years since the first session in 2005 until 2019. This hospital-wide policy for CRM refresher training was formalized after other departments expressed interest. The non-ICU neurology (NICN) and Pediatric Thoracic Surgery (PTS) departments, both with 18 beds, began CRM training in 2016 and 2018, respectively, and followed the same policy of bi-annual training.

Study design

A multi-method design was applied to explore factors influencing sustainability of CRM training. We used the Consolidated Framework for Sustainability Constructs in Healthcare (CFH)¹¹, developed by Lennox et al. 2018, to structure and interpret our findings. The framework served as a useful lens through which to categorize emerging factors while also accommodating additional context-specific insights. The visual representation of the CFH used in this study (Figure 1) is adapted from Cowie et al. (2020)¹², who applied the framework in a hospital-based context. The decision to use the CFH framework was informed by prior research demonstrating that sustainability of hospital-based interventions is often hampered by a lack of insight into context-specific barriers and facilitators.¹² Data were gathered in the following order: focus groups, observations, and in-depth interviews.

Data collection:

Focus groups explored the experiences of healthcare professionals who had participated in CRM training, including physicians, nurses, care assistants, and support staff. The questions were intended to inform the subsequent observations and helped identify the presence or absence of CRM skills in daily practice. Four one-hour sessions were conducted: two in the PICU, and one each in the NICN and PTS. Open-ended questions addressed teamwork, communication, and CRM practices with a focus on factors that supported or hindered the sustained use of CRM training and tools. The focus groups were prepared and led by the CRM program manager and the first author, while two junior researchers took minutes and asked additional questions if relevant. The sessions were recorded with participants' permission, transcribed verbatim, and analyzed.

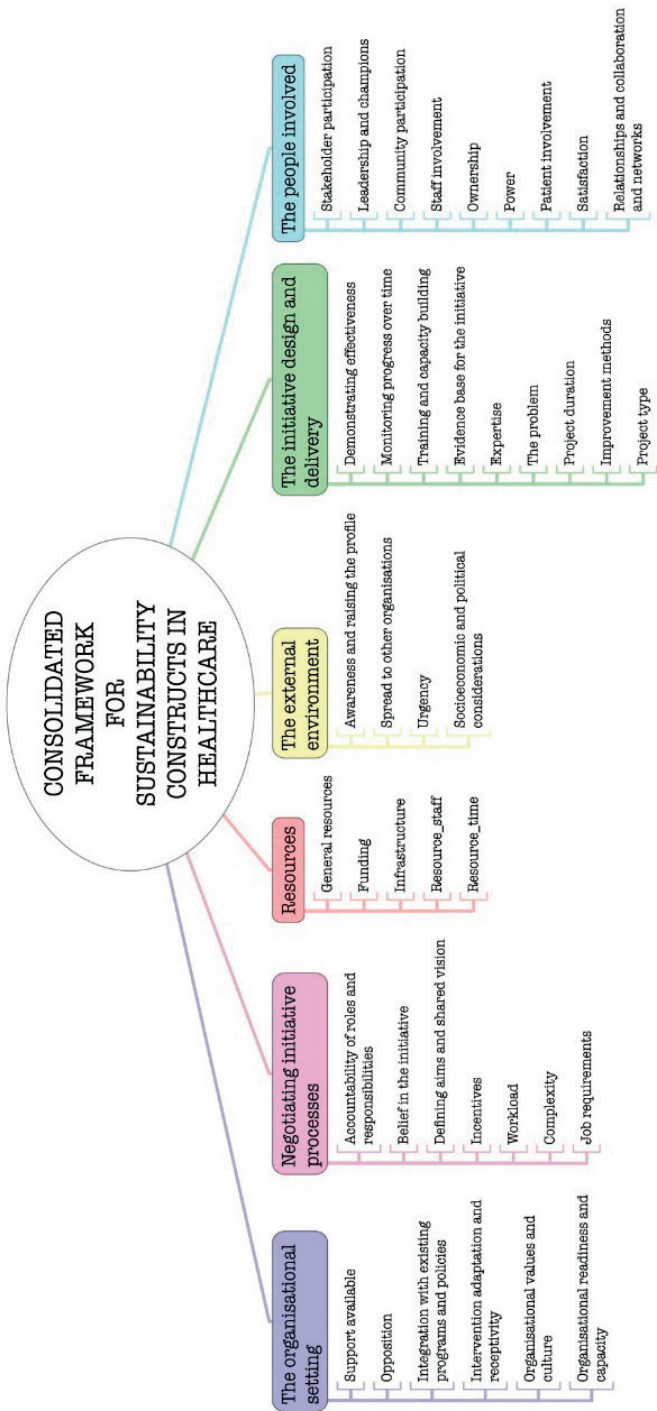


Figure 1. Adapted from Cowie et al. 12, with permission.

The Consolidated Framework for Sustainability Constructs in Healthcare, illustrates key domains and their interrelations relevant to sustainable healthcare practices

Observations were conducted by two student observers each independently observing one of eight separate day shifts: two in the PICU, and three each in the NICN and PTS departments. The observation days had been scheduled in consultation with department managers, and day shifts were chosen to reflect typical daily routines. Shadowing was used as the observation technique. During each shift, the observer followed various team members to capture key events and contextual explanations. While it was not possible to observe all activities of the entire team, efforts were made to gain a representative impression of daily team dynamics. A pre-designed observation form was used that included general CRM skills such as day starts, huddles, and evaluations. The observers noted the following aspects: CRM skills applied, the frequency of occurrence of these skills, and possible reasons why certain skills were or were not effectively applied. The observations were recorded and transcribed into Word documents and analyzed to identify experiences and areas for improvement regarding CRM skills.

We conducted 24 interviews to deepen understanding of key mechanisms identified during the observations. Data collection concluded upon reaching sufficient insight into the main questions emerging from earlier phases. The interplay between focus groups, observations, and interviews was essential to understanding CRM adoption and its potential barriers and facilitators. To mitigate potential bias given the CRM program manager's involvement, the focus groups were co-facilitated by the first author, with two junior researchers taking notes, probing when needed, and independently conducting the initial analysis.

Participant selection

Eligible individuals for the focus groups were invited to participate via email and asked about availability on several dates. The date with the greatest diversity in professional roles and years of CRM exposure (ranging from 2 to 17 years) was selected to ensure a broad range of perspectives. (Supplementary file 1) Interviewees were approached face-to-face after the observations.

Data analysis

All transcripts (from focus groups, observations, and interviews) were thematically analyzed using both inductive and deductive approaches.¹³ We began with an open, inductive coding process to identify themes that emerged naturally from the data, without applying a predefined framework. This phase was conducted by two junior researchers (RvV and KA), under the supervision of the first author (AvdB).

Subsequently, the first author re-coded the data deductively, based on the Consolidated Framework for Sustainability Constructs in Healthcare (CFH) to ensure alignment with the research questions. Coding was cross-checked by two additional researchers (RH, CvdS.)

to enhance consistency and reliability. This iterative process enabled integration of grounded themes with theory-informed categories. Themes were included when supported by multiple participants and/or data sources, ensuring that findings reflected recurring patterns rather than isolated remarks. While we did not systematically analyze responses by professional roles, the multidisciplinary nature of the focus groups allowed themes to emerge across roles and departments.

Intervention

The two-day CRM training covers a comprehensive range of topics, including information management, communication, stress management, leadership, decision-making, and risk management. (Figure 2.)

To ensure practical application, these topics are reinforced through simulated events and debriefings. Essential CRM tools highlighted in the training include briefings, huddles, debriefings, and structured communication protocols like SBARR (Situation, Background, Assessment, Recommendation, Readback).

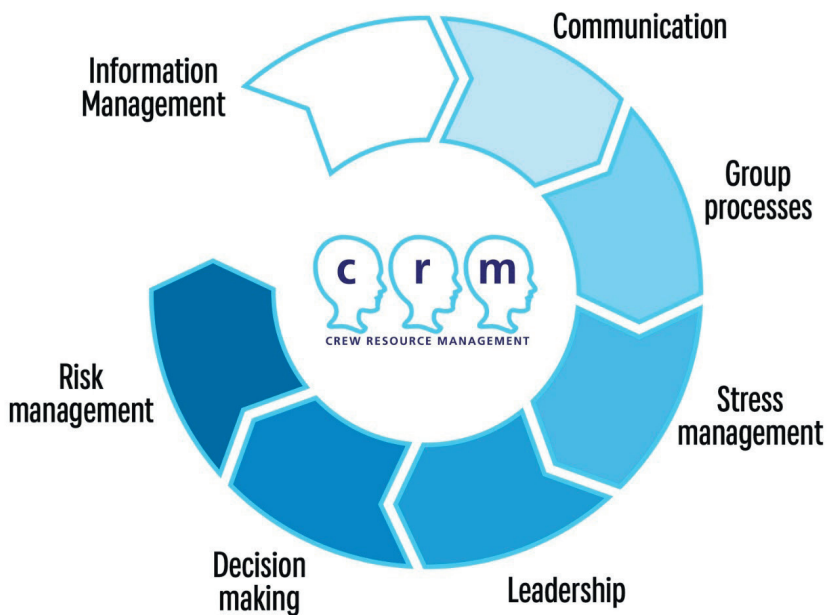


Figure 2. CRM topics include information management, communication, stress management, leadership, decision-making, and risk management.

This figure highlights the core areas covered in the CRM training sessions analyzed in this study.

The training program offers both basic and advanced levels, enhanced by a 'train-the-trainer' approach to ensure ongoing knowledge transfer and skill development. A key aspect of the training is its emphasis on reflective learning from daily practice, aligned with the Safety II approach.¹⁴

A structured roadmap guides the CRM training through the key phases of exploration, elaboration, preparation, implementation, evaluation, and continuous improvement (Supplementary file 2). Evaluation methods, incorporating input from all professionals, include self-developed questionnaires to gather improvement strategies, alongside the Safety Attitudes Questionnaire, which is designed to assess and monitor the safety culture.¹⁵ Following a two-day basic CRM training course and/or one-day follow-up training course, teams are expected to address both challenges and successes identified during the sessions. This proactive approach aims to support sustainability by encouraging ongoing team engagement and reflection. The current study examines how such strategies are perceived and enacted in practice, and the extent to which they contribute to sustained CRM use.

Results

Triangulation of Data Sources

Observational data were used to complement and contextualize findings from focus groups and interviews. The themes presented in the following sections reflect mechanisms that support or hinder CRM sustainability. Observations helped reveal discrepancies between reported and actual practices, which were further explored in interviews to understand underlying contextual factors. For example, during a PTS shift, no formal huddle was observed; instead, nurses exchanged updates informally at the nursing station. Interviewees later cited structural and organizational barriers as reasons for the absence of a formal huddle. In contrast, in the PICU, morning briefings and frequent huddles were observed, with active participation from nurses and residents, mirroring the strong team structure reported by participants. However, although daily evaluations were reported as routine practice, they were not observed during any of the three PICU shifts. Interviewees attributed this to variation in team composition and the presence – or absence – of individuals who initiate the process.

A total of 20 participants participated in the four focus groups, and 24 in the interviews, with observations data collected over the course of 8 days. The data analysis overall revealed that CRM sustainability requires addressing factors at multiple levels. (Figure 3) At the organizational level, critical factors include leadership support, alignment with institutional goals, and readiness to create a supportive environment for teamwork.

HEALTHCARE PROFESSIONALS' BARRIERS AND FACILITATORS IN 17 YEARS OF CRM TRAINING: A CFH-BASED REVIEW

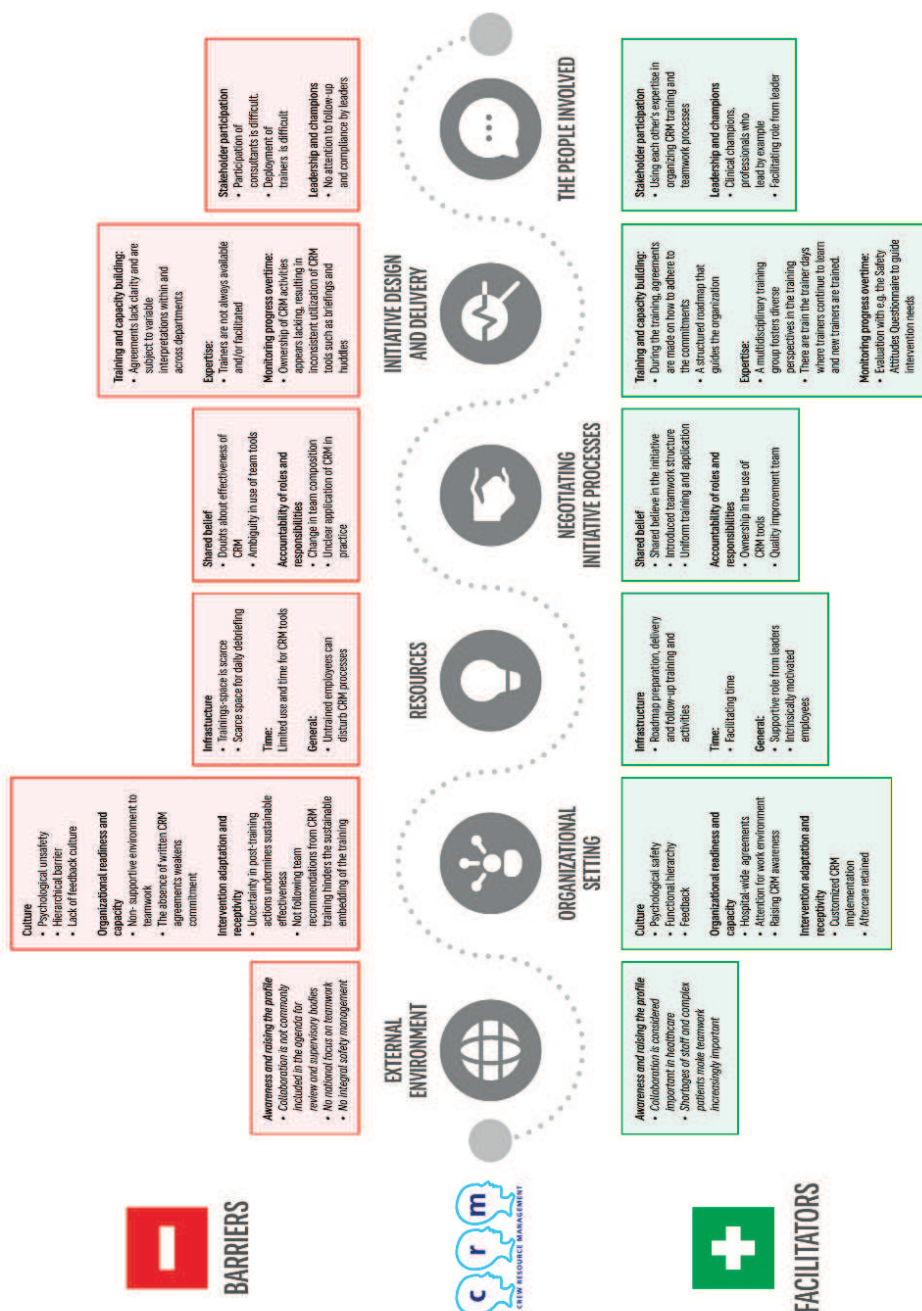


Figure 3. Results incorporated into this adapted figure from Cowie et al. (2020) 12, reproduced with permission.

The figure presents the integration of study findings within the Consolidated Framework for Sustainability Constructs in Healthcare (CFH), showing the application of CRM practices to the sustainability context.

At the team level, facilitators such as effective communication, a shared mental model, and ownership of CRM tools play a crucial role. At the individual level, personal competencies like adaptability, resilience, and the ability to integrate CRM practices into daily routines are key.

External Environment

The CFH domain External Environment did not emerge as a distinct theme in our data. During the focus groups and interviews, participants did not mention any constructs related to this domain. In Figure 3, we included hypothesized constructs in italics for this domain, which we expected might play a role.

Organizational Setting

In the organizational setting, psychological safety emerged as a critical facilitator for CRM sustainability. Over time, the organization's efforts to foster a culture of psychological safety have become more structured, yet the sense of safety is still not universal. While some employees feel safe to speak up, others remain more hesitant, particularly depending on team dynamics and leadership style. This evolution highlights how psychological safety is not only a facilitator but also a dynamic element that requires continuous attention and adaptation.

*"I always thought you were allowed to ask even the dumbest questions.
But that depends on who you're working with". (FG PICU)*

Another theme, hierarchy, was both a barrier and facilitator over time. Initially, hierarchy was seen as disruptive, particularly when used as a power tool, but as CRM practices matured, hierarchical structures began to support communication. This shift highlights the evolving nature of organizational structures and their role in facilitating CRM implementation.

A third theme, feedback culture, has also evolved over time. In the past, feedback was often perceived as difficult to give and receive, with varying levels of effectiveness. Over time, departments that fostered open communication and closer-knit teams developed a more robust feedback culture, facilitating the continuous improvement of CRM practices.

"Feedback does get done, there is an open atmosphere" (NICN I4).

This evolving feedback culture contrasts with earlier perceptions of feedback as a static phenomenon, suggesting that feedback is actively acted upon to improve practice. Several participants described a culture characterized by mutual respect, open

communication, and the ability to speak up across professional boundaries. This was seen as foundational for psychological safety and teamwork. For example, a respondent stated:

"I don't feel there's any hierarchy. I feel like I can always approach everyone" (PICU I2).

Regarding *the capacity and readiness of the organization* to implement CRM training, a key barrier was the lack of clear written agreements on CRM use, leading to limited commitment from departments. Additionally, the lack of essential infrastructure, such as managing the flow of individuals in and out of a ward, can disrupt teamwork. A front desk can help solve this problem. Although several departments demonstrated strong local leadership, many respondents described a lack of structural support at the executive level—such as limited access to training rooms or protected time for training. This perceived misalignment created friction between local initiatives and institutional priorities.

Conversely, several facilitating factors were found to contribute to the sustainability of CRM training, particularly the existence of a comprehensive roadmap that outlines methods, mutual expectations, responsibilities, and aftercare processes. Such a roadmap ensures that the training is well-aligned with the department's context and also includes specific follow-up measures such as the use of CRM tools. Appointing a program manager dedicated to overseeing the continuity of CRM training further strengthens the implementation process and aids sustainability by ensuring consistent follow-up, addressing challenges, and adapting the program to evolving needs.

In terms of *receptivity and adaptation* to CRM training, hesitancy to instigate action is seen as a limiting factor, possibly stemming from a lack of follow-up on action items post-training. However, adapting the training to the specific needs of a department and developing a concrete plan of post-training action are recognized as important facilitators for training effectiveness. (Table 1).

Table 1: Barriers and facilitators domain organizational setting

Construct: Definition (as described by Lennox et al.)	Context	Barriers/ Quotes	Facilitators/ Quotes
Culture Organizational beliefs and values that support a culture for the initiative and its sustainability.	Psychological safety Differences in psychological safety affect communication and collaboration; essential for CRM success.	<u>Psychological Unsafety</u> Quote FG PICU: "I always thought you were allowed to ask even the dumbest questions. But that depends on who you're working with"	<u>Psychological safety</u> Quote FG PICU: "I do believe there's is a culture focused on safety."
	Hierarchical Power dynamics can inhibit CRM, but a functional hierarchy where communication is encouraged strengthens collaboration and CRM effectiveness.	<u>Hierarchical barrier</u> Quote FG NICN: "It also seems hierarchical, where it's like 'I am the doctor, so when I say something, nurses must respond right away,' and if they don't, they actually find it strange."	Quote PICU I 4: "But I believe that every ward has an open culture where you can just speak freely with each other."
	The absence of a feedback culture limits CRM practices, but an open feedback atmosphere enables consistent team performance and CRM sustainability	<u>Lack of feedback culture</u> Quote FG NICN: "Uhm, I find it difficult to notice that there is a huge gossip culture in the department, and I really think that's inappropriate."	<u>Functional Hierarchy</u> Quote PICU I 2: "The approach is very good; I don't feel there's any hierarchy. That's not my experience. I feel like I can always approach everyone." <u>Feedback:</u> Quote NICN I 4: "Feedback does get done, there is an open atmosphere."
Organizational Readiness and Capacity: Capacity and readiness of the organization to undertake the initiative.	The lack of formal CRM agreements creates confusion. A structured roadmap helps clarify roles and responsibilities, supporting CRM sustainability.	<u>Non-supportive environment to teamwork</u> Quote FG PICU: "When people just walk in unannounced... we don't have a proper reception desk now." <u>The absence of written CRM agreements weakens commitment</u> Quote NICN I 11: "There is a framework, but it is unclear. It's not written down anywhere.... Sometimes I miss a clear framework in this place where it says: there is no choice, you just participate."	<u>A detailed roadmap planning CRM training</u> Quote SGI 10: "We also have a roadmap in place. It outlines who is responsible for what, who makes arrangements, what expectations are set and how responsibilities are divided." <u>Raising awareness about CRM.</u> Quote PTS I 20: "CRM fades quickly, but it does add. On your own, you become more aware of its importance. Does everyone find it important?" Quote PICU I 21: "The focus on CRM lasts for about three months, and then it starts to decline. Maybe using posters as reminders would help."

Table 1: Continued

Construct: Definition (as described by Lennox et al.)	Context	Barriers/ Quotes	Facilitators/ Quotes
Intervention adaptation and receptivity: The ability of an initiative to respond to change and adapt to fit with local contexts and requirements.	Uncertainty post-training weakens CRM effectiveness, while customized training ensures CRM tools are contextually relevant and sustainably applied. Department-specific CRM adaptations enhance effectiveness but often require additional effort to implement.	<u>Uncertainty in post-training actions undermines sustainable effectiveness</u> Quote PICU I 9: "It does get done, but sometimes you're driven by the hustle of the day." Quote PTS I 17: "Sharing collective responsibility, reading emails. Opinions vary greatly on how to manage time." <u>Not following team recommendations from CRM training hinders the sustainable embedding of the training.</u> Quote SG I 10: "Unfortunately, we've also had departments where nothing got done."	<u>Customized CRM training</u> Quote PTS I 12: "That it should become a training in which the team can see itself reflected." Quote SG I 10: "So 1) collecting pictures 2) looking for what's going on in a department. And what is also important are the reflection conversations. You do the reflection talks with the target group of the department, so that you also have information from the patient's perspective so that connects to their work processes." <u>Aftercare retained.</u> Quote PTS I 12: "Last time, we formed a small working group and created a top five list. We began working on that."

Legend for Quotes in the Table:

- Source:I = Interview; FG = Focus group
- Department: PICU = Pediatric Intensive Care Unit; NICN = Non-ICU Neurology; PTS = Pediatric Thoracic Surgery; SG = Sophia General (staff with cross-departmental roles)
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Resources for sustainable CRM training

Barriers and facilitators related to the resources needed for sustainable CRM training are classified into three constructs: infrastructure, time, and general resources. Table 2 provides an overview, including quotes that highlight these barriers and facilitators.

Infrastructure: a significant barrier is the lack of adequate training rooms and spaces for team briefings and evaluations. Conversely, the existence of a roadmap and an environment that supports CRM principles are strong facilitators. Departments that did develop designated spaces for training and team learning activities found this approach to be a key enabler.

Time: The lack of protected time was often seen as a major constraint. This challenge evolved, as more departments started to allocate dedicated time slots for CRM training, allowing for more consistent participation and follow-up. Sufficient protected time was considered an important facilitator for both trainers and participants.

General: A barrier to sustaining CRM practices is the presence of team members who have not received CRM training. Conversely, the involvement of leaders who actively promote CRM training along with the engagement of intrinsically motivated individuals with relevant knowledge and expertise, serves as a facilitator for the sustainability of CRM practices. (Table 2).

Negotiating initiative processes

Successful negotiation of initiative processes in our study depends heavily on a shared belief system among professionals. Two distinct groups can be identified: those who genuinely believe in CRM training and those who remain skeptical. Skepticism about the effectiveness of CRM often leads to inconsistency in the application of training and tools across teams.

“The daily start is embraced. But not everyone is convinced about the huddle. Because the majority isn’t convinced, the implementation doesn’t work either.”
(PTS I 11)

Conversely, for those committed to CRM, the continuous use of its tools reinforces their perceived value. *Roles and responsibilities* in CRM initiatives ensure team consistency and clarity. When responsibilities and roles are not clearly defined or change due to team adaptations, for example, agreements can be lost, leading to ambiguity in the application of CRM tools. Then, essential tools such as the huddle risk not being used as intended, thereby reducing the effectiveness of CRM initiatives. On the other hand, when teams take ownership of the use of CRM tools and a sense of responsibility is encouraged, it can foster collaboration and improve the quality of care.

Table 2. Barriers and facilitator's domain Resources

Construct: Definition (as described by Lennox et al.)	Context:	Barriers/ Quotes	Facilitators/ Quotes
Infrastructure: The resources required to support the initiative, such as buildings, office space, materials, and supplies.	The lack of space for training and debriefings is a significant barrier to CRM implementation. A structured CRM roadmap ensures clarity and better management of responsibilities, enhancing CRM sustainability.	<u>Training-space is scarce</u> Quote SG I 9: "What we immediately run into is leadership. EMC loves that we provide CRM training but then doesn't facilitate anything. So, even just reserving suitable spaces is already a hassle." Quote NICN I 10: "There isn't really a space where daily evaluations can take place. Now people just walk in while someone is crying. There are plans for this in the new building as well"	Roadmap preparation, delivery and follow-up on action points from the training Quote SG I 9: "...a roadmap that gets initiated, outlining who handles what, who makes the arrangements, what the expectations are, and how we divide responsibilities."
Time Time and energy to dedicate to the initiative	Time constraints on follow-up and evaluations hinder CRM continuity. A time investment from leaders and trainers is necessary to overcome these barriers and ensure the effectiveness of CRM practices.	<u>Limited follow up and time for CRM tools.</u> Quote PICU I 24: "On busy days, a daily evaluation would add value. However, it's not always feasible. Due to time constraints, doing it earlier in the day conflicts with other tasks."	<u>Time</u> Quote SG I 9: "We expect a time investment from a trainer." Quote PTS I 17: "shared responsibility, how to handle time."
General: Any resources needed to manage and maintain an initiative.	Untrained staff can disrupt CRM processes, especially during critical moments. However, intrinsically motivated employees help sustain CRM by organizing resources and participating beyond formal working hours, ensuring continuous CRM engagement.	<u>Untrained employees can disturb CRM processes.</u> Quote FG PICU: "...people who are in the wrong place and get in the way during acute situations are surprised when you say something about it; as they don't understand their role."	<u>Supportive role from leaders</u> Quote SG I 9: "A prerequisite is that your manager gives you the space to do it." <u>Intrinsically motivated employees</u> Quote SG I 9: "People who truly find it important make sure it works. They arrange things themselves and have people come in their own time."

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"We can only do it together. Responsibility lies with both sides." (NICN I10)

To maximize the impact of CRM initiatives, *accountability* must be broadly shared within the team. Table 3 outlines the key barriers and facilitators related to the negotiation of CRM processes.

Initiative design and delivery

For the domain of initiative design and delivery, three key constructs were mentioned that contributed to the sustainability of CRM training within the organization, first: *Training and Capacity Building*: The sustainability of CRM largely hinges on effective staff orientation and ongoing educational support. A major barrier is the inconsistent application of CRM principles and tools, often due to the lack of a vision.

"It does work, but it's not done consistently. There, they used to do the huddle as a standard practice." (FG PTS)

When CRM practices are not clearly defined and standardized, they are implemented inconsistently. Over time, the presence of a roadmap greatly facilitates the various phases of CRM training, ensuring a more cohesive and sustained approach.

Second expertise: Adequate expertise of trainers is vital for sustaining CRM training efforts. Unfortunately, the limited availability of trainers impedes the consistent delivery of CRM training. On the positive side, the existence of a multidisciplinary training group serves as a strong facilitator. Trainers who can guide discussions from diverse perspectives enhance the training experience. Additionally, organizing "train-the-trainer" days ensures continuous learning and may result in the availability of more trainers.

"Twice a year, all trainers come together for half a day to continue learning." (SG I 9)

Third, *monitoring progress over time*: Sustaining CRM practices requires the ability to effectively monitor progress over time. A significant challenge is maintaining focus on CRM activities, particularly as priorities shift within the organization. To counter this, the use of CRM tools, such as briefings and huddles, is essential for reinforcing CRM practices. Additionally, repeat training sessions play a key role in maintaining momentum and ensuring CRM practices remains tailored to the evolving needs of each department. Participants indicated that evaluation tools, such as self-developed questionnaires and the Safety Attitudes Questionnaire, helped keep CRM themes on the agenda. (Table 4)

Table 3: Barriers and facilitators domain negotiating initiative processes

Construct: Definition (as described by Lennox et al.)	Context:	Barriers/ Quotes	Facilitators/ Quotes
Shared Belief: The belief that the initiative will be valuable, producing the intended benefits and improvements to care.	The lack of widespread belief in CRM's effectiveness, particularly in activities like the huddle, affects CRM adoption, as people hesitate to fully engage. Confusion over CRM tools, such as repeating discussions during handovers and huddles, reduces their perceived value, making staff hesitant to use them consistently. Implementing a clear teamwork structure, where roles are well defined, increases accountability and helps ensure safety and quality in patient care	Doubts about the effectiveness of CRM Quote PTS I 11: "The daily start is embraced. But not everyone is convinced about the huddle. Because the majority isn't convinced, the implementation doesn't work either." Ambiguity in the use of team tools Quote PICU I 22: "Barriers: Care and time. Discussing seven patients during the handover and then again during the huddle feels redundant."	Shared <u>believe in the initiative</u> Quote FG NICN: "You have to make choices, but if people could increasingly experience the necessity of CRM, they might also be willing to make a sacrifice." The introduced teamwork structure Quote PICU I 18: "I found it a revelation that as a senior nurse, you know how to ensure safety and quality, but it's the clarity of roles at the bedside that really stands out." Uniform training and application. Quote PICU I 1: " ..And when you say, 'I don't think this is CRM-compliant,' it's like a button flips."
Accountability of Roles and Responsibilities: Roles and responsibilities in the initiative are clearly defined and distributed across teams to prevent reliance on specific individuals.	Team changes can cause role confusion, weakening CRM practices. Clear roles are essential for sustained implementation, but lack of consistency undermines efforts. Shared responsibility between team members, acknowledging that CRM requires collective effort, reinforces accountability and encourages collaboration in CRM use.	Changes in team composition Quote FG NICN: "I mean, when the composition of a team changes, previous agreements get lost." Unclear application of CRM in practice. Quote FG PICU: Yes, but what I see happening during the 'huddle' is that it becomes like a mini-round!"	Ownership in the use of CRM tools Quote PICU I 18: "Everyone needs to embody that." Responsibility quality improvement. Quote NICN I 10: "We can only do it together. Responsibility lies with both sides."

Legend for Quotes in the Table:

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Table 4: Barriers and facilitators domain the initiative design and delivery

Construct: Definition (as described by Lennox et al.)	Context	Barriers/ Quotes	Facilitators/ Quotes
Training and Capacity Building Orienting and training staff to deliver the initiative successfully, with ongoing educational and skill-building support for new workers.:	Lack of clarity in agreements leads to inconsistent CRM practices, but a structured roadmap and formalized agreements improve consistency and effectiveness.	Agreements lack clarity and are subject to variable interpretations across departments.	<u>During the training, agreements are made on how to adhere to the commitments.</u>
		Quote FG PTS: "And the question is, is it a problem that some things slip? Do you understand what I'm saying? That we lose the huddles because they don't work—is that really a problem?"	Quote FG PICU: "I just happen to be a senior, but what I mean is that it's very nice when you agree on something, that people actually follow through. We've had CRM training, and we've made agreements to stick to them."
		Quote FG PTS: "It does work, but it's not done consistently. There, they used to do the huddle as a standard practice."	A structured roadmap planning CRM training and follow-up guides the organization.
		Quote FG PTS: "When there's really a lot going on, I do appreciate having a huddle."	Quote SG I 7: "A: We have a conversation with a CRM group, if there is one. We discuss the checklist and look at what their role is. X and I walk around the department, sometimes taking pictures of what catches our attention."
			Quote SG I 9: "In one department, there was an explosion of activity, with people getting to work on all sorts of things, especially briefings and huddles, time-outs. In another department, for example, it was the tip and top boxes that were being promoted again."
Expertise: Having adequate expert knowledge and experience to carry out an initiative.	Trainer shortages, particularly among physicians, hinder CRM training. A multidisciplinary approach to training, combined with ongoing education for trainers, ensures CRM practices are spread and maintained effectively.	Trainers are not always available, especially physician trainers.	A multidisciplinary training group fosters diverse perspectives in the training.
		Quote SG I 7: "The availability of trainers, especially doctors, is a bottleneck."	Quote PTS I 17: "Multidisciplinary work, although sub-specialists can sometimes be a challenge." There are "train the trainer" days where trainers continue to learn, and new trainers are trained. Quote SG I 9: "Twice a year, all trainers come together for half a day to continue learning."

Table 4: Continued

Construct: Definition (as described by Lennox et al.)	Context	Barriers/ Quotes	Facilitators/ Quotes
Monitoring Progress Over Time: The ability to monitor the Initiative using standardized systems or mechanisms over time.	Lack of ownership for CRM tools leads to inconsistent use, but evaluation through tools like the Safety Attitudes Questionnaire ensures that CRM practices are consistently improved and sustained.	Ownership of CRM activities appear lacking, resulting in inconsistent utilization of CRM tools such as briefings and huddles. Quote PICU I 1: "Debriefings happen inconsistently, usually at the end of the day."	Evaluation with tools like the Safety Attitudes Questionnaire to guide interventions. Quote SG I 9: "Feedback is given to management, which leads to follow-up evaluation meetings."

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The people involved

In the domain People Involved, two relevant constructs were mentioned: *Stakeholder Participation and Leadership and Champions* (Table 5). Sustainable CRM training requires active involvement of all stakeholders. However, some sub-specialists affiliated with other departments feel disconnected from a specific ward and do not adhere to department policies. Although agreements have been made about their involvement, these are not always taken seriously.

“Participation with medical coordinators is going well, but working with sub-specialists is still a challenge.”(PTS I 11)

Facilitators include involving employees at the team level and leveraging each other's expertise in organizing CRM training and teamwork processes. Leadership and Champions is the second construct: sustainable CRM needs leaders and champions who advocate, communicate, and support the initiative.

“The first few weeks focus on CRM skills. Maybe more attention is needed for aftercare, because those skills tend to fade over time.” (NICN I 13)

A barrier is the perceived time investment in using CRM tools, and there is a noted lack of follow-up and compliance by leaders. Facilitators are formal leaders and advocates who prioritize CRM issues, ensuring these topics are consistently addressed over time at the management level.

“You have to lead by example, not just say something and then fail to follow through.” (PTS I 11)

Additional context-specific themes emerged that extended or nuanced CFH constructs. These are shown in Table 6.

Table 5: Barriers and facilitator domain the people involved

Construct: Definition (as described by Lennox et al.)	Context	Barriers/ Quotes	Facilitators/ Quotes
Stakeholder Participation: The need for involvement and participation from stakeholders who are affected by the initiative	The lack of engagement from consultant physicians and the vagueness of formal CRM frameworks hinders effective CRM implementation. However, involving professionals from multiple disciplines enhances the sustainability of CRM practices and fosters greater integration across teams.	Participation of consultant physicians is difficult. Quote PTS I 1: "Participation with medical coordinators is going well, but working with sub-specialists is still a challenge." Quote NICN I 10: "There is a framework in place, but it's vague and not written down anywhere; it's said they once committed to it... they come in, do their part, and then leave. That's why it's different." Deployment of trainers remains a challenge Quote SG I 8: "... availability of trainers is a bottleneck. Especially when it comes to physician trainers."	Using each other's expertise in organizing CRM training and teamwork processes. Quote FG NICN: "... that you use each other's expertise, from doctors to nurses and back, and all other disciplines, so that you work together instead of in isolation."
Leadership and Champions: A person or group of people who have the ability and skills to advocate, communicate, and support an initiative to achieve lasting change.	Active leadership and leadership by example are critical for the sustainability of CRM. The lack of follow-up and inconsistent leadership can become barriers, while leaders engaging in regular team activities like huddles and encouraging follow-through can sustain CRM practices.	No attention to follow-up and compliance by leaders Quote NICN I13: "The first few weeks focus on CRM skills. Maybe more attention is needed for aftercare, because those skills tend to fade over time."	Clinical champions, professionals who lead by example Quote NICN I 10: "Attention to CRM topics by department management." Quote PTS I 11: "You have to lead by example, not just say something and then fail to follow through." Facilitating role from leaders Quote NICN I 11: "I find huddling very important; I always tell the seniors." Quote PTS I 12: "Starting with the day shift because then I can still connect with the night shift briefly. Like, how was your shift, can I help with anything? I value teamwork."

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Table 6. Themes beyond CFH framework

Theme	Explanation	Quote	Quote Context
Future Visioning	Participants envisioned what ideal collaboration would look like: who should be involved, what should or should not happen.	SG I: In the ideal world, a structure would help. But if someone says, 'patient care comes first', I'm left empty-handed.	A CRM trainer expresses her wish to embed training structurally but struggles with the recurring argument that 'patient care comes first', which blocks long-term planning.
Interpersonal Norms	Participants described shared expectations about how team members should interact, including but not limited to collaboration and communication. These interpersonal norms influenced daily routines, team dynamics, and mutual.	FG PICU: We always close the day together, not just one person leaving, and the others surprised they're gone.	This quote illustrates an interpersonal norm of courtesy and coordination: finish the day together and don't leave without informing colleagues, so tasks and handovers are clear.
Positive reflective Dialogue	Thinking in ideals (a '10') helped participants reflect on what could or should change.	FG PTS 3: Yes, I can think of that... maybe it helps to think of what we would stop doing.	A participant engages in guided reflection, using 'what we should stop doing' as a prompt to rethink current practices, a form of forward-focused dialogue.
Shared Responsibility Dynamics	Participants described how mutual expectations around task completion and communication shaped their sense of ownership. When roles and follow-up were unclear, frustrations about accountability emerged. This dynamic was especially visible in informal team interactions, beyond formal leadership structures.	FG NICN: If you've received it and don't read it, that's your responsibility. But you did get it, so I'd say: that counts.	The participant expresses frustration about communication and accountability, pointing to blurred ownership when tasks or information are not followed up.
Learning Mindset	Beyond having psychological safety, participants showed curiosity and a readiness to learn from daily experiences, team reflections, and mistakes. This mindset supported continuous improvement.	FG PICU: There's so much we can learn from that!	An enthusiastic reaction to a reflection, emphasizing the team's openness to learn from experience and conversations.

Discussion

This study examined the long-term sustainability of Crew Resource Management (CRM) practices on three wards in a children's hospital. The study findings reveal the complexity of dynamics affecting CRM sustainability, particularly illustrated by the finding that factors such as leadership, training involvement, and team engagement can both hinder and promote sustainability. Integrating CRM tools into daily routines, such as team briefings, huddles and debriefings, proved crucial to ensuring CRM's long-term sustainability. While observations provided a snapshot of real-time practice, the focus groups and interviews offered deeper insight into the mechanisms that support the long-term integration of CRM. Leadership was an important factor, with a shift over time from centralized leadership to distributed leadership among all team members. De Brún et al. also emphasized the importance of collective leadership in healthcare teams for achieving success of interventions such as CRM training.¹⁶ A key aspect of CRM sustainability is the need for context-specific adaptation of CRM tools and training, which supports Moore et al.'s recommendation that interventions should be tailored to the unique needs of each department.¹⁷

Our findings underline the importance of a feedback culture as a facilitator for CRM sustainability. Feedback culture is preferably characterized by respectfulness and openness, aligning with the work of Mann et al.¹⁸, who demonstrated that respectful communication and interprofessional collaboration not only improve team functioning in general but also foster psychological safety within the context of quality improvement interventions. As in our study, Mann et al. emphasized the value of ongoing support and coaching after initial training to maintain and reinforce positive behavioral changes.¹⁸ Furthermore, the iterative nature of their intervention process underscored the importance of continuously adapting training programs. A process where CRM tools are not only adapted to the specific context but are also regularly reviewed and refined is critical for preventing inconsistencies or reduced effectiveness in practice.

Using the CHF Framework, we systematically examined the organizational, team and individual factors that influence CRM practices. However, by adopting an inductive-first approach, we identified additional themes – such as reflective dialogue around ideal situations and interpersonal norms, that may not have emerged through a purely deductive lens. This underscores the value of remaining open to emergent, context-bound factors when interpreting sustainability in practice. While CRM training was adapted for local recognizability (e.g. using local examples and visuals), the theoretical content remained consistent and was regularly reviewed by experts. However, fidelity in clinical practice was not systematically assessed, so the extent to which CRM tools were applied as intended remains unclear.

The long history of CRM training in the hospital's PICU (17 years) provided unique insights into the evolution of CRM practices and their sustainability. The inclusion of two other departments (and a multidisciplinary group of physicians, nurses, and care assistants) enriched the study and reduced selection bias.

Nevertheless, several limitations of the study need to be addressed. Data were collected in a single tertiary hospital, limiting the generalizability of our findings. Although the study focused on internal factors such as leadership and departmental commitment, external factors such as national health care policy, regulatory changes or institutional guidelines, which can significantly impact CRM sustainability, were not examined. While our single-site design limits generalizability, the cross-units analysis offered a unique view of sustainability mechanisms under shared institutional constraints but differing local cultures. External policies and regulatory influences were not explicitly addressed during focus groups or interviews. We acknowledge this as a limitation and recommend that future research actively explores how system-level factors such as national policy or institutional regulations may influence the sustainability of CRM practices.

Our study adds to the body of research on the sustainability of CRM, an area that so far has been under studied. Baker et al. emphasized the importance of team leadership in maintaining a culture of safety, which is crucial to the sustainability of CRM practices.¹⁹ Our findings are consistent with this observation, as team-level leadership played a central role in ensuring regular use of CRM tools such as briefings and debriefings. Our findings are consistent with those of Yun et al., who suggested that effective leadership in high-stress environments depends on adapting leadership styles to the specific context and challenges faced by teams.²⁰ Similarly, this study found that the ability to adapt leadership styles was key to overcoming barriers to CRM sustainability.

An important aspect that distinguishes our research is its emphasis on the need for CRM practices to fit the unique challenges of different departments. Likewise, Moore et al. and Leeman et al. put emphasis on tailored interventions to specific hospital infrastructures and needs.^{17,21} Scott et al. highlight the critical role of acknowledging and addressing the complexity of healthcare contexts in ensuring the effectiveness of interventions like CRM. Without considering contextual factors such as team dynamics, organizational culture, and interprofessional interactions, even well-designed interventions may fail to achieve their intended outcomes.²² Our findings demonstrate that for CRM practices to remain effective and sustainable over time, they must be contextually relevant and supported by mechanisms such as team engagement, interdisciplinary collaboration, and leadership at all levels. Nevertheless, some participants were concerned about the lack of visible support at the executive level. Others perceived a lack of strategic prioritization, evidenced, for example, by limited access to training rooms or insufficient protected time.

In line with Zurynski et al., our findings emphasize that while external factors like leadership and resources are critical, tailoring CRM tools and practices to changing local needs is essential for fostering collective responsibility and buy-in across diverse teams.²³

This study has several important implications for clinicians and policymakers. First, the sustainability of CRM practices requires an ongoing commitment from leadership at all levels, extending even to individual employees. The shift from centralized to distributed leadership observed in this study is critical to sustaining CRM practices on the long term. Our findings also highlight that CRM practices need to be adapted when needs of teams and departments change. Lennox et al. likewise argue that healthcare interventions must be constantly assessed and adapted to remain effective.¹¹

Moreover, our research highlights the role of psychological safety in maintaining CRM practices, consistent with Edmondson's work on creating safe environments in which team members can speak up without fear of repercussions.^{24,25}

Future research should examine how external factors such as national healthcare policies, changes in relevant regulations and institutional mandates affect the sustainability of CRM practices in different settings. In addition, it would be worthwhile to explore how different leadership models – such as transformational leadership or collective leadership – affect the implementation and sustainability of CRM practices in different healthcare settings. Finally, research is needed on how interdepartmental collaboration and shared CRM practices can support sustainability in hospitals with multiple specialized departments.

Conclusion

This study shows that sustaining CRM practices in clinical settings relies on leadership at all levels, continuous adaptation of CRM tools to local contexts, and a team culture grounded in respect, collaboration, and psychological safety. Striking a balance between flexibility and fidelity to core CRM principles is essential for long-term effectiveness.

By studying three units with different CRM histories within a single institution, we demonstrated how local context and team dynamics shape sustainability, even under shared organizational conditions. These insights are relevant for other healthcare settings seeking to embed CRM beyond initial implementation.

CRM training should not be viewed as a one-time intervention, but as a dynamic, ongoing process. To support sustainability, healthcare organizations and policymakers should invest in long-term strategies such as follow-up training, leadership development, and team-based coaching.

Acknowledgments

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The authors have no competing interests to declare.

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Supplementary File 1:

Members Focus groups:

Department	Experience in working years	Role
PICU	>40	Senior ICU-nurse
PICU	>30	Senior ICU-nurse
PICU	>10	ICU-nurse
PICU	<10	Department assistant
PICU	>40	Pediatric intensivist
PICU	<40	Pediatric intensivist
PICU	>30	Senior ICU-nurse
PICU	>30	Senior ICU-nurse
PTS	<10	Pediatric nurse
PTS	>10	Pediatric nurse
PTS	<10	Pediatric nurse
PTS	>20	Nurse Specialist
PTS	>40	Care assistant
PTS	>20	Pediatric nurse
PTS	>20	Medical coordinator
PTS	UNK	Secretary
NICN	>30	Pediatric nurse
NICN	>10	Care assistant
NICN	>20	Pediatric nurse
NICN	<10	Pediatric nurse

Department: PICU = Pediatric Intensive Care Unit; NICN = Non-ICU Neurology;

PTS = Pediatric Thoracic Surgery

Supplementary file 2:

The intervention: Description of the content and design of the CRM training according to Gross' recommendations:

INTERVENTION DESIGN

Aims

The aim of the intervention is to provide staff with knowledge, skills and attitudes needed for risk management, patient safety and optimize teamwork processes (Buljac, 2021)

Methods

Three forms of training are available for employees of the Erasmus MC Sophia Children's Hospital. Two of these, the two-day CRM basic training and the one-day CRM follow-up training have been set up in cooperation with the Center for People and Aviation. Each CRM training is concluded with a simulated event, where CRM principles are trained in a team scenario. This simulation is videorecorded and fragments from the film are discussed during the debriefing. Because there was a high demand for this training, a fourth training course was developed by the CRM trainers of the PICU, the 'train-the-trainer' method.

Content

The CRM basic training course includes seven parts: information management, communication, stress management, group processes, leadership, decision making, and risk management. (See Figure 1.)

Figure 1. CRM Content



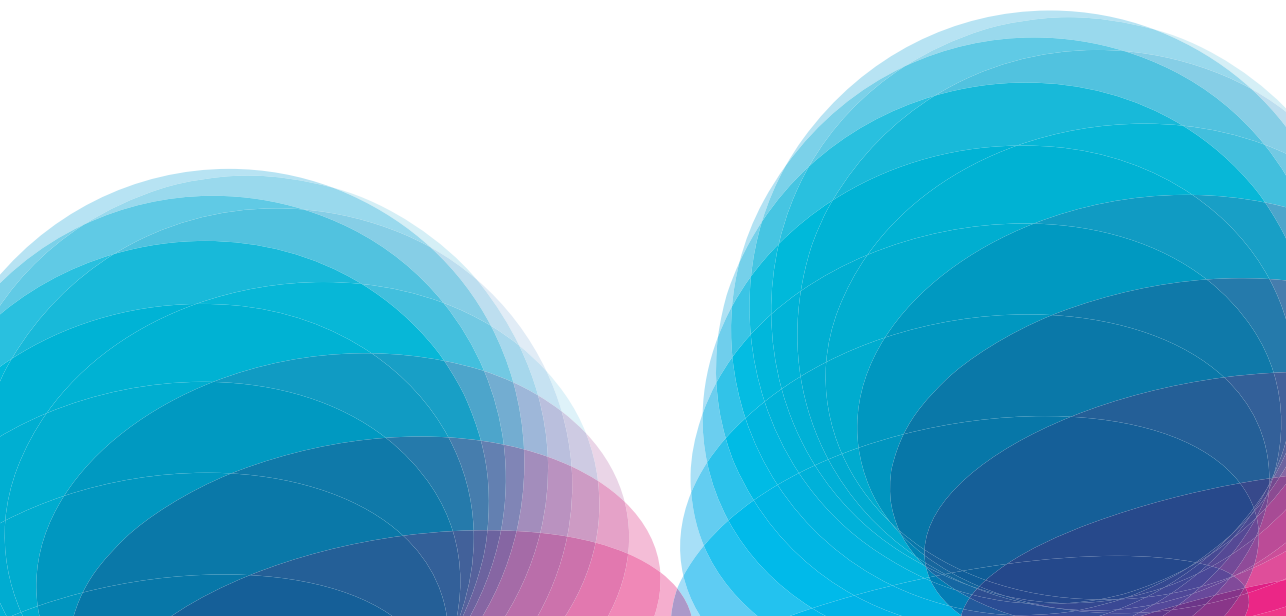
Discussed CRM-tools during the training:

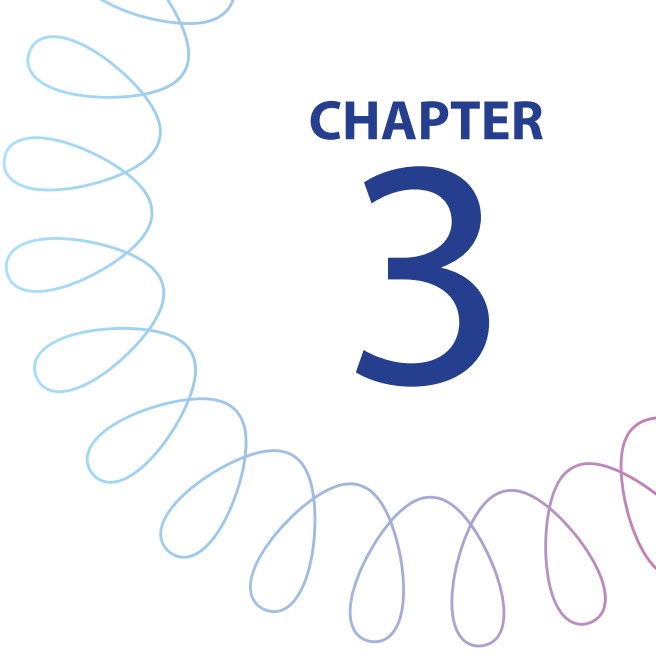
- Day start/ Briefing:
Assign roles and responsibilities and create a short- or long-term plan with a goal
- Huddle:
Ad hoc meeting to discuss an (acute) situation to recalibrate the team's situational awareness
- Evaluation of the shift / Debriefing:
Debriefings / day evaluation: after an event or shift, a brief team reflection focused on teamwork skills or improvement.
- Structure in communication/roles:
SBARR: Situation, Background, Assessment, Recommendation, Readback

TRAINING CONDITIONS	Duration of training • Base training: 2 consecutive days at the start of implementation. Initially, training was delivered by CRM experts in collaboration with aviation consultants. • Follow up training: 1 day. The one-day follow-up training is provided bi-annually. • Train the trainer: Over time, a train-the-trainer model was adopted, in which internal trainers, previously trained and certified by CRM experts, deliver the program. To ensure consistency in content and delivery, all trainers follow the same standardized curriculum and participate in biannual train-the-trainer refreshers.
	Target group: All clinical team members (physicians, nurses, and support staff.
	No of participants: 12 -15 participants
	Trainer qualification: No formal trainer qualification
	Method of evaluation: After the training self-developed questionnaire and wrapping up evaluation at the end of the course Statistical data : Safety Attitudes Questionnaire Outcomes: Improvement strategies
TRAINING EVALUATION	Roadmap organization CRM training: After it is determined with the department that CRM training will be started, a roadmap is set in action, see overview of the road map in Figure 2. (See next page)

Explore	Elaborate	Prepare	Execute	Evaluate	Secure
Few months before CRM training			Training	Few weeks after training	
Interview with management team/ program manager/ CRM trainers	Elaborate input exploration conversation	Scheduling the training sessions	Provide training according to schedule	Discuss training outcomes with the management team and CRM trainers	Prepare approach regarding training outcomes and place ownership with CRM working group of the department.
Discuss content and mutual expectations	Collect video and image material from the department	Department checklist		Discuss outcomes Safety Attitudes Questionnaire.	Create plan regarding the results of the Safety Attitudes Questionnaire and place ownership with CRM working group of the department
	Adapt the presentations to the respective department				Tracking new employees for basic training
	Develop team scenario appropriate to the department concerned				Gathering information and topics for follow- up trainings

Figure 2. Roadmap organization CRM-training



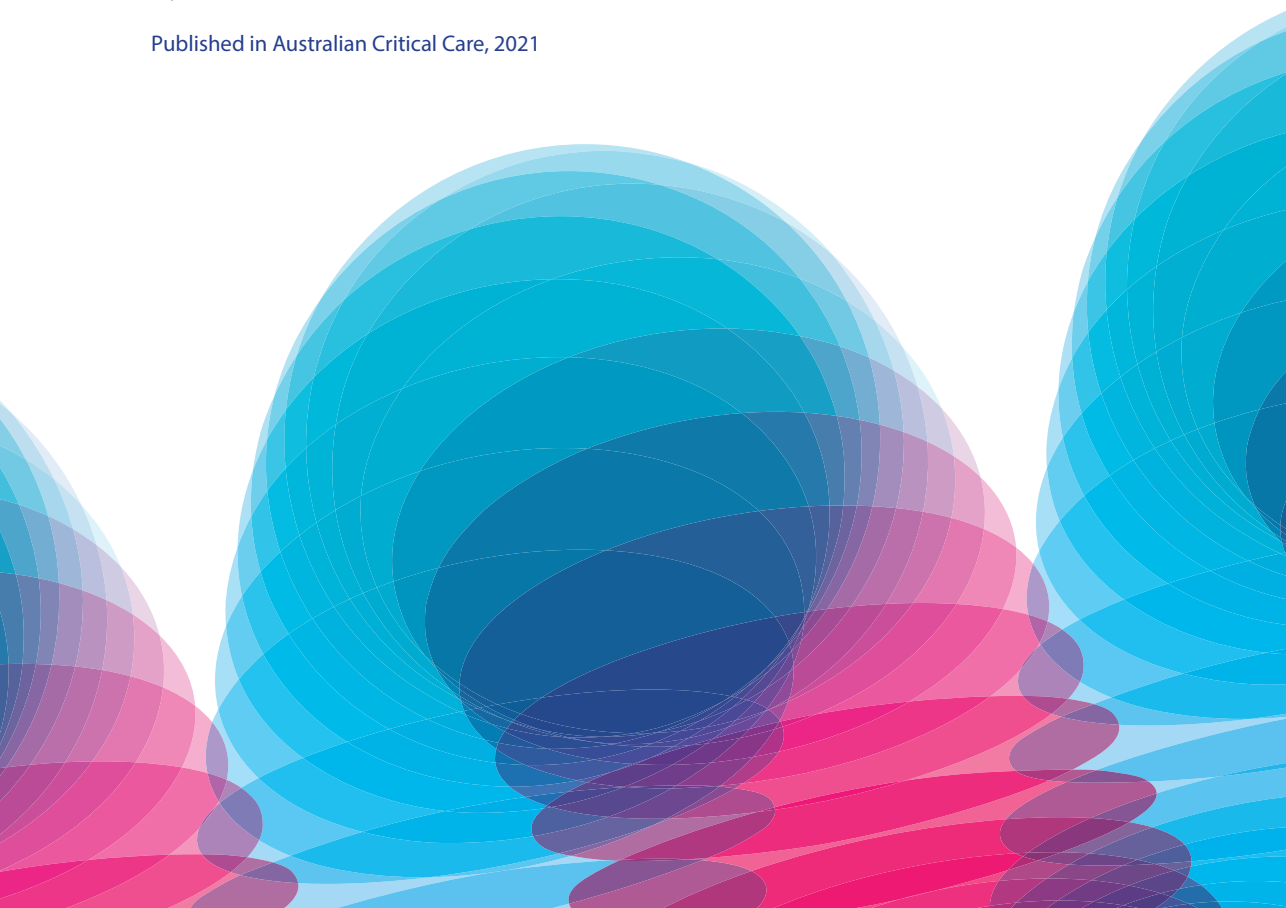


CHAPTER 3

THE PATTI[®]: AN ASSESSMENT TOOL FOR PICU NURSES' TECHNICAL AND NON-TECHNICAL SKILLS

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Abstract

Background:

Cardio-respiratory arrests are rare in Pediatric Intensive Care Units, yet Intensive care nurses must be able to initiate resuscitation before medical assistance is available. For a resuscitation to be successful, instant decision making, team communication and the coordinating role of the first responsible nurse are crucial. In-house resuscitation training for nurses includes technical and non-technical skills. The aim of this study was to develop a valid, reliable and feasible assessment instrument, called the Professional Assessment Tool for Team Improvement (PATTI®), for the first responsible nurses' technical and non-technical skills.

Methods:

Instrument development followed the Consensus based Standards for the selection of health Measurement Instruments (COSMIN) guidelines and professionals' expertise. To establish content validity, experts reached consensus via group discussions about the content and the operationalization of this team role. The instrument was tested using two resuscitation assessment scenarios. Interrater reliability was established by assessing 71 nurses in live scenario sessions and videotaped sessions, using intraclass correlation coefficients (ICC) and Cohen's kappa. Internal consistency for the total instrument was established using Cronbach's alpha. Construct validity was assessed by examining the associations between raters' assessments and nurses' self-assessment scores.

Results:

The final instrument included 12 items, divided in four categories: Team role; Teamwork and communication; Technical skills; and Reporting. Intraclass correlation coefficients were good in both live and videotaped sessions (0.78 to 0.87). Cronbach's alpha was stable around 0.84. Feasibility was approved (assessment time reduced by >30%).

Conclusions:

The PATTI® appears to be a promising valid and reliable instrument, to assess both technical and non-technical skills of the first responsible PICU nurse. The ability of the instrument to detect change over time (i.e. improvement of skills after training) needs to be established.

Introduction

Resuscitations in pediatric settings are rare events for which time elapsed until start and the quality of the resuscitation have a significant impact on the clinical outcomes.¹⁻⁵ Healthcare professionals are rarely exposed to these events and both development and maintenance of effective resuscitation skills rely on training.⁶⁻⁹ To ensure quality, every resuscitation event should have a designated team leader.¹⁰ Effective team leadership requires specific skills, such as empowering the team to speak up, designating tasks and keeping the overview of the resuscitation process -situational awareness.¹¹ Healthcare professionals are familiar with technical skills being assessed, such as in Basic Life Support or Advanced (Pediatric) Life Support (A (P) LS) training.^{10,12} Teamwork skills, however, did not receive much attention during these training sessions.^{13,14} Gilligan et al. described in a prospective study the leadership role of ALS-trained nurses in simulated cardiac arrest situations as a good alternative when a doctor is not available.¹⁵ Lack of confidence, fear of litigation and of harming the patient are important factors that withhold nurses from successfully initiating resuscitation.¹⁶⁻¹⁸ Greater confidence might help reduce feelings of helplessness and educational programs should also address this.^{19,20} Dwyer et al. found that removing barriers to nurse-initiated resuscitation can be achieved by training and emphasizing the individual contribution in achieving a favorable outcome.¹⁸ Aiken and colleagues²¹ showed that the educational level of nurses is crucial, i.e. higher competence among nurses in hospital wards results in a reduced incidence of mortality, morbidity and adverse events.

Next to this, teamwork failures and communication breakdowns are substantial contributing factors to adverse incidents in healthcare.^{22,23} Through team training, teams may be able to prevent most of these incidents.^{22,24,25} Other high-risk industries, such as aviation, have invested in Crew Resource Management (CRM) and subsequently achieved better performance to manage error.^{26,27} CRM training has since been successfully implemented in the healthcare sector.²⁸⁻³⁰ Assessments of team performance can give insight into issues that need improvement.^{31,32} Teamwork skills such as communication, leadership, decision-making and team interaction have proven to be as important as technical skills, as reflected by the availability of many tools to assess health professionals' teamwork skills.^{33,34} One published tool, the Imperial Pediatric Emergency Training Toolkit (IPETT) aims to assess technical and teamwork skills in a pediatric intensive care setting and focuses on general non-technical skills, mainly of physicians.³⁵ As the IPETT was not used to assess nurses' skills, we set out to develop a new tool that would allow us to assess the technical and non-technical skills of nurses.³⁵

Background

In our Pediatric Intensive Care Unit (PICU) between 40-50 resuscitations per year (approximately 2% of annually admitted patients) are carried out, which is comparable to other PICUs.^{36,37} In our facility, a physician fulfills the role of team leader in the resuscitation setting. In practice, intensive care nurses are often the first present in the case of a cardiorespiratory arrest^{8,16}, then it is crucial that one nurse, the 'first responsible nurse', takes the lead in the resuscitation process and instructs other nurses and monitors the quality of the resuscitation, prior to physician arrival.³⁸

Using simulation sessions, we have been training our nurses and doctors in technical- and teamwork skills since 2005, as part of the Patient Safety Management System. The literature confirms that simulation is an effective method of training resuscitation teams in teamwork skills.³⁹⁻⁴¹ During the debriefing in the team training sessions our nursing staff suggested that technical and teamwork skills should be regularly assessed. They indicated the discrepancies between regular assessment during their formal training and the lack thereof after finishing education. Next to the yearly mandatory APLS training⁴², the PICU nurses made clear that regular assessments in teamwork training would make them feel confident about their technical and non-technical skills.

To address nurses' leadership role during resuscitations, it was decided to focus on resuscitation procedures first because these require exceptional technical and teamwork skills, especially from the 'first responsible nurse'.

Research objective

We aimed to develop, and test the validity, reliability and internal consistency of the Professional Assessment Tool for Team Improvement (PATTI[®]) which assesses technical and non-technical skills of nurses in the PICU.

Methods

Design

This is a prospective psychometric evaluation of the skills assessment tool named the Professional Assessment Tool for Team Improvement (PATTI®), following the COSMIN guidelines and the assessment guidelines from CITO, the Dutch Institute for educational measurement.⁴³

Setting

Our PICU has 4 units with 28 beds, and staff consisting of 125 Pediatric Intensive care nurses, 11 intensivists (pediatricians and anesthesiologists), 5 pediatric intensive care fellows and 10 junior doctors. There is a 24/7 presence of both a consultant and fellow in the hospital. Yearly 1700 children are admitted between the ages of 0 and 18 years, who are treated for a variety of issues including congenital anomalies, trauma, neonatal and craniofacial surgery. The PICU also serves as one of the two extra corporal membrane oxygenation (ECMO) centers for the Netherlands. A blueprint for effective teamwork, developed in our facility, has been in use for both resuscitations and other procedures where teamwork is critical. This blueprint defines teamwork roles and tasks.

Participants

An expert panel consisted of eleven simulation experts working on the PICU (doctors N=4 and nurses N=7), who served both as developers and raters, and received rater training prior to the start of the project. The simulation training experts all have been trained in technical and non-technical skills and are now working as teamwork trainers next to being simulation experts, which makes them best equipped to determine the criteria for technical and non-technical skills. An assessment specialist guided the experts in successive stages of the development and test phases of the PATTI®.

All 125 PICU nurses were invited to participate in pilot simulation training sessions to test the PATTI® in the successive stages and 71 (56.8%) participated.

An iterative approach was used to develop the PATTI®. First, the 11 simulation experts and the assessment specialist formulated the criteria the tool had to meet to achieve content validity (the degree to which the content is an adequate reflection of the construct to be measured), based on teamwork tasks and responsibilities according to the CRM principles.^{44,45} The technical skills content was based on the guidelines for APLS.⁴⁶ The measurement properties were selected using the COSMIN guidelines.⁴⁷

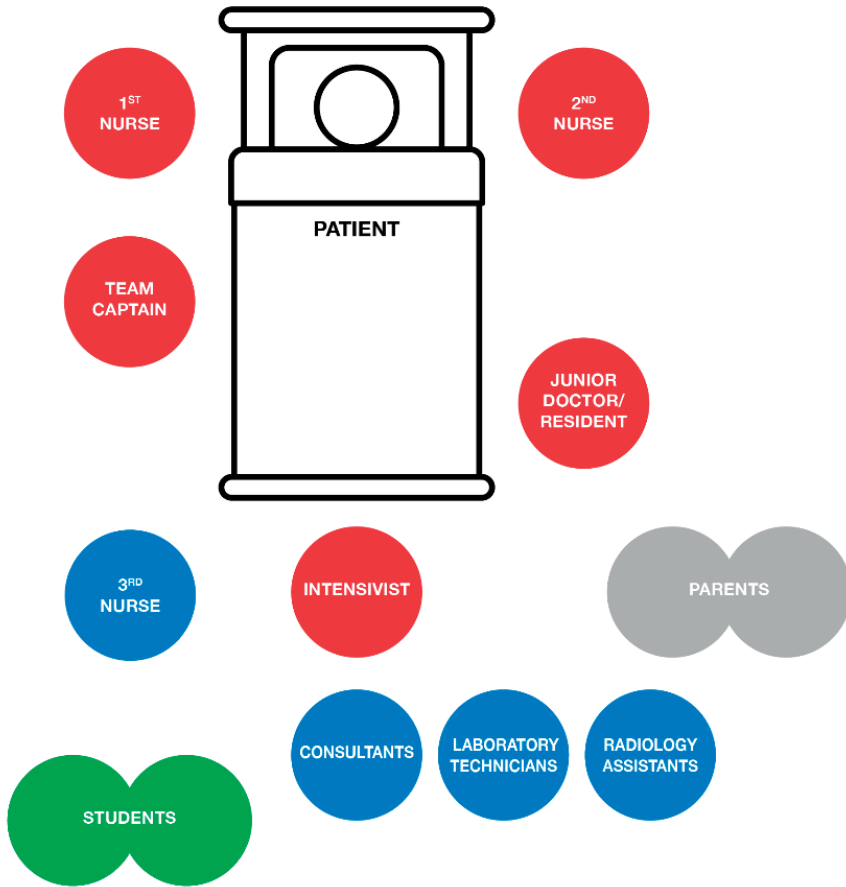


Figure 1. Bird's eye view of team members' positions, tasks and roles in a PICU acute care situation

- Red circles: 1st nurse at headboard, right-hand side of patient, team captain (usually pediatric intensive care fellow), intensivist at footboard, junior doctor/resident, 2nd nurse at headboard, left-hand side of patient.
- Blue circles: 3rd nurse, consultants (e.g. cardiologist, anesthesiologist), laboratory technicians, radiology assistants.
- Grey circles: Parents may be at close distance but, if necessary, will be asked to step back.
- Green circles: Two students (medical or nursing) allowed in the context of training.

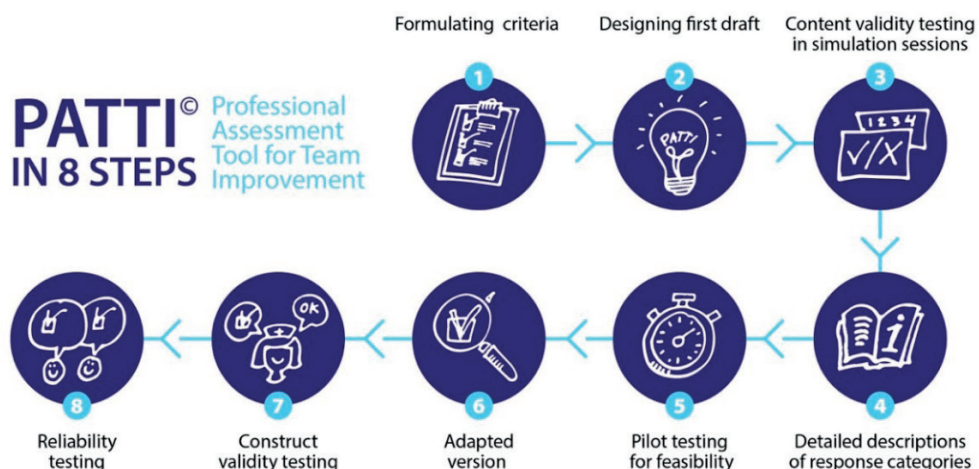


Figure 2. Development of the Professional Assessment Tool for Team Improvement (PATTI®)

Second, we drafted a preliminary version, on which we reached consensus via group discussions for three 8-hour sessions with our simulation experts and the assessment specialist. The deliberations resulted in a version consisting of 16 items divided in four categories: Team role; Teamwork and communication; Technical skills; and Reporting. The response categories ranged from 1 (very poor) to 4 (very good).

Third, content validity was further established through 62 pilot simulation training sessions, as this triggered the most debate. To support uniformity of assessment, we chose to use two simulation scenarios that are highly standardized and that nurses are expected to master: the shockable and non-shockable resuscitation protocol. To maintain equivalence, the age of the child was the same in both scenarios.

Fourth, the items in the PATTI® were evaluated and re-worded by the simulation experts and assessment specialist, based on the simulation pilot sessions, and a list with detailed descriptions of the response categories was drawn up to ensure good interrater reliability.

Fifth, the resulting version was evaluated again and tested for feasibility (time needed to complete) in the simulation pilot sessions.

As a sixth step, several items were removed or integrated with other items that in the fifth step proved difficult to score. The result was a 12-item version containing the 4 subscales; A) Team role (6 items); B) Teamwork and communication (3 items); C) Technical skills (2 items); and D) Reporting (one item)

Validity and reliability testing

Bearing in mind that a gold standard to establish criterion validity does not exist, we sought to determine the construct validity of the PATTI[®]. Other studies have shown that nurses are able to assess their own skills⁴⁸⁻⁵⁰, therefore we compared the experts' assessments with nurses' self-assessment scores of the PATTI[®]. We hypothesized that a correlation of 0.60 or higher between the PATTI[®] scores of the assessors and the nurses' self-report assessments would indicate sufficient construct validity.

Then, we set out to test the reliability of the PATTI[®]. To support interrater reliability, the simulation training experts attended an in-house assessor training program delivered by the assessment specialist. Next, two infant resuscitation assessment scenarios were performed: asystole and ventricular fibrillation. Interrater reliability was established in live pilot sessions and sessions in which videotaped scenarios were assessed by multiple pairs of assessors. Pairs of assessors were used because we had noted that assessing teamwork skills proved difficult for a single observer.

The interrater reliability of the 12-item PATTI[®] was iteratively tested in four phases by the 11 assessors:

Phase 1. In 32 live simulation sessions with one pair of assessors per session, the agreement between assessors' individual scores was determined. The live sessions were videotaped.

Phase 2. The four videotaped scenarios performed in Phase 1 for which the PATTI[®] score ranged most widely between two assessors were scored again with multiple pairs of assessors. Finally, the consensus scores of all pairs were compared and interrater reliability was calculated. This yielded a lower intraclass correlation coefficient (ICC) than that in the first phase. We were not yet satisfied with the results.

Therefore, in Phase 3 we continued with the assessment of 48 live simulation sessions comparing the consensus scores of two or more pairs of assessors assigned during live sessions. This yielded a higher ICC than in the previous step.

Phase 4. The ICC scores of individual assessors in 136 live simulation sessions with two assessors per session were again compared. In each phase, the assessors discussed any differences in scoring to reach consensus and improve the interrater reliability.

Statistical analysis

To examine construct validity, correlation between assessors' and nurses' self-assessment scores was calculated using the Spearman rank order correlation coefficient. As there is no gold standard test, we applied hypothesis testing beforehand according to the COSMIN guidelines. This implies that we do not look at the p-value of a correlation or a rule of thumb for effect size, but in this case at the preferred value of the correlation of 0.60 to support construct validity.

Interrater reliability among pairs of assessors for the total score and for the subscales A, B and C of the PATTI® was evaluated using the intraclass correlation coefficient (ICC). Values between 0.75 and 0.9 indicate good reliability.⁵¹ The ICC was calculated in IBM SPSS Statistics for Windows version 25.0 (Armonk, NY) using the two-way mixed model, type absolute agreement and single measures (with 95% confidence intervals). For the single item subscale D, we calculated the percentage agreement between the pairs of assessors because the raters had used only response categories 3 and 4.

Internal consistency for the total scale was established using Cronbach's alpha, aiming for values between 0.70-0.90. We chose Cronbach's alpha to determine if the items of the PATTI® are sufficiently correlated to justify the use of a total and subscale score. Structural validity was not tested with factor analysis because the subscales were theory driven. A p-value <0.05 was considered to reflect statistical significance.

Ethical considerations:

Permission for this study was requested from the Medical Ethics Review Board of our institution. The board concluded that the investigation was not subject to the Medical Research Involving Human Subjects Acts and further review was waived. Through anonymizing collected data, participants' privacy is guaranteed, and research data are stored in accordance with Good Clinical Practice guidelines.⁵²

Results

Content validity for the PATTI[®] was established in 62 pilot rounds: the expert panel reduced the 16-item draft version to 12 items, each with four response categories (Table 1).

Table 1. Professional Assessment Tool in Teamwork (PATTI[®])

Scenario type: Ventricle Fibrillation / Asystole (delete if not applicable)					
Candidate:			Date:		
Assessor 1: (the one filling out the form)	Assessor 2:		Results:		
	1	2	3	4	Notes
a. Team role in first responsible Nurse					
1. Stays on the patients' right side					
2. Coordinates and assigns tasks to the second and third nurse					
3. Gives clear commands					
4. Checks whether the tasks have been performed					
5. Gives medication and fluid in time to the patient or delegates this to the second or third nurse					
6. Ensures that a colleague attends to the parents/caretakers					
b. Teamwork and communication					
7. Has situational awareness on process and product and evaluates joint actions					
8. Acts pro-actively in bringing in expertise and shows assertive behavior					
9. Invites team members to think about the problem, listens, contemplates aloud and achieve an adequate solution					
c. Technical skills					
10. Follows the right protocol and executes it correctly based on readings of vital parameters.					
11. Recognizes the complexity of the situation and asks for the right expertise					
d. Reporting					
12. Reports all interventions during the scenario (defibrillation, medication, amounts/doses and frequency)					

Legend: Subscale A: 6 items; Subscale B: 3 items; Subscale C: 2 items; Subscale D: 1 item;

Total scale: 12 items

One of the adjusted items was “provides adequate monitoring of vital signs” which was integrated into item 10: “follows the guidelines by degree of (in) stability of the vital signs”, because that is one of the criteria in the resuscitation protocol. The item: “acts safely and effectively under stress” was removed, because the level of stress proved difficult to assess. The item: “always mentions all findings of relevant interventions” and the item: “observes and evaluates joint actions, maintains situational awareness of process and product” were integrated into one item: “has situational awareness on process and product and evaluates joint actions.”

Use of the PATTI® proved feasible, especially since the assessment time for three simulation sessions could be shortened from 120 minutes to 60-90 minutes.

The Spearman rank order correlation coefficient between the assessors' PATTI® total scores and the self-assessment scores for 32 pairs was 0.343 (95% CI -0.006 to 0.617). Nevertheless, one outlier deflates the correlation between the two scales (Figure 3).

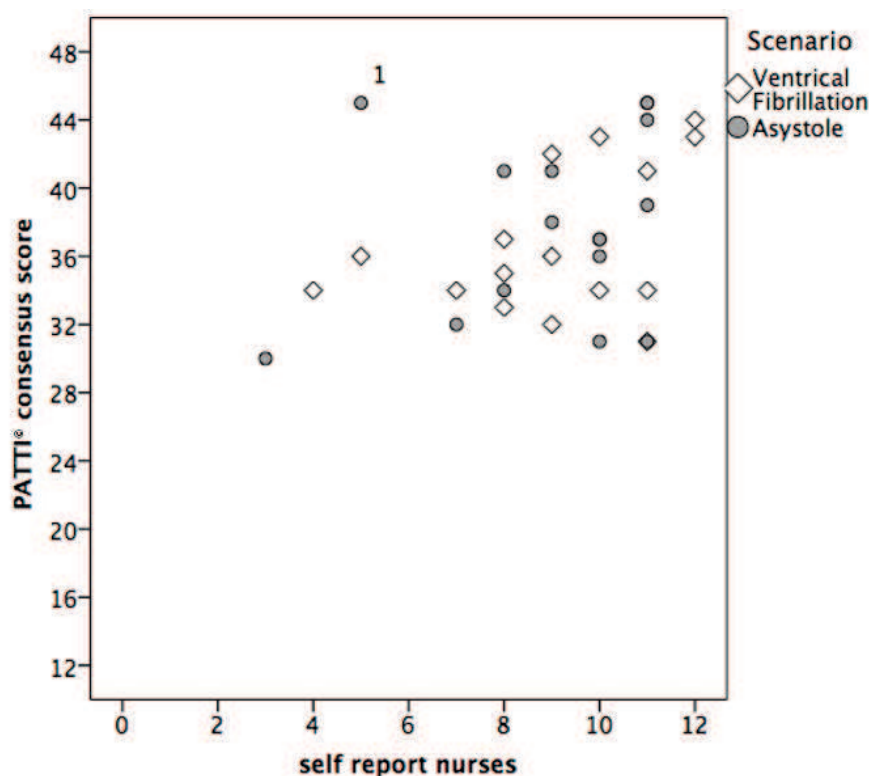


Figure 3. Correlation between the assessors' PATTI® consensus scores and nurses' self-report scores

Without this outlier, the Spearman rank order correlation coefficient improved to 0.445 (95%CI 0.108 to 0.690) which is still lower than $r=0.60$. Therefore, the hypothesis was rejected, and construct validity was insufficient.

The ICC, used as a measure of interrater reliability, between the assessors varied from 0.78 to 0.87 in four different phases (Table 2).

Table 2. Interrater reliability coefficients between individual and consensus scores pairs of assessors

Phase	1	2	3	4
Comparison	Individual scores	Consensus scores between pairs of assessors	Consensus scores between pairs of assessors	Individual scores
Scenario	32 pilot life	4 videotaped	48 real life	136 real life
ICC Sum Score Total	0.87	0.78	0.79	0.88
ICC Sum score subscale A	0.80	0.75	0.66	0.82
ICC Sum score subscale B	0.80	0.65	0.82	0.84
ICC Sum score subscale C	0.63	0.55	0.65	0.78
Percentage agreement: Subscale D	69%	NA	85.4%	96.6%
Cronbach's alpha total scale	0.83	NA	0.85	0.82

NA = Not Applicable, ICC=intraclass correlation coefficient, using the two-way mixed model, type absolute agreement and single measures

Legend:

Subscale A: 6 items

Subscale B: 3 items

Subscale C: 2 items

Subscale D: 1 item

Total scale: 12 items

Phase 1. The ICC between assessors' individual scores during these sessions of the total PATTI[®] sum score was 0.87. The lowest ICC of 0.63 was seen for subscale C (technical skills items).

Phase 2. The four videotaped scenarios resulted in an ICC of 0.78 for the total score again with a lower ICC for the subscale C.

Phase 3. The assessment of 48 live sessions yielded an ICC of 0.79 for the total PATTI® score between pairs of assessors. The ICC for subscale C (0.65) and subscale A (0.66) were lower compared to subscale B (0.82).

Phase 4. The ICC score of pairs 136 live sessions was 0.88. Also, the ICC of all subscales were between 0.78 and 0.84. Data on subscale D are missing for Phase 2, because the participants' report was given outside of the simulation room and thus could not be reviewed by the assessors.

As demonstrated by Cronbach's alpha (0.83) internal consistency was established (Table 2).⁵³

Discussion

We developed a tool that seems able to assess both technical and non-technical skills of PICU nurses in a simulation setting. We found adequate interrater reliability, good internal consistency and content validity of the PATTI® tool. Construct validity, however, in terms of the correlation between the PATTI® and the self-reported skills assessment of the nurses, was lower than hypothesized beforehand. Three explanations may account for this. First, the variation in scores on both scales is relatively low (no scores in the lower left quadrant in Figure 3), which deflates the correlation. Second, for each PATTI® item the self-report options were 'failed' and 'pass' and in hindsight this might have stimulated them to score 'pass' more often. Third, the difference in scores by the assessors and the self-assessments may be explained by the fact that the self-assessment was done by a small group of nurses with little to no experience in using the PATTI®. In follow-up studies we should use the same response categories for both the observers and the self-report options to improve the correlation. Another option to test criterion validity is to ask an independent expert panel to judge the videos and give an expert opinion that could be compared to the PATTI® total score.

The literature describes several assessment tools for teamwork skills.³⁴ Most of them focus on physicians, not on nurses or other healthcare professionals.^{34, 54, 55} In the study by Carr et al., junior doctors were assessed not only on teamwork skills, but also on general clinical management skills.⁵⁶ Pugh et al. studied internal medicine residents and assessed critical team errors, individual team member contributions, task performance, and overall team performance.⁵⁷ In a study on nurses' and respiratory therapists' APLS skills, the teamwork skills were not assessed.^{58, 59} The lack of assessment tools for our Dutch PICU context necessitated developing the PATTI®. Our assessment tool expands on this

work, as it focuses on leadership, communication and other teamwork skills as well as on technical skills.

The use of the PATTI[®] enables professionals to identify shortcomings in specific areas. For example, a nurse who has good technical skills may not think aloud and instruct others, and might score less well on the teamwork item “Has situational awareness on process and product and evaluates joint actions”. Additionally, self-assessment of nurses’ competencies can raise awareness of individual educational gaps and address teamwork skills as in the above example.⁶⁰ Feedback on item-level such as “checks whether the tasks have been performed”, will encourage nurses to create better closed-loop communication. Thus, team situational awareness may improve and lead to better performance in resuscitation events and promote better patient outcome.⁶ Obtaining evidence of improved patient outcome after resuscitation will be difficult; first of all, due to the low incidence of resuscitation events in PICU, and secondly because of the many confounding factors influencing outcome of PICU patients such as, for example illness severity, underlying disorders, and age range.

A strength of our measurement properties study is that many end-users were involved in developing and testing of the tool. The ICC above the threshold of 0.7 shows we effectively reduced the interpretive bias by thoroughly practicing and discussing rater outcomes via pilot sessions. For example: When a nurse fails to take the lead in the simulation setting as required, and the assessor knows he/she does that very well in real situations, the assessor may be inclined to consider this. The potential bias caused by the assessors knowing most of the participants, was resolved by instructing the assessors to base their scores only on the observed behavior. The simulation training scenarios were standardized, so that results could be compared, especially over time.

Several limitations of this study should be addressed. First, the PATTI[®] was developed in a high-quality simulation setting, but not yet applied in clinical practice. Live resuscitations are more chaotic, with many healthcare professionals attending, and can provide many learning opportunities. Thus, it would be of great didactic value to film such a live resuscitation and have “the first responsible nurse” afterwards assessed by trained assessors with the PATTI[®]. Second, this was a single center study, and it would add value to test this tool in other centers/units as that would increase the tool’s generalizability. Third, the PATTI[®] has been tested only for the PICU environment and its usability in other critical care areas cannot be determined. Another issue is the time-consuming, iterative approach that was utilized in the development process of the PATTI[®]. As the assessments were executed by coworkers of the nurses, this necessitated time and effort put in achieving the highest possible inter-rater reliability. But even though scenario training and skills assessments are time consuming, they provide an opportunity to increase

healthcare professionals' confidence in their skills and therefore better teamwork which may lead to improved patient outcomes.⁶¹

Future perspectives

We have started to use the PATTI® before and after a training program for PICU nurses to assess their teamwork and resuscitation skills. Comparison of the before and after outcomes will provide evidence of the responsiveness of the scale and will be published at a later stage. Next, intensive care physicians will be assessed on their technical and teamwork skills. We set up a training program to improve their resuscitation skills and will use the PATTI® to evaluate the progress of individual candidates. It will be interesting to explore if our educational program not only improves resuscitation skills but can also enhance nurses' confidence. However, increased confidence may be hard to assess. The self-assessment with the PATTI® for "the first responsible nurses" should have the same response categories as the PATTI® for educators and the correlation should be tested again to determine if the correlation will improve. As the PATTI® has been developed based on international guidelines on technical and non-technical skills, it will be interesting to test the generalizability internationally.

Conclusion:

These are the first findings on the psychometric properties of the PATTI®. The results of this study on reliability and validity are a starting point for more research on this topic. Educators and managers can use the PATTI® to assess PICU nurses' technical and non-technical skills and if needed provide additional training. The discrepancy between the self-assessments of nurses and the assessor's assessments, can provide a starting point for a discussion on how to better train and assess resuscitation and teamwork skills. By synchronizing the scoring options for self – assessment with those for the raters' assessment, better reflection on the individual nurses' skills can be facilitated, thus increasing the potential for learning in technical and non-technical skills.

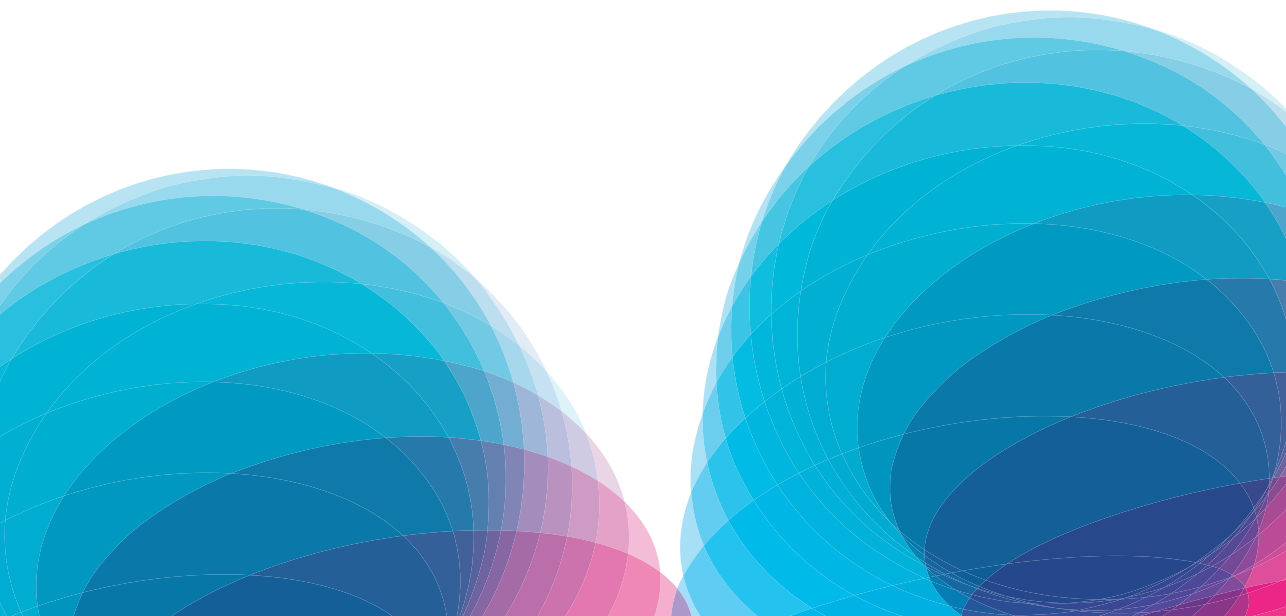
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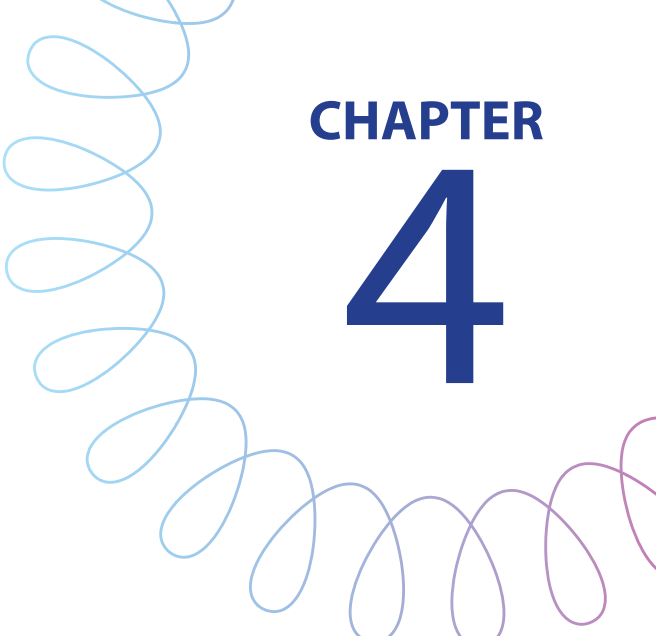
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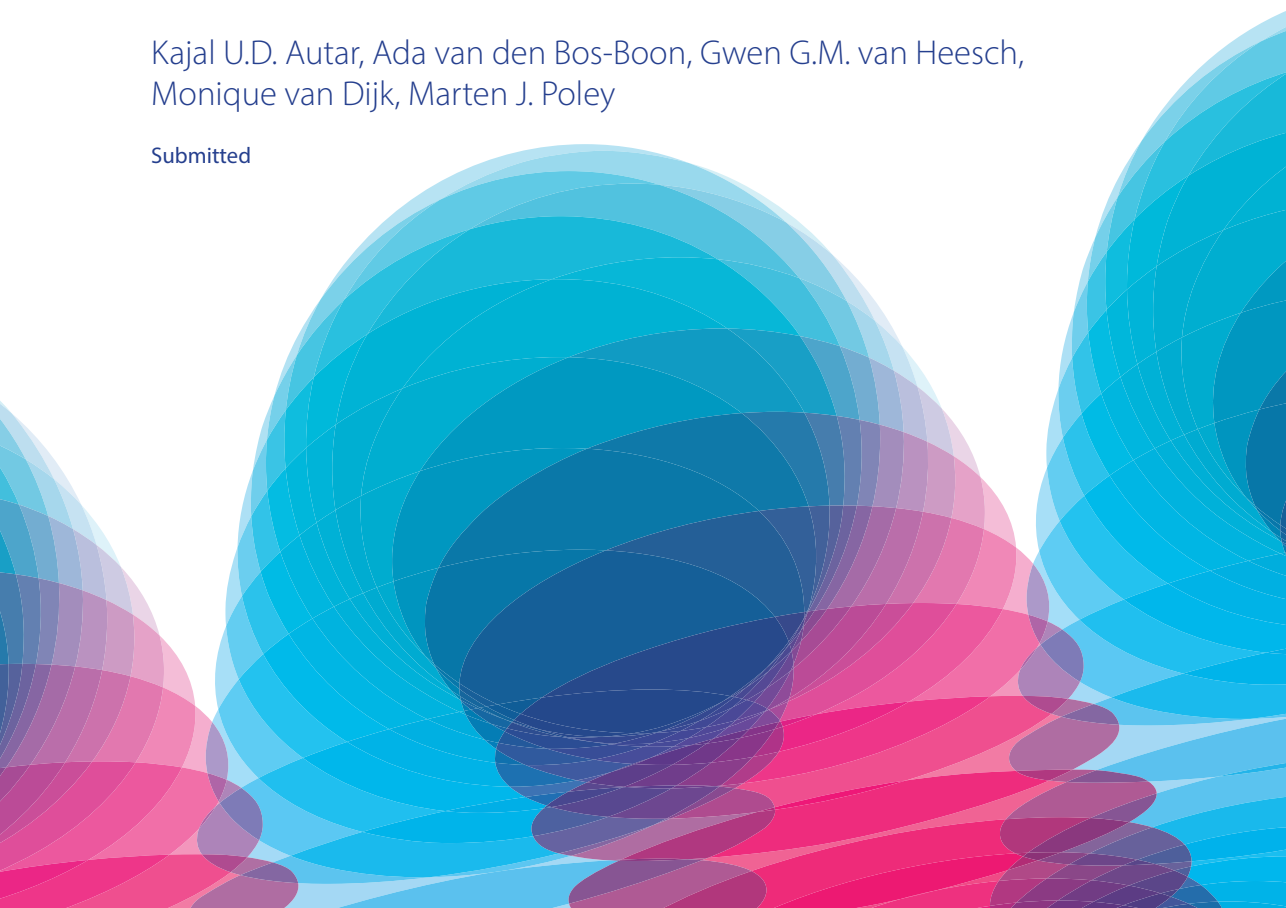
CHAPTER

4

EXPLORING PATIENT SAFETY CULTURE AND OPPORTUNITIES FOR IMPROVEMENT: A MIXED METHODS STUDY IN A DUTCH PEDIATRIC INTENSIVE CARE UNIT

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Monique van Dijk, Marten J. Poley

Submitted



Abstract

Background:

Hospitals often face complex and life-threatening situations that heighten the risk of medical errors. Improving patient safety culture is important to reduce these errors. This study aims to identify trends in patient safety culture within a pediatric intensive care unit (PICU) and to explore strategies for improvement.

Methods:

The study had a mixed-methods design, combining quantitative and qualitative methods, and was done at the PICU of Sophia Children's Hospital (Rotterdam, The Netherlands). The Safety Attitudes Questionnaire (SAQ) was used to measure patient safety culture, with surveys administered in 2009, 2012, 2014, 2017, 2019, and 2023. Trends in patient safety culture over time were analyzed. Additionally, staff members provided recommendations to improve patient safety, which were subsequently categorized into overarching themes. An expert panel was convened and interviews with staff members were conducted to further evaluate the most frequently mentioned recommendations and assess their feasibility for implementation.

Results:

From 2009 to 2023, patient safety culture demonstrated overall improvement. However, specific domains, including stress recognition, perceptions of management, and working conditions, still show room for further improvement. Most recommendations identified through the SAQ fell within the themes of interprofessional communication, medical equipment hospital working environment, and staffing. Concrete suggestions included appointing a dedicated contact person to improve communication with parents and establishing clear agreements to strengthen communication and teamwork within the PICU.

Conclusions:

The patient safety culture at the PICU of Sophia Children's Hospital improved over the years, although areas for improvement remain. Sustained improvements in patient safety culture require continuous investment in interprofessional communication, workplace conditions, and staffing. This study not only highlights long-term trends but also presents actionable strategies proposed by staff to address persistent challenges. Effective implementation and ongoing evaluation of these interventions are essential to strengthen safety culture, enhance staff well-being, and ultimately improve patient outcomes.

Key words:

Patient safety; Safety culture; Safety climate; Pediatrics; Pediatric Intensive Care; Quality improvement

What is already known on this topic

Patient safety culture plays a vital role in reducing medical errors and in improving the overall quality of healthcare. Previous studies showed that the safety culture in pediatric intensive care units (PICUs) is often suboptimal, leaving room for improvement. Measuring patient safety culture is a critical first step in addressing this issue, and validated tools such as the Safety Attitudes Questionnaire (SAQ) are available for this purpose.

What this study adds

Using a combination of methods, including the SAQ, this study provided a 14-year longitudinal analysis of patient safety culture trends in a PICU, and analyzed numerous staff recommendations for improving patient safety. Overall, patient safety culture in the PICU gradually improved over the years, but the study also highlighted specific domains that require further attention. The findings included practical and feasible suggestions for improving patient safety culture.

How this study might affect research, practice, or policy

This study can serve as a foundation for future research on (gaps in) patient safety culture in PICUs and on how staff recommendations can be effectively implemented to achieve optimal results. The findings may influence the development of patient safety protocols in PICU settings, which in the end will contribute to a stronger overall safety culture and improved patient outcomes.

Introduction

In hospitals, complex and life-threatening situations frequently arise. An estimated 98,000 people die each year due to medical errors, such as surgical injuries or mistaken identity.¹ A more recent estimate suggests that approximately 200,000 preventable hospital-related deaths occur annually in the United States.² Many of these errors, often caused by communication breakdowns or deficits in clinical performance, are preventable. Addressing this issue requires improving the patient safety culture, which is about the values, norms, and behavioral characteristics of staff members in relation to their organization's patient safety performance.³

Monitoring patient safety culture over time can help identify areas for improvement. Several tools have been developed to measure patient safety culture from the perspective of frontline workers, including the Safety Attitudes Questionnaire (SAQ)⁴ and the Hospital Survey on Patient Safety Culture (HSPSC).⁵ Despite the growing use of these instruments, evidence on the patient safety culture in pediatric healthcare settings remains limited. Studies suggest that the safety culture in these settings is often suboptimal, leaving room for improvement.^{6,7}

Moreover, there is little information on practical approaches to improving patient safety culture. A few studies, using the SAQ, analyzed staff recommendations for improvement. For example, recommendations in the study by Gleeson et al. included "staffing issues", "patient-focused care", "hospital environment", "safe reporting culture", and "training and education".⁸ An example of a recommendation from the study by Campione & Famolaro was "action planning where results are analyzed and shared with staff".⁹ These studies suggest various strategies to enhance patient safety culture, including appointing a case manager to improve communication between medical staff and patients and promote unity among staff members¹⁰ and implementing feedback interventions to enhance communication and interdependence among staff.¹¹

A previous SAQ-based study done in our Pediatric Intensive Care Unit (PICU) at Sophia Children's Hospital found that, while patient safety culture was strong compared to benchmark data, there was room for improvement.⁷ Staff recommended actions such as "improve nurses-physician communication" and "report and take action on incidents, complications and deaths". Since then, several initiatives have been introduced in our PICU, including structured debriefings and enhanced incident reporting mechanisms. However, challenges in communication and incident follow-up remain. This suggests that, despite the progress that has been made, further efforts are needed to ensure sustained improvements in patient safety culture.

Therefore, this study aims to: 1) identify trends in patient safety culture over time within our PICU, as measured by the SAQ, and 2) identify areas where patient safety could be improved, based on staff recommendations collected through the SAQ.

Methods

Study design

The study design was a combination of a retrospective and a prospective study, using both quantitative and qualitative methods. The quantitative component was retrospective, using SAQ data collected since 2009. The qualitative and prospective components of the study consisted of an expert panel and staff interviews.

Study setting

The setting of this study was the PICU at a tertiary university children's hospital in an urban environment, serving a referral area of approximately 5 million people (constituting >25% of the Dutch population) with 44,000 births each year. The PICU has a capacity of 28 beds, distributed across four units: two intensive care units and two high care units. It admitted 1,383 patients in 2023, ranging in age from newborn to 22 years (56% below the age of 3 years). The PICU offers comprehensive care across all pediatric and surgical subspecialties.

Data sources, data collection, and data analysis

Safety Attitudes Questionnaire (SAQ)

The study used the SAQ to collect data on patient safety culture.⁴ The SAQ is a widely used tool, which consists of 36 items that evaluate six dimensions of patient safety culture: teamwork climate, job satisfaction, perceptions of management, safety climate, working conditions, and stress management. All items are answered using a five-point Likert scale, ranging from disagree strongly (score of 0), disagree slightly (25), neutral (50), agree slightly (75), to agree strongly (100). Each scale score was calculated as the mean of its component items and thus was calibrated from 0 to 100. No scale score was calculated if any of the component items were missing. Negatively worded items were reverse scored, so, for all scales, higher scores indicated a better patient safety culture. The final section of the SAQ asks respondents to give their top three recommendations to improve patient safety in their department. Several studies showed that the SAQ is valid and reliable.^{4,12-14} The SAQ used in this study was translated into Dutch using a standardized forward-backward procedure.⁷

The SAQ was administered in 2009, 2012, 2014, 2017, 2019, and 2023. All staff members, both full- and part-time, with a significant work attendance in the PICU, were eligible to participate. This included physicians, nurses, nurse practitioners, pharmacists, technicians, ward clerks, and managers. The questionnaires were handed out before crew resource management (CRM) trainings and completed anonymously.

The data analysis began by examining the trend in patient safety culture over time. Descriptive statistics were used to show how the six subscale scores of the SAQ varied across survey years. Second, all provided recommendations were categorized into the following twelve themes, which are described in Table 1:

- Staffing
- Medical equipment and hospital working environment
- Training (and education)
- Incident reporting
- Action planning
- Communication between professions
- Feedback
- Teamwork
- Communication with parents
- Protocols
- Working conditions
- Continuity of care

The first six of these themes were taken from previous studies that analyzed recommendations from the SAQ.⁷⁻⁹ Six additional themes emerged from frequently mentioned recommendations in this study. While some themes are related (e.g., communication between professions, feedback, and teamwork), they were categorized separately, as each was identified as a distinct and important issue by the respondents. A second reviewer independently assessed cases where there was uncertainty about the categorization of a particular recommendation. Any disagreements between the two reviewers were resolved through consensus, with input from a third reviewer when necessary.

Once each recommendation was assigned to a theme, it was counted how many times a theme was mentioned for each survey year and for the full sample. Then, it was analyzed which specific recommendations were most frequently mentioned under those themes each year. The analysis resulted in a final list of themes and recommendations, which was used for both the expert panel and the interviews.

Table 1: Descriptions of themes

Theme	Description
Staffing	Staff shortages, qualified staff, and occupation according to care level.
Medical equipment and hospital working environment	All equipment and their usage that are important for the care processes.
Training (and education)	All trainings and forms of education, including scenario trainings, clinical lessons about illnesses, education about the use of medical equipment, CRM training, and the training and supervision of interns.
Incident reporting	Everything that is related to reporting of (near) incidents or quality issues and to the provision of feedback following reporting of incidents.
Action planning	All steps guiding the organization to focus on patient safety.
Communication between professions	All sorts of communication between professions, such as physical communication, documentation of patient's data, and meetings, including communication tools such as (de)briefings, huddles, and evaluations.
Feedback	All aspects of feedback giving and receiving.
Teamwork	Collaborations within and between professions and work culture.
Communication with parents	All sorts of communication with parents.
Protocols	Stimulating evidence-based ways of working, among others using protocols and keeping protocols up to date.
Working conditions	Different aspects of the job, such as way of working and workhours.
Continuity of care	Continuity in medical policy and staff, including devoting sufficient attention and time for the patient.

Expert panel

An expert panel, encompassing a manager, senior nurse, and a patient safety expert, was held to evaluate the most mentioned recommendations. Practically, this implied that the recommendations that were considered irrelevant (or no longer relevant) were excluded. The expert panel also discussed if and how the recommendations could be implemented to see if implementation was feasible.

Interviews

In the interviews, staff members were asked how the recommendations for improving patient safety could be implemented. A total of ten interviews were done, among two managers, three physicians, and five nurses working at the PICU. A manager at the PICU suggested respondents, who were then randomly selected from different units to ensure a diverse representation of perspectives, minimizing the risk of selection bias. The interviews were semi-structured and guided by a topic list. They consisted of questions such as "What is the situation like now (for a certain theme)?" and "How would you implement the recommendation?".

Results from the expert panel and the interviews were combined in the analysis due to overlapping responses, allowing for a more efficient presentation of the findings.

For the data analysis, all interviews were recorded and transcribed. The transcriptions were then coded in three stages.¹⁵ First, during open encoding, codes were connected to the text. Second, during axial encoding, the coded pieces were put below the corresponding themes. Third, during selective encoding, the coded pieces were connected to each other. The themes of the recommendations were used as the codes for the analysis.

Results

Patient safety culture in the Sophia Children's Hospital

The number of respondents who completed the SAQ ranged from 153 to 191 per survey year, with a median of 175 and a total of 1,029 (Table 2).

Table 2: Background characteristics of respondents across the years

		2009 N= 153	2012 N= 180	2014 N= 178	2017 N= 172	2019 N= 155	2023 N= 191
Gender, n (%)	Male	17 (11.1)	13 (7.2)	14 (7.9)	11 (6.4)	13 (8.4)	16 (8.4)
	Female	136 (88.9)	161 (89.4)	164 (92.1)	159 (92.4)	122 (78.7)	175 (91.6)
	Missing	0 (0.0)	6 (3.3)	0 (0.0)	2 (1.2)	20 (12.9)	0 (0.0)
Age in years	Mean (SD)	40.9 (8.9)	42.1 (9.0)	43.6 (9.4)	45.0 (9.8)	42.5 (10.9)	42.8 (12.1)
Profession, n (%)	Nurse	104 (68.0)	129 (71.7)	123 (69.1)	112 (65.1)	83 (53.5)	121 (63.4)
	Physician	15 (9.8)	15 (8.3)	18 (10.10)	22 (12.8)	14 (9.0)	21 (11.0)
	Other	28 (18.3)	30 (16.7)	31 (17.4)	33 (19.2)	34 (21.9)	49 (25.6)
	Missing	6 (3.9)	6 (3.3)	6 (3.4)	5 (2.9)	24 (15.5)	0 (0.0)
Followed a CRM-training course on this PICU, n (%)	Yes	137 (89.5)	152 (84.4)	143 (80.3)	162 (94.2)	145 (93.5)	132 (69.1)
	No	16 (10.5)	26 (14.4)	15 (8.4)	10 (5.8)	10 (6.5)	59 (30.9)
	Missing	0 (0.0)	2 (1.1)	20 (11.2)	0 (0.0)	0 (0.0)	0 (0.0)
Employment, n (%)	Full-time	60 (39.2)	55 (30.6)	52 (29.2)	56 (32.6)	55 (35.5)	70 (36.6)
	Part-time	92 (60.1)	112 (62.2)	121 (68.0)	110 (64.0)	78 (50.3)	120 (62.8)
	Flex work	1 (0.7)	9 (5.0)	4 (2.2)	2 (1.2)	1 (0.6)	1 (0.5)
	Missing	0 (0.0)	4 (2.2)	1 (0.6)	4 (2.3)	21 (13.5)	0 (0.0)

Most of the respondents were females, with an average age in their early 40s, and most were employed part-time. Furthermore, most respondents had followed a CRM training. Nurses were clearly overrepresented. Generally, the distribution of these characteristics was quite stable throughout the study years.

Table 3 presents the mean SAQ subscale scores (and standard deviations) throughout the survey years.

Table 3: SAQ subscale scores per survey year

Subscale score		2009	2012	2014	2017	2019	2023	Cohen's d between 2009 and 2023
Teamwork climate	Mean	66.8	64.1	70.3	67.2	75.2	75.8	0.77
	(SD)	(11.7)	(9.5)	(12.0)	(12.0)	(13.1)	(11.4)	
	N	147	168	171	164	142	188	
Safety Climate	Mean	63.6	62.8	68.8	66.8	67.6	70.7	0.59
	(SD)	(11.6)	(10.3)	(11.4)	(13.1)	(12.9)	(11.2)	
	N	148	163	170	165	144	187	
Job Satisfaction	Mean	62.8	65.9	68.7	68.2	75.4	77.3	1.05
	(SD)	(14.7)	(14.7)	(13.0)	(13.9)	(14.2)	(13.1)	
	N	151	170	176	167	150	180	
Stress Recognition	Mean	53.0	57.0	53.7	58.9	57.7	55.3	0.13
	(SD)	(15.6)	(17.2)	(16.4)	(17.0)	(19.1)	(20.0)	
	N	148	171	172	167	148	188	
Perceptions of Management	Mean	50.4	52.3	55.9	49.1	55.0	58.0	0.57
	(SD)	(14.0)	(12.9)	(13.4)	(15.1)	(11.2)	(12.7)	
	N	151	172	171	166	134	154	
Working Conditions	Mean	52.5	55.8	58.1	55.0	57.6	62.7	0.70
	(SD)	(14.3)	(13.7)	(11.3)	(15.1)	(12.3)	(14.8)	
	N	142	165	168	168	122	188	

Teamwork climate, job satisfaction, and safety climate consistently had the highest scores. Generally, the subscale scores appeared to increase throughout the years, although some years, particularly 2017, showed interruptions in this positive trend. When comparing 2023 to 2009, most scale scores increased, with medium effect sizes. A relatively large increase was observed in job satisfaction (77.3 versus 62.8). Stress recognition was an exception, with the score in 2023 being only 2.3 points higher than in 2009, indicating a minor effect size.

Furthermore, the subscale scores of 2023 show that there is still room for improvement, especially in stress recognition, perceptions of management, and working conditions, where the scores are below 70. The recommendations from the SAQ are analyzed in the next section to explore options for improving the patient safety culture in our PICU.

Recommendations to improve patient safety culture

Out of the 1,029 respondents, 705 provided a total of 1,574 recommendations. Table 4 shows that most of these recommendations fell within the themes of communication between professions (28% of all recommendations), medical equipment and hospital working environment (13%), and staffing (11%).

Table 4: Total recommendations per theme (per survey year and full sample)

Themes	2009	2012	2014	2017	2019	2023	Total
Staffing	21 (7.4%)	40 (15.9%)	8 (2.9%)	39 (15.1%)	35 (17.8%)	30 (9.9%)	173 (11.0%)
Medical equipment and hospital working environment	22 (7.8%)	25 (9.9%)	39 (13.9%)	23 (8.9%)	38 (19.3%)	61 (20.1%)	208 (13.2%)
Training (and education)	13 (4.6%)	27 (10.7%)	22 (7.9%)	18 (7.0%)	12 (6.1%)	33 (10.9%)	125 (7.9%)
Incident reporting	11 (3.9%)	16 (6.3%)	24 (8.6%)	19 (7.4%)	12 (6.1%)	29 (9.5%)	111 (7.1%)
Action planning	19 (6.7%)	14 (5.6%)	15 (5.4%)	17 (6.6%)	8 (4.1%)	4 (1.3%)	77 (4.9%)
Communication between professions	89 (31.4%)	66 (26.2%)	95 (33.9%)	79 (30.6%)	43 (21.8%)	74 (24.3%)	446 (28.3%)
Feedback	18 (6.4%)	7 (2.8%)	9 (3.2%)	3 (1.2%)	6 (3.0%)	16 (5.3%)	59 (3.7%)
Teamwork	40 (14.1%)	19 (7.5%)	12 (4.3%)	17 (6.6%)	12 (6.1%)	36 (11.8%)	136 (8.6%)
Communication with parents	1(0.4%)	2 (0.8%)	3 (1.1%)	8 (3.1%)	7 (3.6%)	4 (1.3%)	25 (1.6%)
Protocols	18 (6.4%)	13 (5.2%)	18 (6.4%)	4 (1.6%)	0 (0.0%)	0 (0.0%)	53 (3.4%)
Working conditions	6 (2.1%)	12 (4.8%)	15 (5.4%)	14 (5.4%)	12 (6.1%)	15 (4.9%)	74 (4.9%)
Continuity of care	25 (8.8%)	11 (4.4%)	20 (7.1%)	17 (6.6%)	12 (6.1%)	2 (0.7%)	87 (5.5%)
Total recommendations	283 (100%)	252 (100%)	280 (100%)	258 (100%)	197 (100%)	304 (100%)	1574 (100%)

Throughout the years, these frequently mentioned themes were rather stable, showing their ongoing relevance. However, the theme of ‘medical equipment and hospital working environment’ seemed to increase in recent years, while ‘staffing’ showed quite some variation over time. Table 5 shows which specific recommendations were most mentioned under those themes.

Table 5: Most mentioned recommendations

Theme	Most frequently mentioned recommendations
Staffing	"More staff", "better occupation according to the care level", "more staff next to the bed" and "more qualified nurses".
Medical equipment and hospital working environment	"More workspace", "better availability of materials", "better implementation of medical equipment", "better equipment for medication monitoring", "double checking of medications" and "medication administration checks".
Training (and education)	"More CRM trainings", "more clinical lessons about illnesses" and "more scenario trainings".
Incident reporting	"Easier way to report incidents", "more incident reporting", "more feedback/discussion/evaluation of incident reports".
Action planning	"Transparency and sharing results and improvements of the PICU with staff members".
Communication between professions	"Better communication between disciplines and other departments", "better documentation in HiX (patient documentation system)", "better medical information transfers", "more use of briefings", "more use of huddles", "more debriefings during and after complicated cases" and "more use of debriefings after acute situations".
Feedback	"More giving and receiving feedback between staff members on the work floor".
Teamwork	"Better teamwork between disciplines", "more respect for each other", "more team spirit" and "open and safe team culture".
Communication with parents	"Better communication with parents".
Protocols	"Work according to protocol", "evidence-based working", "more accessible protocols" and "up to date protocols".
Working conditions	"Better workhours", "work pressure" and "rules regarding absence of staff members on the PICU".
Continuity of care	"Having the same physician/nurses for a patient", "more similar medical policy by different physicians", "keeping the patient on the same unit", "better after care" and "more time for the patient".

Relevance, feasibility and implementability of the recommendations to improve patient safety culture

The relevance and feasibility of the recommendations were assessed by the expert panel. For each theme deemed relevant and feasible, explanations and potential solutions for implementing the recommendations are given. The findings of the expert panel and those of the interviews with staff members often overlapped, which is why they are discussed together in this section. In the presentation of these results, some related themes will be combined: staffing and working conditions, incident reporting and action planning, and communication between professions, feedback, and teamwork.

Staffing and working conditions

Increasing staffing levels is relevant, but implementation is complex due to financial constraints. However, optimizing staff allocation based on care intensity is already a priority. The management is already in conversation with staff members on how to reduce work pressure. Minor adjustments can be made to further address this issue. For example, introducing clearer rules regarding staff absences from the PICU due to other tasks could help reduce work pressure.

Medical equipment and hospital working environment

The experts mentioned that availability of materials is currently an issue, because of shortages of original materials. Therefore, substitute materials are being used now. Issues concerning workspace and materials are already recognized by the management. Solutions will be included in the planned renovation of the hospital.

Training (and education)

The experts emphasized that more priority should be given to all sorts of training, considering it a management decision. “Staff members should also initiate trainings themselves” (Expert 1). However, not all staff members are doing this. Managers have implemented a new training plan that includes a points system where staff members must accumulate a certain number of points by the end of the year. Points can be earned through activities such as clinical lessons and theme evenings. This point system encourages continuous professional development and helps identify areas where additional training may be needed.

Incident reporting and action planning

Incident reports are analyzed monthly by a team that focuses on quality. Feedback from these analyses is shared with staff through a monthly newsletter. However, according to the expert panel, there is a desire for greater insight and feedback regarding the outcomes of incident reporting. This sentiment was shared by the interviewed nurses, one of whom stated: “Rather than only sharing the big things, it is also important to share the little things” (Nurse 4). This approach could foster a more engaged and informed culture, as staff would better understand how their reports are being utilized.

Current initiatives, such as newsletters with concise summaries and screensavers, are valuable. Additionally, Physician 1 suggests: “One or two education days on incident reporting might be useful. Visualize what was reported in the last year, what has improved. And make visible who is part of the quality team, how the system works, and be open to ideas from the staff”. This could enhance satisfaction with the incident reporting process.

Communication between professions, feedback, and teamwork

The expert panel identified variability in communication between professions. Expert 2 mentions: “As a nurse, you don’t know that the physician came in because they didn’t inform us. What can be improved is the live communication”. Expert 3 adds: “Parents also mention that they hear something from one physician, but the other doesn’t know anything about that. This can be frustrating for the parents if they must repeat things”. The expert panel believed that the implementation of recommendations regarding communication between professions could be further developed. Interviewees noted that consultant physicians, who are not always present on the PICU, sometimes visit the unit to speak with parents without informing staff. As a result, the responsible nurse may be unaware of what was discussed. Additionally, as one physician mentioned: “This miscommunication leads to confusion and disappointment if things turn out differently when for example other decisions are made” (Physician 2).

A solution could be to establish clear agreements about how consultant physicians should communicate when entering the unit. All respondents agreed that the consultant physician should notify the nurse, senior nurse, or physician before or after a visit. Nurse 1 mentions that consultant physicians could say the following to a staff member if the responsible nurse is not available: “Could you say that I was here and discussed this...”. To ensure these agreements are effectively implemented, all staff members must be aware of them, committed to them, and continually communicate them with consultant physicians.

Staff members provided the recommendation to increase the exchange of feedback between staff members on the work floor. The expert panel, however, acknowledged that feedback is challenging, because it is ingrained in the culture, which takes time to evolve and involves many components. It encompasses example behavior, psychological safety, and how feedback is handled (Expert 3). Expert 1 notes: “Staff members don’t find it difficult to address things, but the way they address things can be improved. Sometimes there is too much emotion or responses are too blunt. Feedback has to do with the tone, the way things are said”. Providing feedback is a crucial element of a patient safety culture, yet it is not well-defined how strategies for improving the feedback process can be implemented.

Manager 1 mentions: “In general, there is psychological safety on the unit to give feedback”. However, Nurse 2 remarks: “Psychological safety could be better”. The interviewees suggest that increasing feedback and psychological safety can be achieved by becoming accustomed to giving and receiving feedback, even on minor issues. It is essential to address matters in an approachable way and make the other person aware of how their actions made you feel.

Communication with parents

A frequently mentioned recommendation was to increase the involvement of patients' parents. Expert 3 remarked: "More involvement of parents will lead to greater satisfaction of both parents and patients. It will also improve the current way of working and teamwork. Some staff members believe that involving parents is difficult due to the complexity of the PICU. However, this perception is unfounded. There are various levels and ways to involve parents". The expert panel felt that it is not yet clear how to implement the recommendations regarding communication with parents. One issue identified is the variability among physicians. "If parents talk with different physicians, they hear different stories because everyone expresses themselves differently. This can be frustrating if you are already in a stressful situation" (Physician 3).

The interviewees suggested assigning a key role to the nurse practitioner to improve communication between physicians and parents. "The nurse practitioner has more regular shifts and serves as the dedicated contact person for parents" (Physician 3). Nurse 2 adds: "It would be nice if there would be a case manager for the parents, where they can ask different types of questions. This person knows the family better and can be a frequent contact person".

Protocols

The recommendations highlight the importance of clear and up-to-date protocols to ensure consistency and quality of care. Although the experts acknowledged challenges in maintaining protocols—often due to a lack of dedicated responsibility—they emphasized that protocols remain essential for promoting evidence-based practices. Ongoing efforts focus on improving the development and regular updating of protocols to better support staff in delivering safe and standardized care.

Continuity of care

The recommendations highlight inconsistencies in medical policies among different physicians as a potential obstacle to patient safety. Expert 1 notes that physicians are already working to address this issue. Physician 2 mentions that whenever possible, the same physicians and nurses are assigned to long-stay PICU patients. Expert 3 mentions that this approach provides greater continuity of care.

Discussion

This study assessed patient safety culture in the PICU at Sophia Children's Hospital by identifying key areas for improvement based on staff feedback. Although patient safety culture has improved over the years, further progress can be achieved by focusing on the recommendations highlighted in the SAQ.

Staff in this study provided numerous recommendations through the SAQ. The themes emerging from these recommendations aligned closely with those found in earlier studies.^{7,8} For example, in the study of Gleeson et al., two major themes were “staffing issues” and “hospital environment,”⁸ which is consistent with our findings, where “staffing” and “medical equipment and hospital working environment” were the most frequently mentioned themes. This suggests that common patient safety issues occur across clinical settings. However, “teamwork”, a frequently mentioned theme in our study, was less prominent in prior studies, marking a notable difference.

The recommendations from the SAQ offered insights beyond those that can be derived from SAQ scale scores alone. After all, while some recommendations addressed issues reflected in low SAQ scale scores (e.g., staffing issues and the SAQ scale ‘working conditions’), others highlighted concerns that were not matched by low SAQ scale scores (e.g., communication issues and the SAQ scale ‘teamwork’). Some recommendations were vague — such as “better communication” or “better teamwork” — and thus provided few actionable cues for improvement. The expert panel and interviews helped refine these suggestions into concrete actions. These qualitative insights clarified staff needs and identified practical strategies to strengthen patient safety culture.

Solutions from the literature and this study's interviews to improve patient safety culture showed similarities. First, during the interviews, it was suggested to appoint a nurse practitioner or staff member as a ‘dedicated contact person’ or ‘case manager’ to improve communication with parents. This corresponds with earlier literature that highlighted the benefits of case management in improving communication and increasing satisfaction among patients and their families.¹⁰

Second, respondents mentioned that consultant physicians sometimes visit the unit to speak with parents without informing staff members. A proposed solution was to establish a protocol requiring staff to be notified before or after the consultant physician meets with parents. This suggestion aligns with Chapman's recommendation to notify the nurse responsible for the patient upon the physician's arrival on the unit.¹⁶

Third, staff expressed a desire for greater insights into incident reporting trends, such as through education days. Alternatively, instead of education days, brief discussions during weekly handovers could offer a practical, continuous learning approach, given staff shortages that may hinder attendance at education days. Enhancing awareness of incident reporting trends could boost staff engagement, ultimately improving the reporting system. This aligns with quality monitoring strategies described by Powell et al.¹⁷

Fourth, feedback emerged as an important topic in this study. Respondents emphasized the need to improve psychological safety by fostering an environment where concerns are addressed openly and where individuals communicate how they feel. This aligns with the concept of 'graded assertiveness', which involves using gentle cues, such as "I am concerned about..." and "It would help me to understand...", to express concerns.¹⁸ While previous studies have highlighted the value of socially constructed learning through peer dialogues,¹¹ our findings provide additional practical insights by revealing specific barriers and preferences within the PICU context. For example, although written feedback is currently used, staff expressed a strong preference for live, real-time feedback to foster immediate learning and improve team dynamics. This supports Brehaut et al.'s suggestion for real-time feedback,¹¹ but extends it by highlighting its relevance in high-stakes environments like PICUs, where timely communication is crucial.

Strengths and limitations

A strength of this study was the use of informal member checking during interviews, allowing participants to confirm or correct summarized statements. Reliability was ensured through the maintenance of an audit trail, documenting all steps and decisions throughout the research process. Additionally, data collection followed a structured sequence: SAQ data analysis was conducted first, followed by an expert panel review, and finally, interviews. This ensured that the interviews were informed by both prior data and expert insights. The validity of the study was supported using the SAQ, a widely used tool with strong psychometric properties. Furthermore, a high response rate was achieved by having staff complete the SAQ immediately before CRM meetings.

A potential limitation of the study is the relatively small number of interviews, with ten participants. Given that the number of nurses on the PICU (over 120 in the year 2023) far exceeds the number of nurses interviewed (five), some opinions could have been missed. However, the study included nurses from different units, as well as both senior and junior nurses, which likely helped to capture a broad range of viewpoints. Furthermore, data saturation was reached, as most respondents provided similar statements.

Future recommendations

Based on the recommendations given through the SAQ, the following actions can be advised. First, communication with parents should be facilitated by assigning a dedicated contact person for each patient. Second, to enhance communication and teamwork between professions, stronger agreements on how to act and communicate within the PICU should be implemented. Given the dynamic nature of PICU teams and ongoing staff turnover, this requires continuous attention, reflection, and adaptability. Regular reflection moments and the integration of learning into daily routines can help teams adjust to changes and maintain effective collaboration. Third, for incident reporting, visualization of reports by education days could be implemented. Fourth, further strategies to enhance feedback are recommended.

While some actions will demand significant effort, time, and financial investment, this study also identified low-resource strategies. For example, improving live communication between consultant physicians and staff through clear agreements can be achieved relatively easily, although these agreements will require ongoing reinforcement.

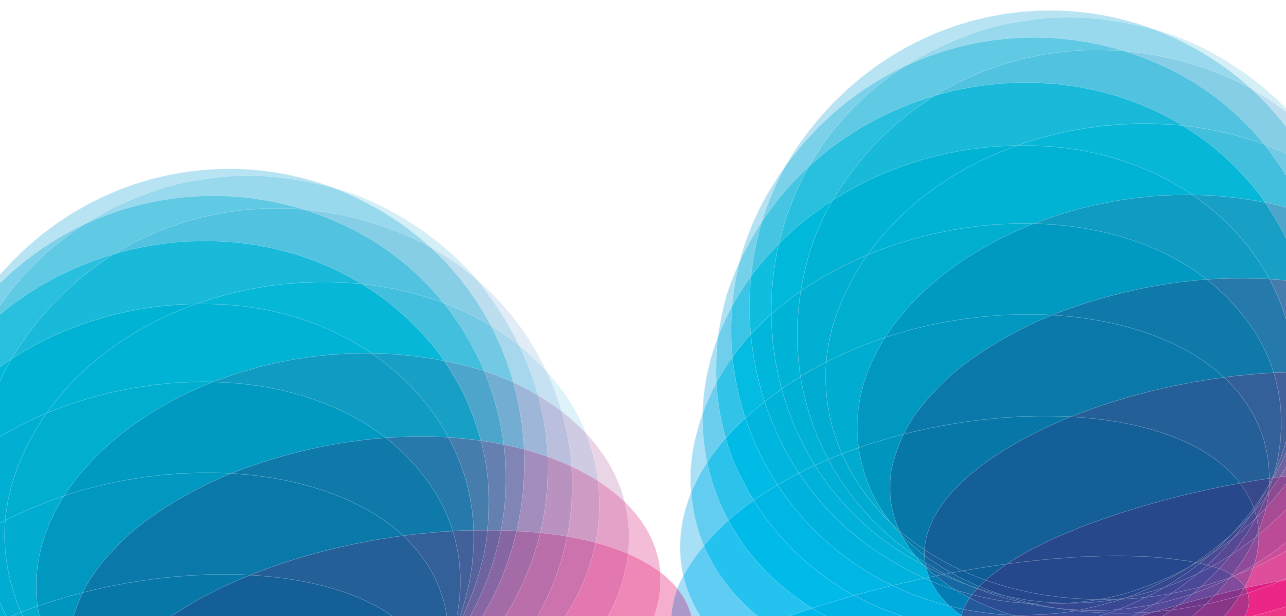
Future studies should aim to provide more insights into how patient safety culture in PICUs (and potentially in other pediatric and adult healthcare settings) can be further improved. Elaborate implementation plans should then be developed, guided by the principles of effective change implementation outlined by Grol et al.¹⁹ Afterward, it should be evaluated whether patient safety culture has improved, through interviews and additional prospective analysis of SAQ results. Furthermore, SAQ results and implemented improvements could be compared across different hospitals to identify general best practices.

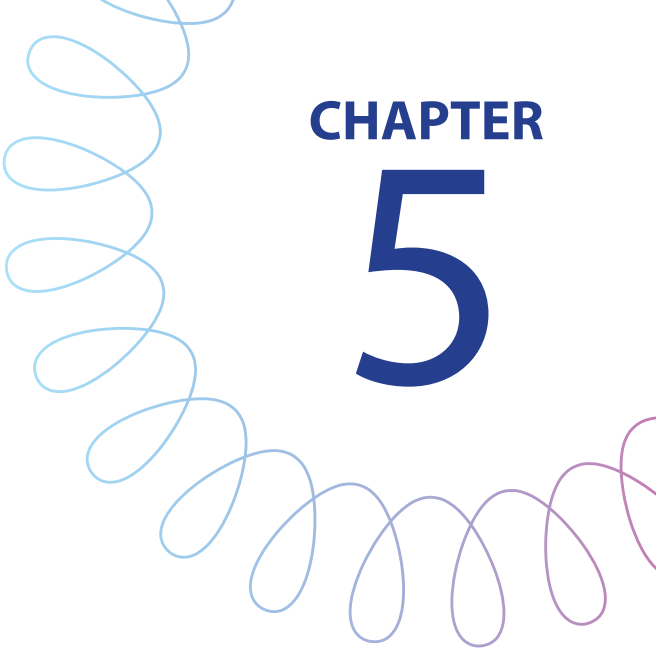
Conclusions

This study highlighted key areas for improvement in the patient safety culture, especially stress recognition, perceptions of management, and working conditions. Staff recommendations centered on communication between professions, medical equipment and hospital working environment, and staffing. Proposed strategies to improve the patient safety culture included appointing a dedicated contact person to improve communication with parents and establishing agreements to strengthen interprofessional communication and teamwork. Implementation of these interventions is essential to strengthen the patient safety culture, ultimately leading to better patient outcomes.

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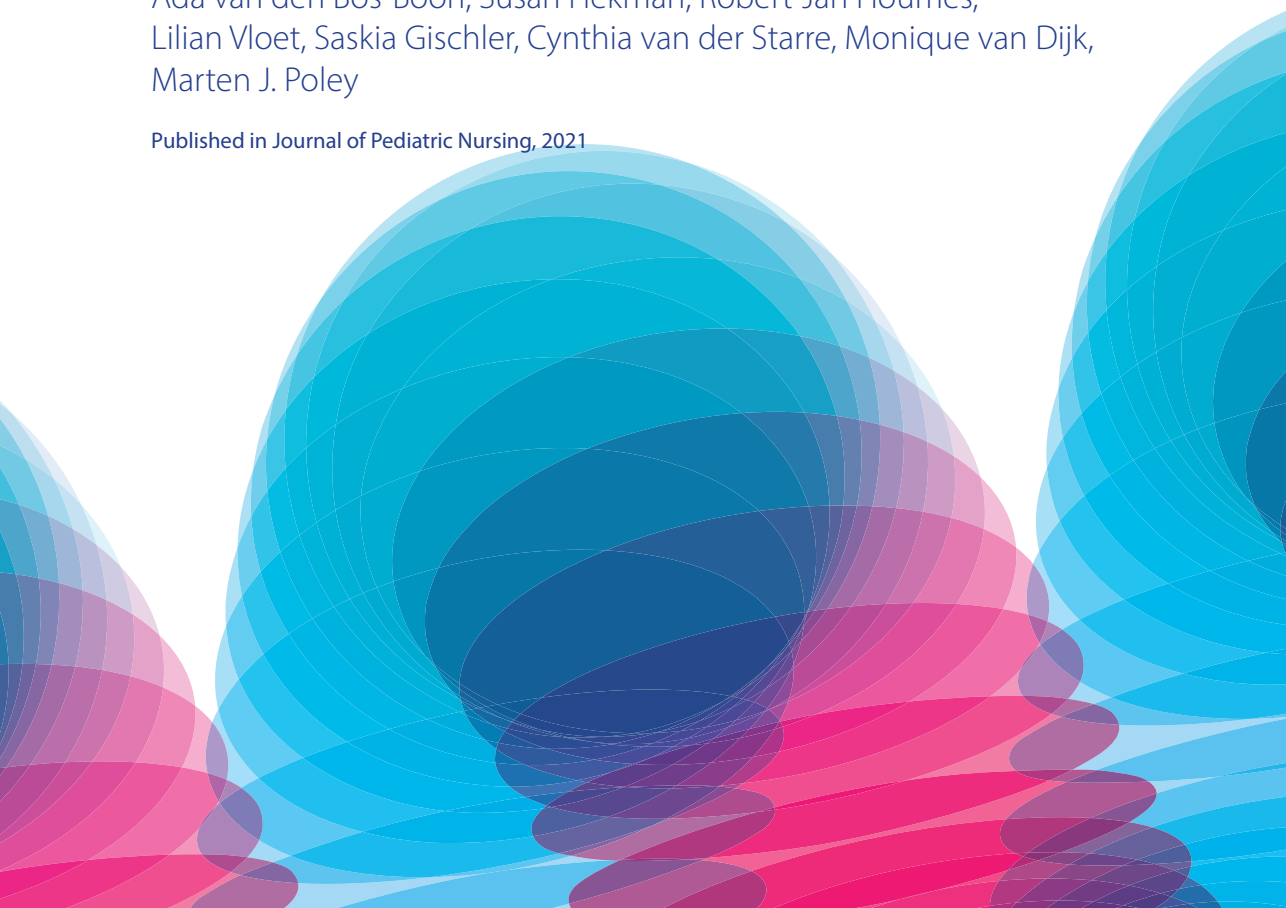
CHAPTER

5

EFFECTIVENESS OF SIMULATION TRAINING AND ASSESSMENT OF PICU NURSES' RESUSCITATION SKILLS: A MIXED METHODS STUDY

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Abstract

Purpose:

The quality of resuscitation and effective leadership are decisive for the outcome of a resuscitation. Nurses are usually the first responders upon cardiac arrest. Therefore, we started the “proficiency check” project, which aims to improve nurses’ resuscitation and teamwork skills. This article describes the effectiveness of the proficiency check and nurses’ experiences with it.

Design and Methods:

This study was done among intensive care nurses working on a pediatric ICU (PICU) in the Netherlands. It was designed as a mixed-methods study combining a quantitative and a qualitative approach. Quantitative data were obtained through a pre-posttest comparison of nurses’ resuscitation and teamwork skills, in a simulation setting. Qualitative data on nurses’ experiences were collected through semi-structured individual interviews.

Results:

Both resuscitation and teamwork skills improved significantly. In 39 nurses (32%), the improvement of both resuscitation and teamwork skills after the intervention was large (effect size >0.8). The experiences of nurses regarding the proficiency check were diverse: on the positive side, increased knowledge and confidence were reported, whereas negative experiences related, among other things, to stress and anxiety.

Conclusions:

Resuscitation and teamwork skills of PICU nurses can be enhanced by the ‘proficiency check’ studied here. This simulation-based training can be further improved by incorporating the nurses’ experiences.

Practice implications:

A simulation-based assessment for resuscitation may play an important role in a PICU, and possibly for other skills and in other settings as well. Particular attention should be paid to the stress that many nurses experience due to skills assessment.

Keywords:

Teamwork, Resuscitation, Nurses, Skills assessment, Pediatric Intensive Care

Purpose

In healthcare, a considerable proportion of incidents, reportedly 22%-36%, are related to teamwork failures and communication breakdowns.^{1,2} An important reason may be that traditional classroom education of healthcare professionals pays little attention to teamwork. One of the changes proposed by Leape to achieve a culture of safety is a shift from reliance on independent, individual performance excellence to interdependent, collaborative, interprofessional teamwork.³ One way to achieve effective teamwork is crew resource management (CRM) training, which aims to prevent errors related to teamwork skills such as leadership, decision-making and communication skills.⁴⁻⁶ An important component of CRM is simulation based training (SBT), which is a tool to practice skills in a realistic and safe environment.⁷ It allows for training and assessing both teamwork skills and technical skills.

In the PICU setting, resuscitation after cardiac arrest is a typical domain in which not only teamwork, but also the leadership role is essential. Having someone take the lead is crucial, as time elapsed after the "no-signs-of-life" assessment is an important contributing factor to the patient's outcome.⁸ The first responder in the PICU is most often the nurse, who is expected to take the team leadership role. However, nurses generally have not been trained to take this role and may lack confidence and be afraid to harm the patient.^{9,10} Another factor contributing to outcome is the quality of the resuscitation skills. However, research into the quality of resuscitation skills is scarce, because it is difficult to measure quality in an acute situation. Current research is mainly focused on patient outcomes. For example, Van Zelle and colleagues described children's long-term health status and health-related quality of life after cardiac arrest, but did not take into account the quality of the resuscitation.¹¹

Nurses working on the PICU of Erasmus MC Sophia Children's Hospital are being trained in advanced pediatric life support skills (APLS) and in CRM, including SBT. This encompasses the training of teamwork skills, such as, leadership, communication, decision-making, and team situational awareness. However, the effectiveness of this training has never been evaluated. This evaluation is necessary to measure whether the quality of the resuscitation is improved. Moreover, little is known about nurses' experiences with SBT for resuscitation. This is an important knowledge gap, because experiences and emotions influence the way in which clinical information is perceived and interpreted during a critical situation. Therefore, experiences can have an impact on the effectiveness of SBT.¹² Thus, insight in the effectiveness of SBT and experiences of nurses during the learning process of SBT is highly valuable. Such insight can help to improve SBT, which in turn may take away obstacles for nurses to initiate resuscitation, as was documented by a study of

Murphy et al.¹³ Eventually, resuscitation outcomes and patient safety on the PICU may be improved.

In the present study, we aimed to evaluate the effectiveness of the so-called proficiency check, which is a SBT aimed at improving nurses' resuscitation and teamwork skills. Furthermore, we aimed to gain insight into the experiences of nurses during the proficiency check. We hypothesized that application of the proficiency check results in improved resuscitation skills and that nurses react positively to the proficiency check.

Methods

Study design

This was a mixed methods evaluation study, combining a quantitative and a qualitative approach. Quantitative data were obtained through assessment of nurses' resuscitation and teamwork skills in a simulation setting before and after application of the proficiency check, using the newly developed and validated instrument named the Professional Assessment Tool for Team Improvement (PATTI[®]; see further below). Qualitative data were obtained through semi-structured individual interviews with selected nurses.

Setting and participants

The setting of this study was the 28-beds level 3-4 PICU at the Erasmus MC Sophia Children's Hospital in Rotterdam, the Netherlands, which admits children between 0 and 18 years treated for, among other things, congenital anomalies, trauma, and neonatal, cardiac and craniofacial surgery. The PICU is staffed by 125 PICU nurses, 12 pediatric intensivists, and 6 fellows. Each year about 40 to 50 resuscitations are performed. The quantitative part of the study included 61 of the 71 nurses who had voluntarily participated in the validation study of the PATTI[®] (*Figure 1*). For the qualitative part of the study, nineteen nurses were interviewed. For this part of the study, inclusion criteria were participation in the proficiency check program and availability during dayshifts.

A project team was formed consisting of simulation trainers (doctors n=5 and nurses n= 5), a methodologist, a nurse manager specialized in nurses' training, a management assistant, and a planner (to schedule the training and assessment sessions). This team was responsible for the development, evaluation and assessment of the "Proficiency Check". Only the simulation trainers were trained in using the PATTI[®].

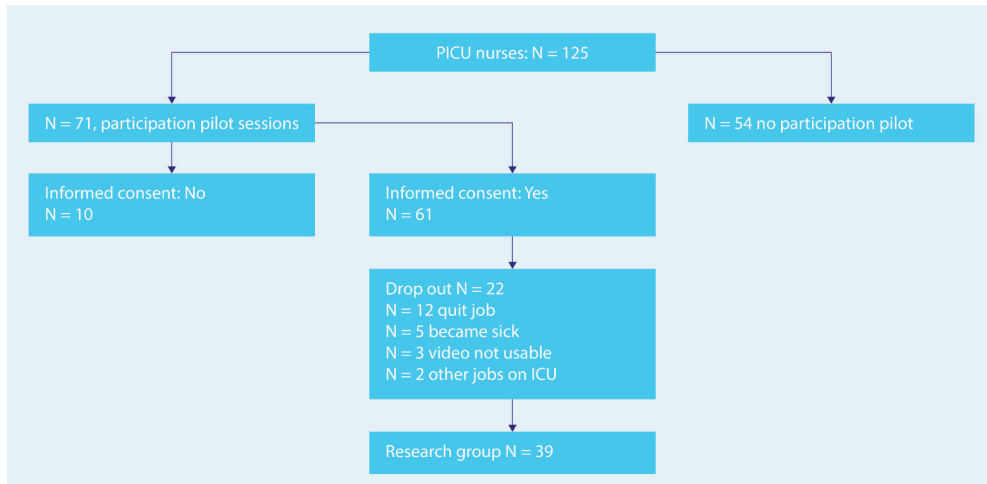


Figure 1. Flowchart of participants selection and drop out

Ethical considerations

For this study permission was requested from the Medical Ethics Review Committee of our institution. The committee concluded that the investigation was not subject to the Dutch Medical Research Involving Human Subjects **Act** (WMO) so further review was waived.

Intervention: the proficiency check

The proficiency check is based on Miller's pyramid of competence¹⁴ (Figure 2). The first layer represents cognition; the second layer technical skills; the third layer attitudes or teamwork skills; and the fourth layer performance at the workplace.

The proficiency check encompasses three phases

Phase 1: E-learning module and online theoretical assessment of APLS skills. The subject must pass this phase before proceeding to phase 2.

Phase 2: APLS skills assessment in practice: nurses individually demonstrate their technical APLS skills on a manikin. The nurse must pass this phase before proceeding to phase 3.

Phase 3: SBT which encompasses scenario training in which one of a team of three nurses – the first responsible nurse – takes the leadership role and secures the quality of the resuscitation. The skills, both technical and non-technical, of this nurse are assessed with the PATTI®.

The proficiency check may be considered a combination of formative and summative evaluation, as it both aims to monitor nurses' learning (to provide ongoing feedback and to improve their learning) and to assess nurses' learning after completing the proficiency check. To give them the opportunity to learn and improve, the nurses were provided feedback both in phase 2 and phase 3.

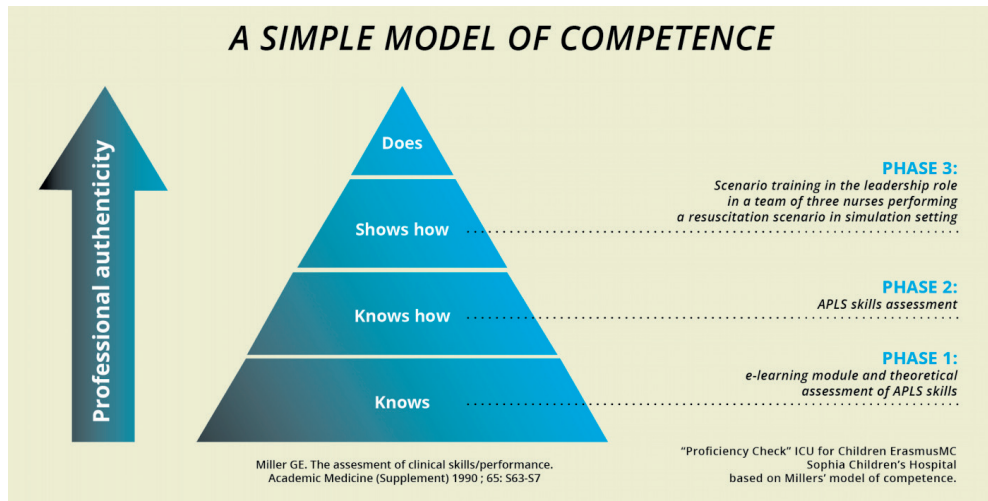


Figure 2. Theoretical framework proficiency check based on Millers Model:

Left side model Miller / right side "Proficiency Check" Sophia Children's Hospital

Implementation of the intervention

To implement the proficiency check, a comprehensive, structured implementation strategy was used, which may briefly be described as follows.

The first phase of the proficiency check (E-learning module and online assessment) could be planned and managed by the nurses themselves. The second phase was already embedded in the training program of the PICU. Therefore, these two phases were rather easy to implement. The third phase of the proficiency check was the most challenging part because of the manpower needed to train and assess the PICU nurses. To ensure the effective implementation of the intervention, pilot sessions were run. These pilot sessions were videotaped. Using the Plan Do Study Act (PDSA) principle, several actions could be taken prior to and during the intervention, referring to: barriers and facilitators, the logistics around the simulation (i.e., manageability, planning of the nurses, assessors, reservation of simulation rooms and assessment materials), the materials in the scenario, the time frame, preparation beforehand, and completeness and reliability of data (see appendix A).

Data collection and outcome assessment

Given the heterogeneity of healthcare teams, assessment instruments should be tailored to specific healthcare teams.¹⁵ As an existing assessment tool fulfilling our requirements was not available, we set out to develop a valid and reliable tool to assess the nurses' resuscitation and teamwork skills. This resulted in the Professional Assessment Tool for Team Improvement (PATTI®). It encompasses 12 items divided into four categories: Team role, 6 items; Teamwork and communication, 3 items; Technical skills, 2 items; and Reporting, 1 item. The response categories range from 1 (very poor performance) to 4 (very good performance) (See Table 1).

Table 1: Professional Assessment Tool for Team Improvement score sheet

Scenario type: Ventricle Fibrillation / Asystole (delete if not applicable)					
Candidate:				Date:	
Assessor 1: (the one filling out the form)		Assessor 2:			Result:
	1	2	3	4	Notes
a. Role in the team					
1. Stays on the patients' right side					
2. Coordinates and assigns tasks to the second and third nurse					
3. Gives clear commands					
4. Checks whether the tasks have been performed					
5. Gives medication and fluid in time to the patient or delegates this to the second or third nurse					
6. Ensures that a colleague attends to the parents/caretakers					
b. Collaboration and communication					
7. Has helicopter view on process and product and evaluates joint actions					
8. Acts pro-actively in bringing in expertise and shows assertive behavior					
9. Invites team members to think about the problem, listens, contemplates aloud and achieve an adequate solution					
c. Technical skills => 10 is a knock out criteria					
10. Follows the right protocol and executes it correctly based on readings of vital parameters.					
11. Recognizes the complexity of the situation and asks for the right expertise					
d. Reporting					
12. Reports all interventions during the scenario (defibrillation, medication, amounts/doses and frequency)					

Legend: Subscale A: 6 items; Subscale B: 3 items; Subscale C: 2 items; Subscale D: 1 item; Total scale: 12 items

Because scores were based on videotaped scenarios, the last item of the PATTI® about reporting after the resuscitation outside the room could not be included in the study. In a later phase we asked the participants to report inside the room, so we could also record this item.

The PATTI® was applied before and after the intervention, from December 2014 till September 2017. The before measurement was rated by two assessors using the videotaped pilot sessions, after inter rater agreement was sufficient. The after measurement was done after nurses completed the three phases of the proficiency check. Nurses worked through the scenario of phase 3 of the proficiency check in teams of three. They took turns in having the role of first nurse and, as such, were assessed successively. During both the before and after measurement, one of two scenarios were assessed: a child with ventricular fibrillation or a child with an asystole. The nurses knew both scenarios and could also prepare themselves with the PATTI® for the teamwork skills. Both during the before and after measurement, nurses were briefed about the child before the start of the scenario and debriefed afterwards. Two assessors rated the nurses on all items. These were doctors and nurses of the project team (so, colleagues of the nurses who were being assessed). The sum of all items resulted in the total score (ranging from 11 to 44). Depending on this score, the nurses could receive some advice for study or could be required to follow a training. The nurses themselves were responsible for working on the areas for improvement and discuss with their manager what they need to improve. We also asked nurses to rate themselves on the 12 items of the PATTI® – but with only two response categories: sufficient (score = 1) or insufficient (score = 0). Accordingly, the total self-assessment score ranged from 0 to 12.

Prior to the study, the PATTI® was validated. This was done in collaboration with the Dutch Institute for Educational Measurement (CITO). Content validity was established in 62 pilot sessions. The interrater reliability between assessors varied from an intraclass correlation coefficient of 0.78 to 0.87. Furthermore, the use of the PATTI® proved feasible; the assessment time could be shortened from 120 minutes to 60 minutes for three consecutive simulation sessions. Further details about the validity and feasibility of the PATTI® are described in Chapter 3 of this thesis.

The semi-structured, individual interviews were held by the second author, who was not in a working relationship (hierarchical or otherwise) with the interviewees, in March and April 2018. During the interviews, 'what' and 'how' questions were used to obtain data. According to Pope et al., this design is appropriate when the aim is to explore experiences and attitudes of individuals¹⁶. The interviews were guided by a topic list (see Appendix B) to cover all important subjects during the interview.¹⁷ The topic list was based on conversations with experts on patient safety on a PICU, conversations with the

developers of the proficiency check, and literature. It was slightly adapted after the first three interviews, based on information obtained from participants. Individual face-to-face interviews lasted approximately 20 minutes and were conducted in a quiet room during nurses' working hours.

Statistical analysis

Sample size calculation

An earlier study of Kurosawa¹⁸ showed a large effect of the training on APLS skills (that is, an effect size of 1.5). To be on the conservative side, the sample size calculation was based on a moderate effect size of 0.50. Using an alpha level of 0.05 and a power of 0.80, this resulted in a required sample size for a paired T-test of 34.

Effect evaluation

Data of the pre-and post-measurement were entered into IBM SPSS 24.0 and stored in a secured database.

Pre- and post-intervention subscales and total PATTI[®] scores were assessed using the absolute standardized mean difference (Cohen's d) and compared with a paired sample t-test. A Cohen's d of 0.20 represents a small effect; a value of 0.50 a moderate effect; and a value of 0.80 and higher a large effect.¹⁹ A p-value < 0.05 was considered statistically significant. Furthermore, for each PATTI[®] item, the percentage passed was calculated as items scored 3 or 4.

Qualitative data analysis

Interviews were digitally recorded – with consent from the participant –and transcribed verbatim. One participant did not give consent to record the interview. During this interview, notes were made instead and used for the analysis. The interview data were subjected to inductive qualitative content analysis.^{20, 21} This method was considered appropriate for this study, considering the lack of qualitative data into this subject. Moreover, this method is often used in analyzing multifaceted and sensitive data from nurses.²⁰ Data were analyzed through three phases: preparation, organizing and reporting phase. In the preparation phase, the unit of analysis was determined. In this study, these were 19 transcripts of interviews. Subcategories were derived from the transcripts using open coding in the organizing phase. Phrases from the interviews were assigned a code. A code represented a subcategory and phrases from all interviews representing the same subcategory were given the same code. The open coding process was repeated to make sure all data was correctly analyzed. Then, similar subcategories were merged into larger categories. Lastly, in the reporting phase, findings were reported by giving an overview of the different categories. As a result, five different themes emerged from the data.²⁰

Results

Quantitative analysis:

Thirty-nine of the 61 nurses who had provided informed consent to use their simulation video sessions in the current study completed a pre- and post-measurement. The flowchart gives the reasons for drop-out of the other 22 nurses (*Figure 1*). The mean age of these 39 nurses was 42 (SD 9.2), the vast majority (n = 37) were female.

Table 2 presents the mean (SD) subscale scores and the total PATTI® score. All scores statistically significantly improved between the pre- and post-measurement (paired t-test, $p < 0.001$), with effect sizes ranging from 1.7 to 2.6.

Table 2. mean (SD) on all subscales and total PATTI score

Subscale	Score range	Before N=39 Total score (SD)	After N=39 Total score (SD)	Effect Size
A: Role in the team	6 - 24	18.1 (1.7)	21.0 (1.7)	1.7
B: Collaboration and Communication	3 - 12	7 (1.5)	10 (1.1)	2.3
C: Technical skills	2 - 8	4.5 (0.8)	6.6 (0.8)	2.6
Total score:	11 - 44	32.8(3.4)	41.4(3.1)	2.6

Figure 3 presents the items of the PATTI® and the percentage of nurses that passed for each item before and after “the proficiency check”. All items on the subscales improved apart from two that already scored 100% before the intervention. The score of reporting after the resuscitation outside the room (item 12) was not based on the videotaped scenario, but considering the sufficient reporting of all nurses, everyone scored “passed”. Two items improved most prominently; item 7: “Checks whether the tasks have been performed” from 7.7 to 79.5 % and item 10: “Follows the right protocol and executes it correctly based on readings of vital parameters” from 20.5% to 94.9%.

The 39 participating nurses also assessed themselves. Due to the gradual implementation of the PATTI® over time, only eleven nurses provided both a pre and post self-assessment score. Seven nurses found themselves improved, ranging from 0 to 5 points improvement, while 4 nurses scored the same (*Figure 4*).

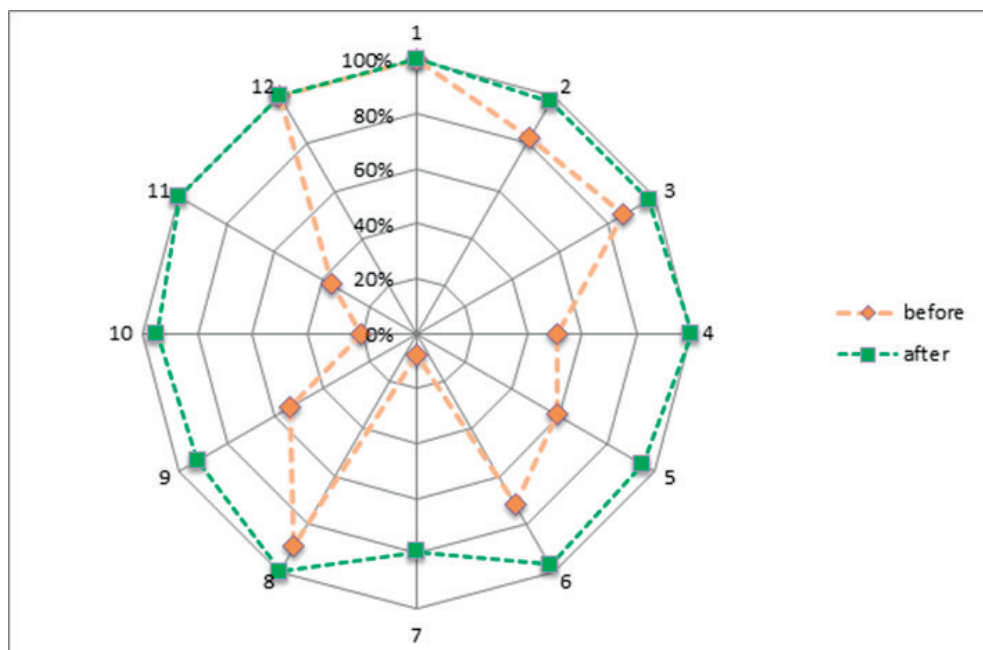


Figure 3. Pre- and post-item scores

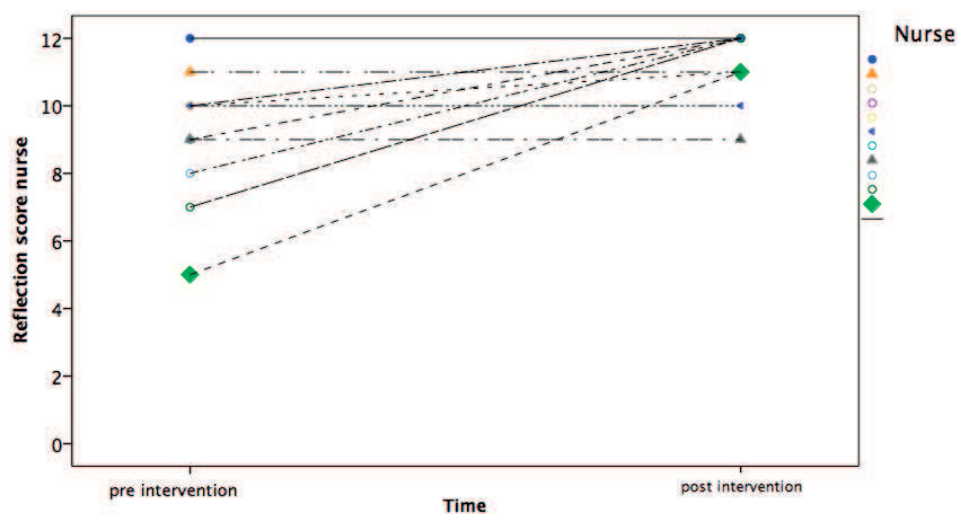


Figure 4. Nurses' self-assessment scores

Qualitative:

The nurses who participated in the interviews were predominantly female (89%), with an average age of 49 years. All participants were specialized as pediatric ICU nurse. On average, participants had 29 years (range 11-39) of experience as a nurse. Most participants had performed 6 to 19 resuscitations in their career as a nurse.

The following themes emerged from the interviews: 1) usefulness of the proficiency check to improve quality of resuscitation; 2) emotional experience of undergoing the proficiency check; 3) effectiveness of assessing resuscitation skills; 4) self-reported improvement in resuscitation and teamwork skills; and 5) self-confidence of nurses after the proficiency check. The main results are presented below.

Usefulness of the proficiency check to improve resuscitation

All nurses found a program to improve resuscitation skills useful. They mentioned that they do not often perform resuscitation and that it is important to keep skills up to date.

"But resuscitation (...), if I have performed it four times in the past twenty years, it would be a lot." (Interview 12)

Emotional experience of undergoing the proficiency check

The reported general emotions about the proficiency check were stress, anxiety and nervousness. All nurses felt some anxiety and were nervous before the proficiency check. Eight out of the 19 nurses described their nervousness as unhealthy: sleepless nights, headaches and two weeks of stress before the proficiency check.

"I was nervous beforehand, but when the moment [of the proficiency check] came, I really had the feeling I could pass out on the spot! That was how nervous I felt." (Interview 15)

Other nurses reported positive feelings after completing the proficiency check. They experienced some nerves but had positive feelings after completing the proficiency check.

"No I did not dread it, but I am not easily shaken. I told my colleagues, like what can happen, when you fail? You get fired? I don't think so, as long as I'm not fired, I'm fine." (Interview 13)

The stress and nervousness experienced before the proficiency check were mainly due to the realization that people would be watching and assessing their skills. Other triggers mentioned were the feeling of doing an examination, insecurity during an examination

and fear of failure. Moreover, the simulation setting was experienced as stressful and intense.

"You are pushed in a simulation box with a headset on your face, like a workout class at the gym. You are aware of everything being filmed; people are watching you while you do your thing. I do not like it." (Interview 11)

Effectiveness of assessing resuscitation skills

Twelve out of the 19 nurses found the resuscitation skills assessment effective in improving these skills. However, the majority of the 12 nurses were not happy with the procedure because the skills assessment predominated over the possibility to improve resuscitation skills.

"I think, you have to train people and not assess people. If you include an assessment in a training, you do not have to emphasize this. You should not put that much pressure on the assessment." (Interview 14)

Seven of the 19 nurses found the skills assessment unnecessary – and too stressful – and would like to focus more on only training resuscitation skills.

"Just practicing, without an assessment, pass, fail. And people who fail are upset for three weeks. That is too big of a negative impact. (...) If you practice regularly and repeat, it will have just as much of an effect." (Interview 16)

Nevertheless, other nurses were more positive and recognized the importance of an assessment to master a crucial skill like resuscitation.

"You know, you do not have to get rid of the assessment completely, because I think that you have to master certain skills." (Interview 12)

The learning process of nurses was sometimes hindered by the skills assessment and resulting negative emotions. Half of the nurses claimed that they learned more from the training ahead of the proficiency check than from the proficiency check itself.

"I do not see the advantage in assessing skills, since it is such a pressured situation which leads to the loss of the learning element, in my opinion." (Interview 17)

Self-reported improvement in resuscitation and teamwork skills

Seventeen of the 19 nurses reported improvement in their technical skills: more up-to-date knowledge about medication and technical skills like compressions. They also felt more knowledgeable about the resuscitation procedures and highlighted the importance of refreshing their knowledge. This also held true for those who were more negative towards the skills assessment during the proficiency check.

"It [technical skills] is in your system now, and it is good to refresh knowledge. What I learned from it is that when something like that happens now, it is fresh in my memory, like I am going to start to induce adrenaline." (Interview 11)

Half of the nurses reported improvements in their communication skills, such as smoother communication.

"Regarding communication skills, you are becoming more aware. You name people by their first name and indicating what you are doing. (...) I think it is good that it is trained." (Interview 16)

In contrast, the others claimed no change in communication skills and not having learned new communication skills. They stated that communication was already very good due to the yearly CRM training. Less than half of the nurses saw improvement in teamwork after the proficiency check. Again, a lot of nurses mentioned that teamwork was already good, due to the yearly CRM training. Improvements in leadership skills were rarely reported; leadership is rather seen as a physician's job.

Self-confidence of nurses after the proficiency check.

Self-confidence about their resuscitation skills increased in most nurses, even though the proficiency check was not always considered the perfect method. Confidence increased due to the proficiency check, but also as a result of practice beforehand.

"Well, I felt safer because you had the feeling that you know things better. Yes, you know what to do, but also that you feel a little safer." (Interview 16)

The *proficiency checks* increased nurses' confidence and decreased dependency on the physician. In turn, this empowered nurses to initiate resuscitation immediately after a child's collapse. Most nurses thought that time to initiation of resuscitation has decreased.

"Well, because you are overruled by physicians. This is what happened. I would start when something happens, but there are also people who are looking at the situation before they will start. And they will make a call and do not start resuscitation until

the physician arrives, and that happened a couple of times. That is a shame. If that continues for three minutes for example. I think this improved and now you are seen as a team member by physicians. There is a strong hierarchy between physicians and nurses which can get in the way of things like this. However, within resuscitation, this has improved [after the proficiency check]." (Interview 5)

Discussion

This study examined the effectiveness of "the Proficiency check", which aimed to improve PICU nurses' resuscitation and teamwork skills and explored the nurses' experiences with it. Assessment with the PATTI[®] tool showed improvement in the resuscitation and teamwork skills of all nurses after the proficiency check – notably communication, collaboration and technical skills. These quantitative results were, in a way, confirmed by the qualitative data: the nurses generally felt more confident to start a resuscitation and felt they had improved their resuscitation skills. We were surprised to find that most nurses beforehand were very anxious about the assessment; some even reported sleep problems and 'unhealthy' stress. Apparently, anxiety and stress due to the assessment could not be taken away by low threshold practicing and tailor-made coaching, which the nurses were offered when needed. The simulation room and patient simulation during SBT were labeled as realistic but were experienced as intense and stressful by some nurses.

The largest improvements as measured by the PATTI[®] instrument concerned the subscales teamwork and communication and technical skills. Less improvement was found for team role, which may be explained by the relatively high pre-intervention score possibly as a result of frequent CRM training. This is supported by a study of Costello et al. In this study, healthcare profession students after interprofessional team simulation had increased awareness of professionals' roles and felt more confident during resuscitation, which may improve patient outcomes.²² Although this study was done in a different setting, we could compare healthcare profession students and the nurses in this study, as they both were participating in a learning experience.

The improvements in teamwork and communication may be due to the fact that in the scenario training nurses have to show leadership in the scenario. Gilligan et al. supports the notion that nurses can show good team leadership in a resuscitation scenario setting but must be supported on how to lead a team.²³

Nurses indicated during interviews that their technical resuscitation skills improved, rather than teamwork skills such as communication. Communication skills were

already felt to be good due to the annual CRM training sessions. Still, the quantitative data show great improvements in communication skills. This discrepancy might be explained by the different types of communication addressed in the quantitative and the qualitative parts of the study. During the interviews, the nurses possibly referred to closed loop communication, since this is the type of communication addressed in the CRM training. The proficiency check, however, dealt with leadership communication; for example, summarizing what is said during resuscitation and empowering the team to create situational awareness. The type of communication the nurses talked about is incorporated in the team role, like ‘checking medication’ and ‘gives clear commands’.

The improvements on the subscale’s teamwork and communication and technical skills can be explained by the low pre-intervention scores due to the fact that PICU nurses were not used to taking the lead during resuscitation. The interviews support this suggestion. Nurses stated that after a child’s cardiac arrest, the physician is always present within a short period of time. The physician, then, is to be in charge and attending nurses follow the physician’s orders, which is related to traditional physician-nurse hierarchy. This is confirmed by a study which holds the idea that nurses have a supportive role during resuscitation.⁸ However, Heng et al.¹⁰, have proposed that nurses, physicians and managers should realize that nurse-led resuscitation will lead to improved patient outcomes, as it can decrease the time interval between the child’s collapse and the start of resuscitation. This is confirmed by Gilligan et al., who found that ALS trained nurses perform as good as ALS trained junior physicians do in resuscitation.²³ Thus, the leadership role can easily be performed by other healthcare professionals as long as they are well trained. Keogh et al. suggest another approach to change the nurse’s role from supportive to leading nurses may also benefit from awareness of different behavioral leadership styles.²⁴ This will help them to increase self-esteem and to identify individual nurses’ skills, which in turn can increase quality of resuscitation.

A strength of this study is the use of standardized scenarios and a reliable, validated measurement tool to measure the pre- to post-intervention change in resuscitation skills. Furthermore, the nurses’ experiences were adequately studied through the semi-structured interviews exploring individual opinions and experiences. Moreover, a rigorous qualitative data analysis technique, appropriate for the study setting, was applied, and the number of participants (19) was high compared to other qualitative studies in this field.

Practice Implications

A simulation-based assessment for resuscitation may play an important role in a PICU. Although this was a single-center study done in one PICU in the Netherlands, we feel that in other settings – in the Netherlands and abroad – trainings comparable to our

"Proficiency check" may be expected to lead to similar improvements in quality of care regarding resuscitations (or even other areas) as well. After all, in these settings, nurses also carry out patient-related procedures (related or unrelated to resuscitation) that they do not often perform, showing the potential benefits of training and assessments. However, no firm conclusions can be drawn about the generalizability of our results to other settings, which may be limited due to, among other things, selection bias (see further below). Furthermore, this study implies that particular attention should be paid to the stress that many nurses experience due to skills assessment. Another consideration should be how to support nurses to take up the leadership role, as this may further contribute to higher quality of resuscitations.

The following directions for future research may be suggested. First, this study did not measure the effect on patient outcomes related to the proficiency check. Although it is difficult to measure this effect, due to many confounding factors, such as improved possibilities to treat patients, more complex diseases, and a changing environment, it would be useful to know whether improved resuscitation skills result in better patient outcomes.

Second, the fact that the interviewed nurses had mixed feelings about the necessity of skills assessment may be an argument to abolish it and rather focus on practicing resuscitation skills. Nevertheless, Mahajan and co-workers recommended that training and assessment should be mandatory in a postgraduate program to support lifelong learning and to give insight in performance gaps.²⁵ We support the idea that skills assessments should not be left out in a training intervention like ours. Further research is necessary to understand whether nurses experience less stress and negative emotions when they are more used to these assessments. Although stress related to assessments may be unavoidable to some extent, it may be recommended, when proficiency checks or similar trainings are held in the future, to inform nurses more extensively about the assessment part and to explain that no consequences are attached to poor performance on it.

Limitations

The following limitations may have introduced bias into the results of the quantitative part of the study. First, the results are susceptible to the Hawthorne effect, which implies that professionals are more motivated to do well when they know they are being observed.²⁶ Second, the results could have been influenced by the fact that most nurses practiced the scenarios during the course of this project, of which the frequency was not registered, but differed per person. The fact that nurses knew which scenarios were used during the proficiency check was not considered as a limitation. The goal of "the Proficiency check" is improvement of quality of resuscitation. Preparation and knowing which scenarios may

have contributed to improved quality of resuscitation, but did not bias it, because the scenarios are recognized earlier in real work practice and dealt with more quickly and thus better for patient safety. Ultimately, the point is that this is a quality improvement in the recognition of an acute situation where leadership, teamwork is required and with the proficiency check trained and assessed. Third, selection bias is possible: the nurses who participated in this study were volunteering, and these may either be the nurses who already feel confident in resuscitation events or those who know they have knowledge gaps to overcome. The reasons for nurses to participate or not were not registered in this study, so we cannot be sure about the degree of bias.

Fourth, this study was done in a simulation setting, whereas in clinical practice the situation is probably more chaotic, with many healthcare professionals attending and every acute situation being unique. It is hard to tell whether in a real-life setting similar improvements in resuscitation skills and teamwork skills would have been found. In the future, it would be worthwhile to evaluate real-life resuscitations through debriefings using the PATTI® as a checklist.

Regarding the qualitative part of the study, it may be considered a limitation that the interviews were conducted by one and the same researcher, as was the data analysis. Participants for the interviews were selected on the basis of their availability during day shifts. Selective non-response may have occurred, because nurses with negative attitudes towards the proficiency check might be less interested in an interview. On the other hand, nurses with negative attitudes toward the proficiency check might be more willing to be interviewed since they want their opinion to be heard.

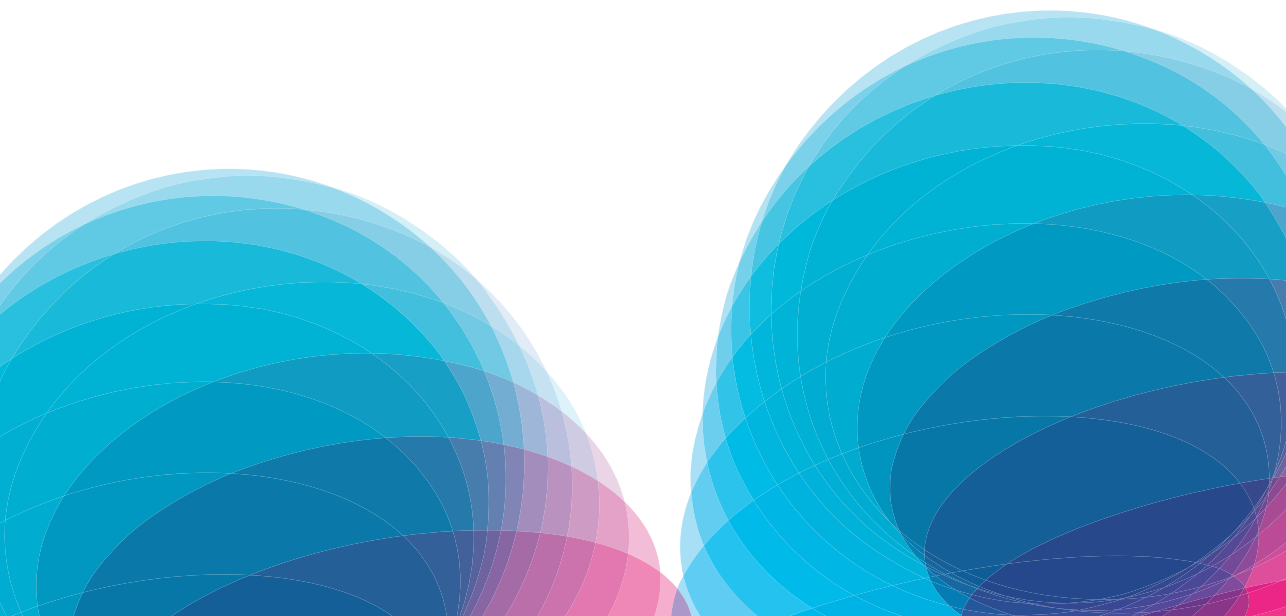
Conclusion

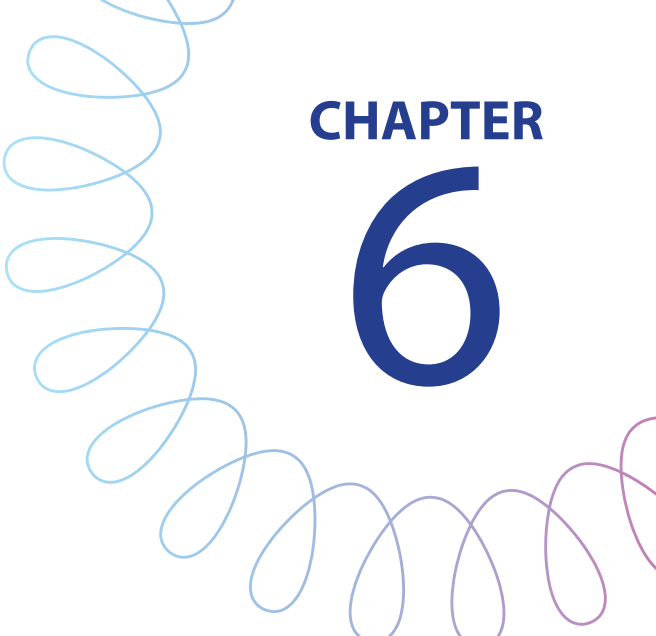
This study shows encouraging improvement of nurses' resuscitation-and teamwork skills in a simulation setting following a proficiency check for resuscitation. We may not automatically assume that this effect can be translated to the real-life setting, and this should be explored in future research. The participating nurses saw the benefit of the proficiency check, acknowledging the relative rareness of cardiac arrest on a PICU. Nonetheless, experiences with the proficiency check were both negative and positive. Negative emotions of nurses included stress, anxiety, nerves, fear of failure and insecurity during the proficiency check. On the contrary, increased knowledge regarding resuscitation, improved resuscitation skills and improved confidence regarding resuscitation skills contributed to the positive experiences of nurses.

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CHAPTER

6

REFLECTIONS ON TEAM TRAINING IN DUTCH HOSPITALS DURING COVID-19, AN EXPLORATORY STUDY DESIGN

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Submitted



Abstract

This exploratory study first examined the content of team training programs in Dutch hospitals and then explored how these were sustained, adapted, or discontinued during the COVID-19 crisis. Special attention was given to the content and application of teamwork methods such as debriefings and huddles, and management support in facilitating teamwork.

An exploratory study was conducted using two consecutive questionnaires. An invitation was sent to all 241 members of the national Dutch healthcare team training network. They were asked to participate if they had relevant experience, or a role related to team training in their organization. Of those invited, 43 expressed interests, 27 participated in the study, 19 completed the first questionnaire, and 17 completed both rounds. Results indicate that briefing, debriefing, handover, and speaking up were the most impactful methodologies for effective teamwork during the pandemic. All experts reported a lack of team training, pointing to challenges such as restricted collaborative learning, misalignment between disciplines, unfamiliar work settings, and diminished mutual support.

Participants emphasized the necessity of continuous team training, even in crises, and recommended prioritizing strategies such as becoming familiar to new environments, fostering collaborative learning, and strengthening mutual support mechanisms. Management support was considered crucial for continuing teamwork training, with hospital directors and departmental management identified as key enablers, whereas financial support was perceived as least important and least influenceable. These findings underline the need for healthcare organizations to embed teamwork structures that remain functional during crisis.

Keywords:

Team training, hospitals, healthcare professionals, patient safety, COVID-19, teamwork

Introduction

Team training is widely recognized as an essential strategy for improving teamwork and care safety and quality.^{4,5} It aims to equip healthcare professionals with the skills and tools to collaborate effectively under pressure. These trainings often include communication techniques, structured handovers, briefing and debriefing routines, and leadership principles.^{1,8,9} However, there is limited empirical evidence on how these trainings were adapted, maintained, or deprioritized during an unprecedented crisis like the COVID-19 pandemic.^{10,11} Previous studies on teamwork interventions^{9,12} focus on the general impact of structured team training but offer no insight into their practical implementation during crises. This study addresses this gap by examining if team training was sustained or discontinued during the pandemic and identifying key factors influencing effective team functioning during the pandemic. Gained insights may help improve future crisis preparedness and ensure that team training remains effective under rapidly changing healthcare conditions.^{1,8,9}

Background

Although the effectiveness of team training in improving teamwork and patient outcomes is well established^{5,13,14}, it remains difficult to determine which specific components of team training are most effective. This is due to a lack of standardized descriptions, as well as substantial variation in the design and delivery of training.² Moreover, no consensus exists on the best training approach across settings.

While earlier studies have focused on structured team training programs under stable conditions, there is a lack of empirical evidence on their practical use and sustainability during crises, particularly how hospitals respond to challenges such as limited resources, shifting priorities and staff deployment.^{10,11,13}

Various challenges and success factors for team training have been described. Weller et al.⁷ and Salas et al.¹ highlight educational, psychological, and organizational factors. Standardization of training content and trainer qualifications has been suggested to improve the quality and consistency of CRM training.¹⁵

Unlike previous reviews of structured team training under stable conditions, this study provides empirical insights into how such training was sustained, adapted, or discontinued during the COVID-19 crisis. By identifying key barriers and enablers, we offer a deeper understanding of what is needed to sustain training under extreme conditions. This study explores how team training contributed to crises preparedness and how the

pandemic affected training practices in Dutch hospitals. To explore these issues, we conducted a two-round expert survey and addressed the following research questions:

1. What team training programs were implemented in Dutch hospitals, considering their aims, methods, content, conditions, and evaluation?
2. Which methods and tools supported effective teamwork during the initial phase of the COVID-19 pandemic?
3. What preconditions of team training should be improved to better prepare teams for future healthcare crises?

To clarify terminology, we distinguish between several often-overlapping concepts relevant to teamwork and team training (see Box 1).

Box 1. Terminology used in this study

-Team training: Formal educational interventions aimed at improving team functioning¹

-Team methods: Practices that promote effective teamwork, such as huddles and debriefings.

-Team tools: Instruments that support team methods, including checklists and structured communication tools like SBAR.^{2,3}

-Teamwork factors: Underlying conditions that influence team effectiveness, such as management support and shared goals.^{6,7}

Methods

This study has an exploratory design using two consecutive questionnaires to investigate how team training, team methods, and team tools were sustained, adapted, or deprioritized during the COVID-19 pandemic in Dutch hospitals. The reporting of this study complies with the Standards of Reporting Qualitative Research (SRQS) guidelines.¹⁶

Study design

We conducted two rounds of data collection using online questionnaires. The first round focused on existing team training programs, the impact of COVID-19 on these programs, the use of team tools and factors perceived as contributing to or missing from effective teamwork during the crisis. The second round used structured closed-ended questions

to quantify the perceived importance, implementation ease, and frequency of use of various team tools and factors. Additionally, participants were asked to rank the levels of support for teamwork training and the extent to which this support could be influenced.

Participants

An invitation was emailed to all 241 members of the national Dutch healthcare team training network, including both experienced and less experienced team training practitioners. They were asked to participate if they had relevant experience, or a role related to team training in their organization. The invitation encouraged self-selection based on affinity with and practical involvement in teamwork training. Network members were encouraged to forward the invitation to colleagues with relevant expertise. Respondents who completed the first questionnaire were invited to the second questionnaire.

Questionnaires

Questionnaire 1 contained 33 open-ended questions based on Gross et al.'s framework², which offers a comprehensive and systematic overview of CRM training components, including design, delivery methods, training conditions, and evaluation strategies. Questions encompassed the influence of COVID-19 on training activities and invited respondents to suggest teamwork methods, tools, and organizational factors they considered helpful or lacking during the pandemic.

Questionnaire 2 had 19 closed-ended questions. Respondents rated commonly used team methods and tools (e.g., debriefing, structured handovers) on 7-point Likert scales, assessing their perceived importance, ease of implementation, and frequency of use during the pandemic. Team factors fostering good care, and the importance of these factors were rated on scales from 1 (not at all contributed or important) to 7 (very much contributed or important). Team factors identified as missed were scored from 1 (not at all missed) to 7 (very much missed). The statements on factors most supportive to teamwork training were ranked in order from a) most to least important for teamwork training and b) most to least influenceable. Both questionnaires were reviewed for face validity by the research team (VE, AvdB). Two independent experts in teamwork training provided additional feedback on item clarity and alignment with the study aims. Their combined feedback was used to refine the final version of the questionnaires before distribution. See supplementary file.

Data collection

The links to the two online questionnaires were sent in November and December 2020 using LimeSurvey. A reminder email was sent one week after the initial invitation. Respondents who completed the first round were invited for the second round.

Data analysis

Qualitative data from the first questionnaire were analyzed using inductive thematic analysis. Two researchers (AvdB, VE) independently coded the responses and iteratively refined the coding through discussion until consensus was reached. Thematic analysis was used to identify enabling and missing team factors and tools. Based on this, researcher VE processed these factors into statements for the second questionnaire. In a collaborative dialogue session, the questionnaire was adapted following the face validity check, integrating feedback from both the research team and the two independent experts to enhance clarity and alignment with the study objectives.

The quantitative data from the second questionnaire were analyzed using descriptive statistics in IBM SPSS Statistics for Windows, version 28.0. Armonk, NY: IBM Corp. The interquartile range (IQR) of the ranking data was calculated. An IQR of ≤ 1 was interpreted as consensus among the respondents. The level of agreement on the ranking of team factors from least to most important and from least to most influenceable, was calculated using Kendall's *W*, with values between 0 (no agreement) to 1 (complete agreement). Kendall's *W* is particularly useful for ordinal data where the order of items matters, but the exact differences are not well-defined. Because the sample size was relatively small, non-parametric methods were applied and the median instead of the mean was used as the central tendency measure.

Ethical considerations

Ethical approval was obtained from the Erasmus MC Medical Ethical Review Committee, including a check on General Data Protection Regulation (GDPR) and Good Medical Practice compliance (MEC-2020-0553). The participants provided informed consent at the start of the questionnaires.

Results

Respondents' demographics

Twenty-seven of the 43 participants (63%) who expressed interest in the study agreed to participate, nineteen of whom (44%) returned the completed first questionnaire and 17 (39%) also completed the second questionnaire (see Table 1 for demographic details).

Table 1. Demographics of respondents of first questionnaire (N=19)

Type of hospital:	
Academic hospital (4)	N= 6
General hospital (8)	N= 13
Sex, n	
Female	10
Male	3
Unknown, n	6
Median age in years (range)	
53 (30-64)	
Departments, n	
Obstetrics, gynaecology	4
Intensive care	5
Operation Rooms	4
Neurosurgery	1
Educational institution	5
Team training role, n	
CRM expert / team trainer	16
department head	1
researcher	1
1 learning and development advisor	1
Experience in healthcare practice in years, median (range)	
25 (5-46)	
Team training experience in years, median (range)	
8 (2-15)	

Team training during COVID-19

Eleven respondents reported that COVID-19 impacted team training activities. In six hospitals, team training stopped entirely, while others resumed with smaller groups or at lower frequency, depending on practical feasibility and distancing rules. All respondents reported that team training included multidisciplinary teams. Table 2 summarizes the training content implemented in hospitals.

Table 2. Team training activities in Dutch hospitals structured according to the framework of Gross et al.²

<u>Intervention design:</u>	Aims: The overarching aim is to improve the quality and safety of care. Specific goals mentioned: 1) improve non-technical skills (e.g., communication, situational awareness, give constructive feedback/speak up) 2) develop personal leadership skills (e.g., support and assist each other, solve conflicts). Training methods: 1) Simulation scenarios to practice teamwork and communication skills in realistic clinical situations mostly in acute settings. 2) Trainings to learn to collaborate and discuss teamwork topics. Contents: Three types of team training -referred to as Crew Resource Management (CRM) by the respondents- are mentioned: 1) Rehearse acute situations in simulation scenarios 2) Dialogue training to discuss how they collaborate in mundane practices and improve organization processes. 3) Observations during multidisciplinary meetings, followed up by a team training on communication styles and behavioral preferences.
<u>Training conditions</u>	Duration of training: 1) Basic initial training (ranging from 1 to 2 days) 2) Follow-up training sessions (ranging from 4 to 8 hours). Some hospitals also have a monthly 1.5-hour team training for scenario-based cases team simulations. Target group: The team consists of professionals working with each other daily. Most hospitals work with multidisciplinary teams in the training. Number of participants: Ranges from 4 up to 15 participants. Trainer qualification: Diverse qualifications including formal qualification (e.g., EUSIM certificate) and non-formal requirements. Most respondents had been trained to perform team training activities (duration 2-3 days in total).
<u>Evaluation</u>	Method of evaluation (whether and how): Verbally or on paper (e.g., using a questionnaire) or via observations. Outcomes included: 1) Validated questionnaires e.g. the Safety Attitudes Questionnaire (SAQ), 2) Non-validated questionnaires 3) Workplace observations to evaluate the training.

Legend: Teamwork training content in the Netherlands: using Gross et al. (2019) recommendations as a framework.

Abbreviations: EUSIM = European Simulation Network SAQ = Safety Attitudes Questionnaire

Team methods and tools during the COVID-19 crisis

Respondents rated several methods and tools that support teamwork on importance, feasibility, and frequency of use in daily practice (see Table 3). Speaking up and debriefing were considered most important (median ≥ 6.5). Consensus on the importance of checklists, team summary and huddles were not achieved. While certain methods were rated as feasible, there was limited consensus on implementation, and actual use in practice was especially low for huddles and team summaries.

Table 3. Team methods and tools to support teamwork (N=19)

Methods and Tools	Importance in teamwork		Ease of implementation		Extent to which the instrument is applied in daily practice	
	Median	Interquartile Range	Median	Interquartile Range	Median	Interquartile Range
Checklists	6	2	5	2	6	2
Briefing	6	1	5	2	5	2
Debriefing	6.5	1	4.5	3	4.5	3
Structured handover	6	1	5	3	5	1
Speaking up	6.5	1	4	2	5	1
Early Warning Systems	6	1	5.5	3	5	3
Team summary	6	2	5	2	4	2
Huddle (a brief and informal meeting of professionals in a team context)	5.5	2	4	3	4	4

Legend: Team methods and tools were scored on importance (1=not important up to 7=very important), implement ability (1=difficult to implement up to 7=very easy to implement), degree of daily application (1=never up to 7=always). IQR ≤ 1 is considered sufficient consensus

In table 4 respondents rated factors that contributed or were missed during the COVID-19 peak. Collaborative learning, mutual support, and clear communication were considered most important to teamwork (median = 7), with sufficient consensus (IQR ≤ 1). However, their actual contributions during COVID-19 were rated lower (median = 5–5.5).

Among missed factors, support for each other and alignment with other disciplines were rated as important (median ≥ 6), but perceived as largely absent during the crisis. Attention to teamwork/CRM training stood out as both important (median = 6) and notably missed (median = 6), with consensus on both ratings.

Table 4. Contributing and missed team factors during Covid-19 (N=19)

Contributing factors	Importance to teamwork		Extent of contributed factors to teamwork during Covid-19	
	Median	IQR	Median	IQR
Collaborative learning	7	1	5.5	1
Mutual support	7	1	5.5	1
Thinking out loud	6	1	5	2
Summarizing	6	1	5	2
Clear communication	7	1	5	1
Stand up meeting	6	1	5	2
Missed Factors	Importance to teamwork		Extent of missed factors to teamwork during Covid-19 peak	
	Median	IQR	Median	IQR
Collaborative learning	6,5	1	4	2
Alignment with other disciplines	6	2	4	3
Becoming familiar with the workplace	6	1	4	3
Support for each other	6.5	1	3	3
Attention for teamwork/CRM training	6	1	6	1

Legend: 1=Not at all important up to 7=Very important and contributing teamwork factors were scored at 1=Not contributed at all up to 7=Contributed very much. IQR ≤ 1 is considered sufficient consensus

Team training aspects to prepare teams for a crisis

Our study identified three key factors to prepare teams for a future crisis.

Supportive team factors

Respondents highlighted the need for learning from diverse perspectives, emphasizing “collaborative learning” (R2), with suggestions such as “cross-train staff more” (R2) and prioritizing “training” (R7). The rapid influx of COVID-19 patients led to reshuffled teams, causing unfamiliarity and limiting expertise sharing. “Alignment with other disciplines” (R3) was noted as essential, with recommendations for “central briefings/debriefings in mixed teams” (R11) and the belief that “regular briefings and debriefings provide good support” (R14).

Unfamiliarity with the work environment was another concern, as teams were reassigned to other departments. Respondents stressed the importance of “know your environment” (R1), linking it to “many staff members working in another department in a new team with few familiarization opportunities” (R5). Additionally, “clarity from the organization

and department managers" (R7) was crucial for support during crisis condition. When teams must function under rapidly changing conditions, respondents emphasized the importance of continuing structured training even during high-pressure situations, to support team effectiveness and crisis preparedness: *"continue teamwork training especially in times of crisis"* (R1) and *"training should be a priority and not seen as a last option"* (R7).

Creating Psychological safety

Psychological safety emerged as a critical condition for effective teamwork under high-stress, unfamiliar conditions. Respondents highlighted the need: *"feeling safe in the team despite all certainty being gone"* (R7) and recommended *"focus on knowing each other, strengths/weaknesses and on creating psychological safety"* (R11). The loss of trusted team structures and unfamiliar roles made trust-building especially difficult: *"trust and psychological safety, these aspects are precisely difficult to create when you are placed out of your trusted team"* (R9).

Level of support

Respondents highlighted that more commitment from organizational and managerial levels for team training was desirable. Respondents called for: *"a sense of urgency by the board"* (R2), *"more direction/support hospital-wide"* (R8), and *"more involvement of medical staff"* (R14). Structural inclusion of all departments and embedding CRM principles were recommended: *"structural application of teamwork training in all departments and using CRM-principles in the departments"* (R5). Workplace learning was seen as an important strategy: *"moving more towards workplace learning"* (R15).

Funding limitations were a recurrent theme: *"it is about available finances, the lack thereof"* (R6). Ranking the most supportive and influenceable factors showed that hospital board support was deemed most important, while financial support was ranked lowest. However, consensus was low (Kendall's $W = 0.184$). Departmental management support was considered most influenceable, with slightly higher but still low agreement (Kendall's $W = 0.369$) (Table 5).

Table 5: Ranking of preconditions met for team training during Covid-19 (N=17)

	Importance (Mean)	Influenceability (Mean)
Support from hospital board	2.25	3.38
Support at department management level	2.88	2.44
Support from medical staff	2.88	2.81
Support ward-level management	3.06	1.94
Financial support	3.94	4.44

Legend: preconditions for teamwork training ranked by degree of importance; 1=most important up to 5=least important and degree of influence ranked from 1=most influenceable to 5=least influenceable

Discussion

This study explored how nineteen Dutch hospitals designed, implemented, and evaluated team training, and how these training activities were sustained, adapted, or discontinued during the COVID-19 crisis. Using Gross et al.'s framework², we inventoried team training practices across hospitals. Results showed considerable variation in design and evaluation strategies.

Our findings highlight the need for clearer and more consistent reporting of team training content. The importance of comprehensive reporting has been emphasized in previous literature as well^{17,18} and our study reinforces this call. Existing frameworks may offer guidance for structuring such reporting, while still allowing room for contextual tailoring. By applying Gross et al.'s framework in this study, we demonstrate how a structured approach can help map variation and inform reflection on potential improvement, without implying uniformity or claiming causal impact.²

While participants from the various hospitals generally endorsed CRM principles like communication, situational awareness, feedback, speaking up, and leadership support, integration of these principles into daily practice remains inconsistent. For example, limited consensus on methods such as debriefing (IQR >1) points to barriers like time constraints and lack of managerial engagement. These observations align with prior research emphasizing the role of contextual and cultural factors in training sustainability.¹⁹

Although our study did not systematically investigate the causes of variation in training practices, participants pointed to several influencing factors, including differences in managerial support, available time for training, and if CRM was structurally embedded. This strong influence of local context on the success and sustainability of interventions aligns with implementation research.^{20,21} We identified three main evaluation strategies of team training: reflections on experiences, assessments of competencies, and observation of workplace behavior. However, these strategies are applied inconsistently across hospitals. This inconsistency makes it difficult to compare results across settings and to systematically assess what works.

To strengthen teamwork in crises, respondents emphasized the importance of information sharing, mutual learning, and a psychologically safe team culture supported by management. Tools such as debriefing and speaking up, considered critical for care quality, were inconsistently applied in practice, highlighting a gap between training and real-world application. Respondents attributed this gap to insufficient managerial support.

Our findings align with crisis management literature indicating that urgency often leads to ad-hoc decisions at the expense of teamwork. In line with high-reliability sectors such as the military, participants highlighted the importance of leadership.²² Leadership and a supportive organizational culture are known to enhance both sustainability and resilience.²³ Proactive team training has been shown to improve crisis performance and adaptability.^{10,11,24-27} The COVID-19 pandemic further underscored the need for resilience, with collaboration, communication, and adaptability as key elements.²⁸⁻³⁰ Tools such as debriefing, speaking up, and joint problem-solving were identified as core contributors to resilient team functioning.²³

Preparing teams for a next crisis

Supportive teamwork factors

The most frequently cited gap was the discontinuation of team training during the initial phase of COVID-19 despite its recognized value as underlined by Rehder et al.¹⁰ and Anjara et al.³¹ Modalities such as virtual simulations, online videos, and team seminars have been proposed in literature as alternatives for regular team training.^{10,29,32}

Creating psychological safety

Psychological safety is a critical condition for effective teamwork in high-stress environments.³³⁻³⁵ Our findings reinforce its importance during the COVID-19 crisis, when disrupted team structures and unfamiliar settings made trust-building challenging. Participants emphasized that mutual understanding, and psychological safety are essential for communication. Research highlights key enablers of psychological safety, including open dialogue, structured learning, and reflective leadership.³⁶ Other important conditions include leadership commitment to team development, regular opportunities for reflection, and fostering an open, non-punitive culture.^{33,36}

Level of support

Respondents emphasized the need for stronger organizational support and medical staff involvement. While management engagement was seen as important, physicians were often not structurally involved, an observation consistent with previous findings on the role of visible medical engagement in sustaining team-based practices.^{5,6}

Both the importance and influenceability of financial support were ranked lowest, suggesting financial support was not widely viewed as a key enabler. Departmental and ward-level leadership were considered more relevant, echoing earlier studies emphasizing the role of reflective frontline leadership in promoting team-based interventions.^{37,38}

Strengths and limitations

A key strength of this study is the rapid deployment of surveys at the early stages of the pandemic, which limited recall bias. Additionally, the content and methods of team training were inventoried in a structured approach.²

However, the findings should be interpreted considering several limitations. A limitation is the low overall response rate. While 241 network members were invited to consider participation, the study used a self-selection approach: only those who felt sufficiently involved with or responsible for team training in their institution were encouraged to respond. This might have discouraged too many members. Second, the study used only two rounds of questionnaires due to the high workload during the early waves of the COVID-19 pandemic. Although a third round could have helped refine or validate emerging priorities, practical constraints necessitated a pragmatic two-round design. Further research into how team training evolved over the course of the entire pandemic could provide a deeper understanding of how to better prepare staff for future crises.

Conclusions

Our findings emphasize the value of a crisis-responsive approach to team training. Management support was considered crucial for continuing teamwork training, with hospital directors and departmental management identified as key enablers, whereas financial support was perceived as least important and least influenceable. While many current models of team training rely on structured, pre-planned training programs, often delivered through classroom-based or simulation formats, our findings suggest that flexibility and integration into daily workflows are critical during crises. Examples such as, virtual simulations to team training or online videos, may be more effective during crises. Future research should explore how these approaches can be effectively implemented across different hospital settings.

Acknowledgments:

We would like to thank all participating experts for their cooperation.

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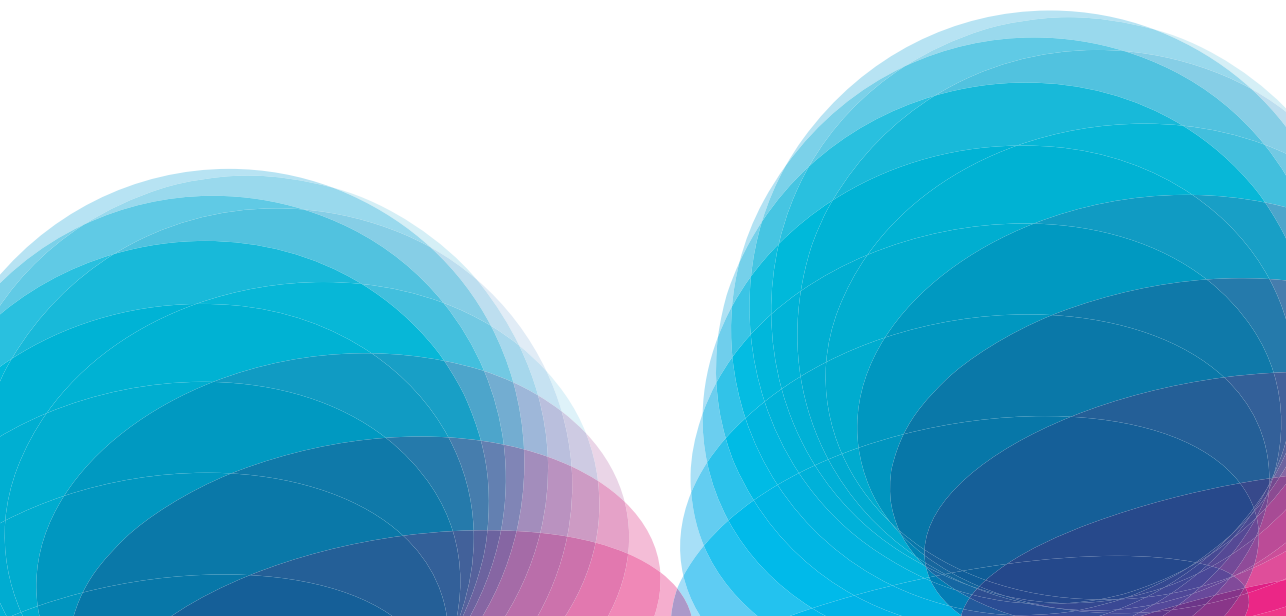
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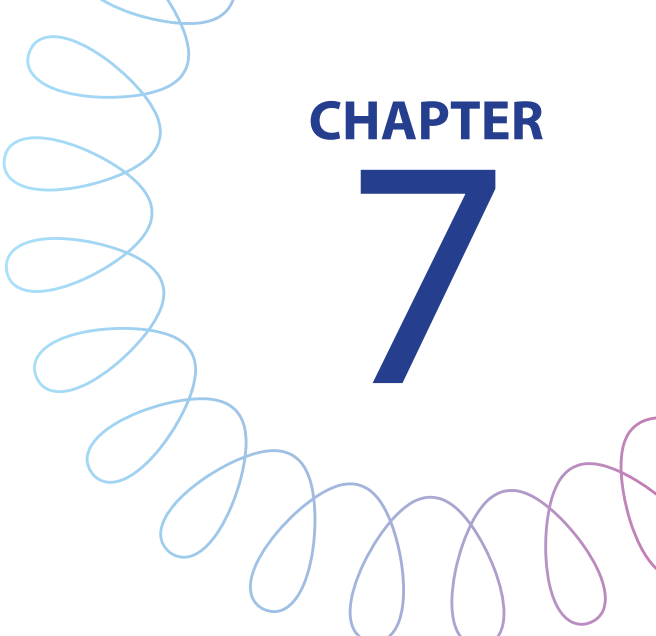
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Supplementary File: Questionnaires



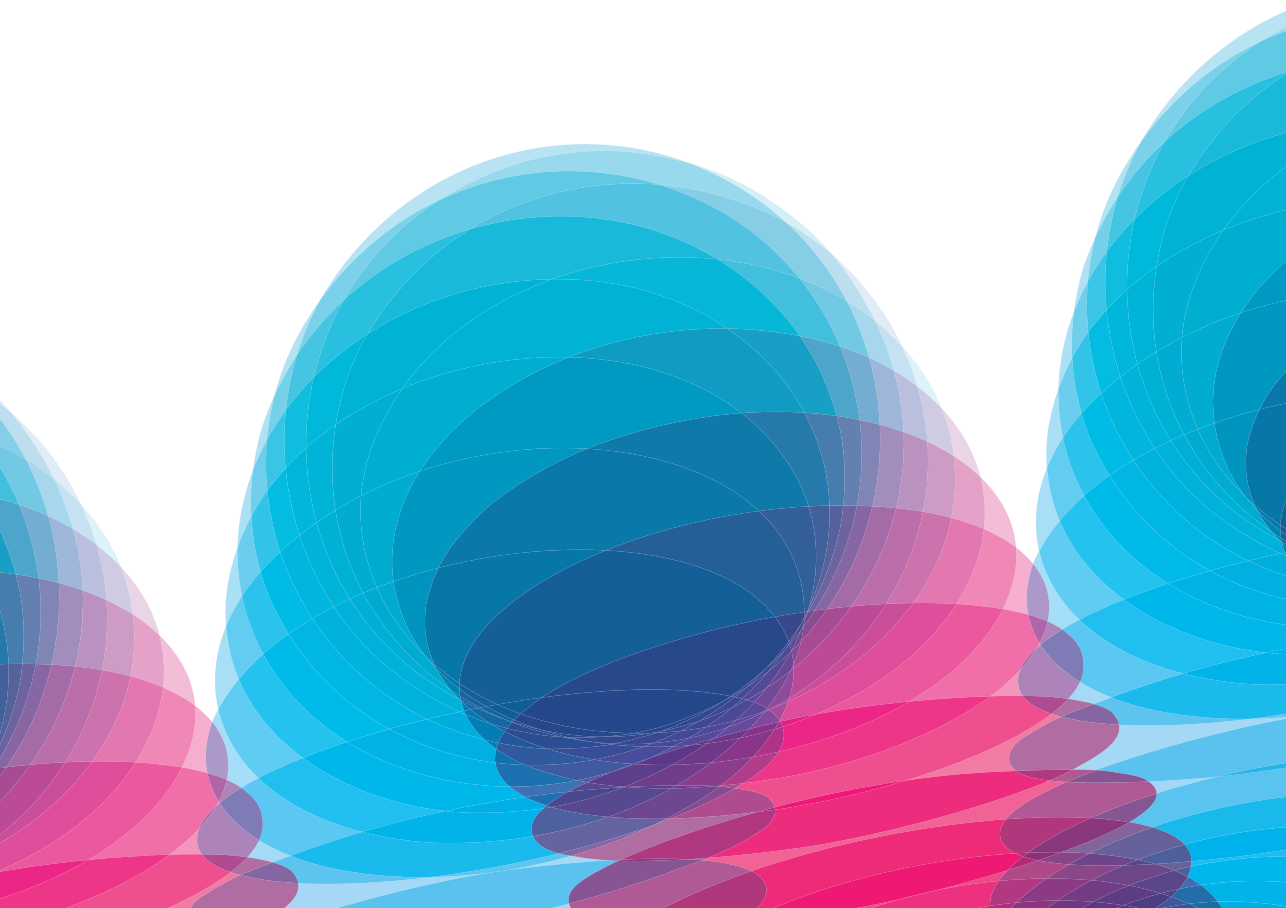




CHAPTER

7

GENERAL DISCUSSION



This chapter places the key findings of this thesis within the broader context of existing research and the health care system. Using a multimethod approach, we examined various aspects of team dynamics, collaboration, and the sustainability of interventions. Central to these findings is the critical role of leadership in fostering sustainable teamwork, psychological safety, and adaptability in crisis situations.

This discussion focuses on four key interconnected themes, all highlighting the pivotal role of leadership strengthening teamwork and supporting healthcare professionals in delivering high-quality care:

1. Sustainability of teamwork interventions
2. Psychological safety and leadership
3. Measurement instruments
4. Team resilience in crisis situations

Theme 1: Sustainability of teamwork interventions

A key challenge in sustaining teamwork interventions is ensuring that training and assessments are not treated as isolated events but are seamlessly integrated into practice. This requires leadership that transforms CRM training from a one-off initiative into lasting behavioral change. The findings of this thesis demonstrate how leadership-driven strategies can effectively embed CRM practices – such as briefings, huddles, and debriefings – into everyday work routines (Chapter 2). Embedding CRM tools in daily practice requires not only strategic commitment but also clinical leadership that connects day-to-day realities with broader goals. These clinical leaders play a key role in sustaining structured reflection and team learning.

Teamwork training does not solely involve maintaining technical skills but also fostering a work environment that prevents burnout and supports team cohesion over time. In practice, however, is often seen as a luxury – particularly by policymakers and, at times, by healthcare professionals themselves who are focused on surviving the demands of daily practice.

Teamwork training efforts not only enhance job satisfaction and patient outcomes but are also vital for sustaining high-quality care. Considering that continuity is key, our approach emphasized an iterative process of refreshers, scenario-based simulations, and integrated team learning. This ensured that CRM practices remained ingrained in practice, even amid staff turnover or shifting team compositions.

Sustaining teamwork practices also requires attention to staff well-being. Sikka et al.¹ added employee engagement as a fourth fundamental pillar to the triple aim formulated by Berwick et al.², which focuses on enhancing the care experience, improving population health, and reducing healthcare costs. This so-called Quadruple Aim highlights that a strong culture of teamwork not only benefits patients but also supports workforce retention and prevents burnout – both crucial for the long-term continuity of care. A pilot study by Copeland on workplace interventions addressing burnout, compassion fatigue, and teamwork showed that cultivating a strong culture of teamwork supports staff well-being, an essential factor for workforce retention and burnout prevention.³

Although the benefits of structured teamwork practices are clear, the key question remains: how do teams ensure that CRM tools become ingrained into their daily routines, rather than being isolated efforts? It has been argued that these tools must be adapted to the specific needs and culture of individual departments.^{4,5} For example, in the PICU at Erasmus MC Sophia Children's Hospital, huddles evolved from 'an extra task' to daily opportunity to share information. Effective implementation of these tools requires the

ability to ask insightful questions, create a psychologically safe space for discussion, structure and summarize important insights, and translate lessons learned into concrete actions. We observed that when all or some of these abilities were missing, huddles and debriefings tended to become routine occasions ('anyone anything to mention?') rather than learning opportunities. Additionally, time-outs before high-risk procedures such as intubations allowed teams to more effectively anticipate potential complications.⁶

Long-term improvement of decision-making and risk awareness requires a more proactive, structured approach, involving, among other things, analyzing work processes and identifying opportunities for learning. So-called 'learning teams' - teams that examine real-life work processes in a non-punitive manner, aim to understand how work is done, and identify opportunities for improvement are often composed of frontline professionals. External facilitators can support this process by guiding discussions and ensuring an objective perspective.^{7,8}

At the time of our research, learning teams had not yet been implemented in the PICU. Based on our findings, they could be a valuable complement to CRM training, by providing a structured format to revisit recurring challenges and support behavioral change through systematic reflection. Nevertheless, other structured approaches - like CRM training, briefings, huddles, and debriefings - can serve similar goals, provided they are embedded in a culture that values psychological safety, skilled facilitation, continuity, and relevance to the team's lived experience.⁹ During my time at the national patient safety program 'Time to Connect' I observed how multidisciplinary conversations - from daily starts and huddles to 'weekly reviews' - varied from quick exchanges to deeper learning and joint decision-making.

For such structured approaches to remain effective, they must be tailored to the unique challenges, team compositions, and workflows of a setting (Chapter 2 and Chapter 6). For example, due to the open bay layout in our PICU, daily ward rounds are conducted without patients or parents. This limits the feasibility of bedside briefings or involving families in rounds.

When the PICU staff was trained by the Dutch Center for Man and Aviation in 2005, we adapted this training to the medical context of the PICU. During a team training session, we conducted a critical analysis of a video-recorded neurotrauma admission, which revealed a lack of clarity in roles and tasks, leading to teamwork inefficiencies. The adaptations ultimately led to a blueprint for effective teamwork at the PICU. Printed on a poster, it clearly defined team members' roles and locations around the bedside (See Chapter 3). Teams adopted this in real-life situations, integrating it into their workflows beyond the training environment.

Theme 2: Psychological safety and leadership

Psychological safety – the conviction that team members can speak up and take risks without fear of negative consequences – is fundamental to the successful functioning of resilient teams.¹⁰ Team members must feel empowered to speak up, reflect on their work, and contribute to a culture that encourages learning from both successes and failures. The literature identifies psychological safety as a defining feature of high reliability organizations (HROs) – including air traffic control, nuclear power plants, and advanced healthcare settings – that operate in high-risk environments with exceptionally low error rates.¹¹ Such environments encourage team members to timely raise concerns and prevent minor issues from escalating into serious failures.^{12,13}

However, the hierarchical nature of healthcare, combined with complex interprofessional collaboration, often creates barriers that make it difficult for team members to speak up as freely as in other high-reliability environments.

Leadership and psychological safety

While creating a psychologically safe environment is a collective responsibility, leaders play a key role in establishing and maintaining it. For example, in our PICU, results from the SAQ and reflections during CRM training sessions led to clearer communication between disciplines and more structured team moments such as huddles and debriefings. Additionally, the persistently low scores on the SAQ's stress recognition domain prompted greater attention to stress management during training sessions. Facilitative leadership is a key driver of psychological safety, as it encourages open communication, mutual trust, and collective learning. Such leaders acknowledge their own mistakes, invite feedback, and create an environment where team members feel supported and where structured reflection is a normal part of working together.^{12,13}

Based on my experience, facilitative leadership plays a crucial role in determining whether team reflection leads to real improvements. A common question is whether this leadership style is innate or can be developed. Research suggests that while some individuals naturally demonstrate qualities such as empathy and adaptability, leadership is primarily a skill that can be cultivated through targeted training and experience.¹⁴

Figure 1 highlights three key leadership strategies that foster psychological safety

Providing structure: Regular briefings, debriefings, and learning teams create safe spaces for open dialogue and continuous improvement.¹⁵

Facilitative leadership: Leaders should adjust their leadership style based on team needs. For instance, stepping back to let frontline staff lead discussions fosters autonomy and shared responsibility.

Driving culture change: Leaders must break down hierarchical barriers and cultivate a culture of openness where constructive feedback is encouraged. Achieving this requires sustained commitment and role modeling of inclusive behaviors.



Figure 1. Three key leadership strategies

Measuring psychological safety

Various instruments have been developed to explore the conditions that support psychological safety. For example, the Psychological Safety Index (PSI) is a 7-item scale that quantifies team members' perceived safety in voicing concerns, with higher scores indicating greater psychological safety.^{16,17} Recent versions of the SAQ include PSI-related questions, suggesting a growing recognition of the importance of this construct, though these were not yet implemented at the time of my thesis research.

While the Professional Assessment Tool for Team Improvement (PATTI[®]) does not measure psychological safety directly, it assesses key non-technical skills – such as communication, situational awareness, and mutual support – that are known to contribute to a psychologically safe environment. By providing structured feedback on these skills, PATTI[®] helps teams identify strengths and areas for improvement. In our simulation-based assessments (Chapter 5), we piloted PATTI[®] to provide team-level feedback. Although still under development, it proved valuable in stimulating reflection on teamwork behaviors.

By stimulating discussion on team behavior and mutual support, these assessments indirectly promoted psychological safety, as teams became more aware of interpersonal dynamics under pressure.

Theme 3. Measurement instruments and feedback culture.

Insights obtained from administering the SAQ and the PATTI[®] offer valuable knowledge of team dynamics and safety culture. However, questions remain about the applicability of these instruments across different healthcare settings, the impact of contextual factors, and how teams can best interpret and act on the obtained insights. (Chapters 3, 4 and 5)

A key challenge to the effective use of these instruments effectively is the healthcare professionals' perception. The introduction of the PATTI[®] instrument in simulation training, for instance, led to mixed reactions among participants. While participants recognized the value of assessing both technical and non-technical skills, some felt uncomfortable from being observed and receiving feedback from colleagues. Without careful facilitation, such feedback may be felt confronting rather than constructive. Therefore, it is essential that simulation training leaders foster a psychologically safe learning environment where feedback is framed as a tool for improvement rather than criticism.

At the same time, participants acknowledged that structured assessments are necessary to maintain competency over time. As noted during a CRM training session, *'Isn't it strange*

that after our professional training as doctors or nurses, we are never formally reassessed on these critical skills?’

Added value of real-time feedback

Real-time feedback allows teams to assess their communication patterns, decision-making processes, and role clarity under actual work conditions. An approach that strengthens real-time feedback is action research, where teams participate in cycles of observation, reflection and intervention.¹⁸ In a PICU-setting, for example, an action research project could involve observations of handovers over several weeks from which it may be concluded that in time-sensitive situations critical information is often omitted. Rather than waiting for annual training sessions to address communication issues, teams can hold weekly reflection sessions where staff discuss observed gaps and test targeted improvements, such as using a standardized checklist for handovers.

For example, during our observation rounds described in Chapter 2, for example, we identified frequent interruptions during morning handovers as a recurring issue. These interruptions caused frustration and inefficiencies but were rarely addressed in formal evaluations. It was not until a senior nurse voice concerns about the repeated interruptions by doctors that a spontaneous discussion emerged about improving handover structure and communication protocols. This discussion was the beginning of the development of concrete improvement actions.

While instruments such as the SAQ provide valuable insights into how professionals perceive safety culture, as described in Chapter 4, they do not capture the full range of experiences within a healthcare setting. In our studies we have missed the perspectives of patients and family members, who observe team communication from a different vantage point and may identify gaps that professionals overlook. In future research, the EMPATHIC questionnaire, developed by Latour et al., may be valuable tool to collect both quantitative and qualitative feedback from patients and families.¹⁹

Theme 4. Adaptability and resilience of teams in crisis situations.

The COVID-19 pandemic highlighted the crucial role of adaptability and resilience in maintaining high-quality care under extreme conditions. Chapter 6 demonstrates that while the crisis posed significant challenges, it also provided valuable lessons in teamwork and crisis management. Our findings confirm that teams with strong adaptability were better equipped to navigate these pressures.^{20,21} While the concepts of adaptability and

resilience are well-documented in the literature, the pandemic added new dimensions to their practical application.

A key challenge was the frequent rotation of staff, requiring teams to collaborate effectively with unfamiliar colleagues. During the pandemic, I briefly returned to work as an ICU nurse and experienced firsthand the importance of essential structured coordination moments. Initially, only a daily start-of-shift meeting was held, but this proved insufficient as staff rotations increased and patient loads fluctuated. Without regular check-ins, teams struggled with role clarity and workload distribution, leading to inefficiencies in decision-making and patient care. These challenges underscored the need for structured teamwork tools to ensure clarity in roles and responsibilities. The introduction of huddles and end-of-day debriefings not only improved situational awareness but also provided a framework for teams to adapt quickly to shifting demands.

Both our field observations and existing literature suggest that structured tools – such as briefings, huddles, debriefings, SBARR (= Situation Background Assessment Recommendation Repeat), and ‘speak up’ strategies – are essential for maintaining situational awareness, team cohesion, and effective decision making, particularly in mixed teams during crisis situations.^{21,22}

Beyond frontline team strategies, leadership involvement in crisis management is equally crucial. One effective real-time observational strategy is the ‘Gemba walk’, introduced by Thull-Freedman et al. during the pandemic.²⁰ Derived from the Japanese term ‘Gemba’, meaning ‘the real place’, this method ensures that decision-makers step out of their offices and engage directly with frontline staff. By observing real working conditions firsthand, they reduce the risk of making assumptions that do not align with practical realities.

While adaptability is crucial in crises, it cannot be developed on the spot. Although prior team training was seen as valuable, our findings suggest that its effect on adaptability during the pandemic was strongly influenced by contextual factors such as leadership support and structural embedding. This highlights the importance of integrating structured team training into routine preparedness efforts.

To move beyond ad hoc crisis responses, healthcare organizations should incorporate:

- Regular simulation-based training to practice technical and non-technical skills under realistic conditions.
- Rapid improvement cycles, enabling teams to reflect on challenges and implement real-time adjustments.

- Continuous learning through structured debriefings and cross-team knowledge sharing, ensuring adaptability is actively practice rather than relying on reactive solutions during crises.

Of note, while technical, medical, and social innovations are central to crisis preparedness, our findings highlight that teamwork and psychological safety are equally critical – yet often overlooked. A key takeaway is the need for initiatives like the Pandemic & Disaster Preparedness Center (PDPC) to expand their focus to include strengthening teamwork strategies. As I finalized this chapter, discussions in the media reflect on the COVID-19 pandemic five years later. Many stakeholders expressed a common concern: a lack of thorough evaluation of what worked well and what could have been improved.

Future research directions:

Sustainable teamwork interventions in various healthcare contexts

Future research should explore teamwork interventions beyond hospital settings, particularly in primary care, elderly care, and home-based healthcare, where professionals collaborate across organizations. The Dutch national patient safety program ‘Time to Connect’ has already identified gaps in care coordination for vulnerable older adults receiving care from multiple providers, underscoring the need for structured teamwork approaches to enhance patient safety and continuity of care.²³

Integration of technology for understanding team processes in various contexts

New technologies offer opportunities to enhance collaboration, streamline coordination, and provide real-time insights into team effectiveness in increasingly complex non-hospital settings. While traditional teamwork tools like CRM have proven valuable, advancing technologies can offer deeper insights into team dynamics. Examples are:

- Real-time analytics: Wearable sensors and video analytics can help teams assess communication patterns and stress responses in high-pressure situations, leading to targeted interventions for improving coordination.
- Augmented reality: Augmented reality-based simulations can immerse teams in realistic crisis scenarios within actual care settings, allowing them to practice decision-making and coordination in a controlled but highly realistic environment.²⁴

Teamwork and digital healthcare environments

- Digital tools, such as electronic patient records and telemedicine, improve communication and coordination but can also strain personal connections in remote teams. Patient and family involvement enhances decision-making, as their

perspectives are essential for personalized and safe care. However, digital tools such as video consultations, patient portals, or messaging platforms can introduce new coordination challenges. For example, online meetings with families or across multidisciplinary teams may lack the informal interactions that help build trust and shared understanding. Additionally, asynchronous communication (e.g., via secure messaging) may lead to fragmented information flow or unclear responsibilities. Further research should explore how multidisciplinary teams can function effectively in these evolving care models, considering both technological and human factors.

The role of patients, families, and informal caregivers in teamwork education

Progress has been made in involving patients, families, and informal caregivers in team-based training for medical students. For example, parents and former patients have contributed to educational sessions by sharing their perspectives on teamwork. Additionally, they have participated in CRM training modules on shared decision-making and communication, offering valuable insights into how teamwork is perceived from their point of view.

Future initiatives could further integrate patients, families, and informal caregivers into teamwork education by:

- Inviting former patients or parents to share their experiences during training sessions as part of reflective, case-based learning.
- Involving patient representatives in designing teamwork scenarios for simulations.
- Using patient feedback (e.g., from EMPATHIC questionnaires) to inform team reflection and uncover communication blind spots.
- Developing co-learning sessions where staff and patient representatives collaborate to improve teamwork.

Teamwork and quality of care: the future perspective

For over two decades, research has highlighted the impact of teamwork on patient safety. In 2000, the report 'To Err is Human'²⁵ framed poor collaboration as a key cause of medical errors, while Hollnagel's Safety-II perspective²⁶ emphasized that teams should learn from daily practice rather than focusing solely on failures. Throughout this thesis, I have explored how structured teamwork interventions contribute to safer and more effective care and concluded that these are essential to navigate dynamic and high-risk environments. To translate my insights into practice, I propose a structured framework (Figure 2) for crisis management and team adaptation, based in Hollnagel's Resilience Engineering principles. This framework bridges the gap between theory and practice by offering concrete strategies for improving teamwork, adaptability, and team resilience.

A framework for resilient teamwork

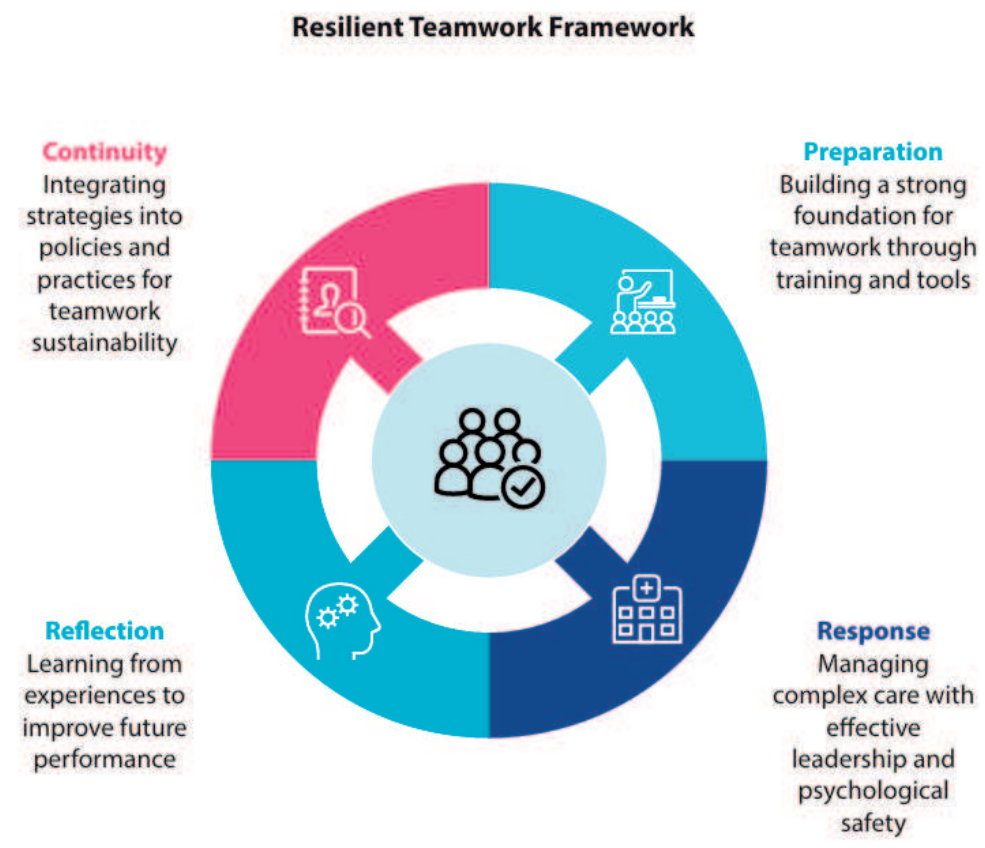


Figure 2. Resilient teamwork framework

The framework distinguishes four phases

Preparation: Preparing a solid foundation for building resilient teams requires structured training and access to tools that help professionals develop essential collaboration skills. However, without periodic refresher courses and integration into daily practice, these skills can fade over time. Additionally, staff turnover underscores the need for continuous onboarding and training.

Response: Appropriate leadership and psychological safety are critical in ensuring that teams remain cohesive and responsive to changing demands.

Reflection: Team resilience is sustained through reflection – “What are three key lessons we can apply from today’s work?” – *along with debriefings, evaluation sessions, and use of feedback tools* like the SAQ and PATTI®.

Continuity: To ensure the long-term effectiveness of teamwork initiatives, they must be systematically embedded into institutional policies and daily practice. Key strategies include:

1. *Integration into quality standards:* Experts from the ‘Time to Connect’ program emphasized that incorporating teamwork objectives into quality benchmarks and performance evaluations make multidisciplinary teamwork an organizational priority.
2. *Formalizing teamwork expectations:* Embedding debriefings and team learning structures into standard operating procedures ensures that reflection becomes a routine practice rather than an ad-hoc activity.
3. *National policy support:* Sustaining teamwork efforts at a national level requires clear guidelines, dedicated funding, and the inclusion of teamwork indicators in healthcare quality standards.

Conclusions

This thesis contributes to the literature on teamwork and patient safety by exploring methods for sustaining CRM training over time and developing a practical assessment tool: the PATTI®. The study findings provide a basis for embedding team training interventions in hospital settings and enhancing collaboration in crises. Despite strong evidence linking teamwork to high-quality, safe care, the merits of teamwork remain undervalued in strategic agendas because teamwork is often seen as something hard to define or measure, and no one feels fully responsible for it. To address this, four key elements are crucial:

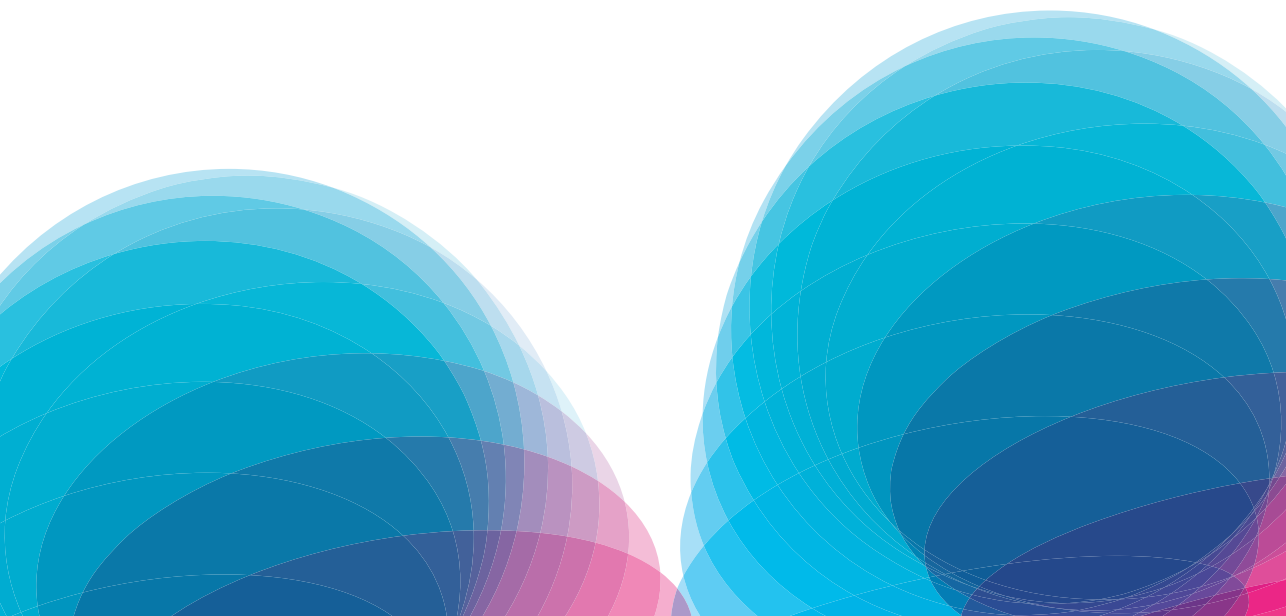
1. Establish teamwork as a Key Performance Indicator (KPI) at both organizational and national levels.
2. Equip leaders with facilitation skills to promote collaboration and psychological safety.
3. Dedicate time and resources for structured team training, reflection, and development.
4. Integrate multidisciplinary teamwork training early in healthcare curricula.

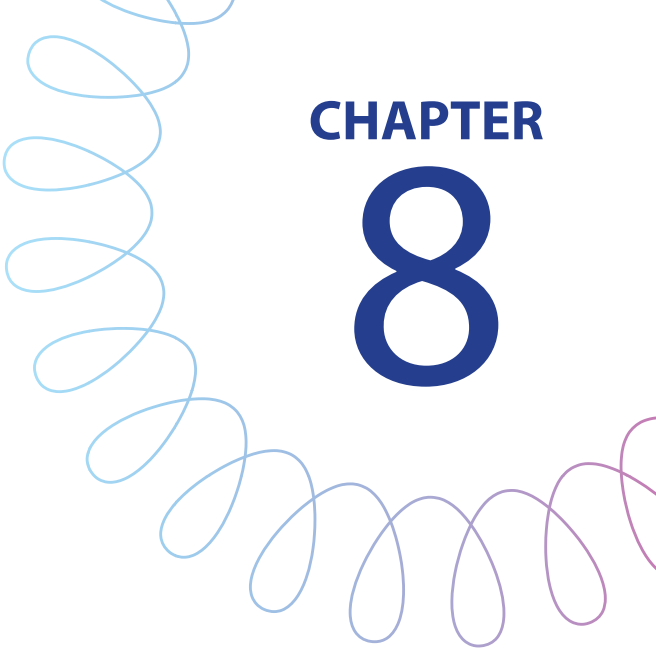
By implementing these strategies, healthcare organizations can elevate teamwork from a secondary consideration to a fundamental driver of patient care.

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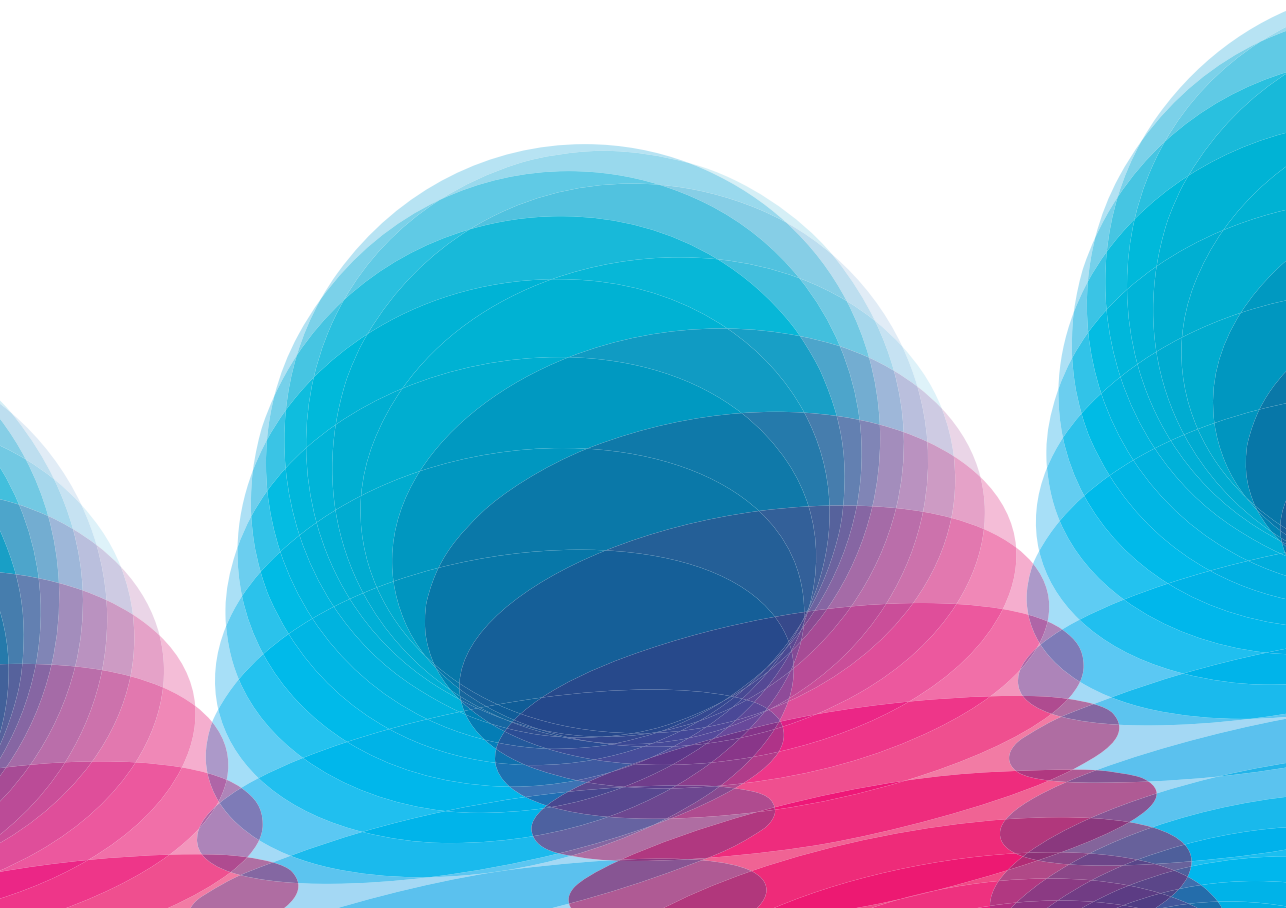


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CHAPTER

8

SUMMARY & SAMENVATTING

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Summary

The growing complexity and dynamics of care call for effective collaboration among healthcare professionals. This thesis explores how teamwork can be supported, assessed and permanently embedded in paediatric care to ensure the delivery of safe, high-quality care.

Chapter 2

explores strategies to maintain the impacts of Crew Resource Management (CRM) training in an academic children's hospital on the long term. Focus groups, observations, and individual interviews suggested that ongoing organizational support from leadership at all levels, a culture of open communication, and periodic training sessions are essential to achieve this—along with reflection at individual, team, and organizational levels. It was concluded that ongoing evaluation and adaptation of teamwork strategies to changing needs of teams are essential. Future research should investigate how organizations can institutionalize effective reflection mechanisms and further tailor CRM to local contexts.

Chapter 3

This chapter introduces the Professional Assessment Tool for Team Improvement (PATTI[®]), designed to assess the technical and non-technical skills of paediatric intensive care nurses. Developed through multiple phases, PATTI[®] was shaped and refined with input from expert collaboration to ensure validity and reliability. It was tested in simulated resuscitation scenarios to confirm its effectiveness in assessing nurses' skills. Beyond measuring skills, PATTI[®] provides insight into teams' collaboration and communication, supporting nurses in their professional development. Future research may explore its usefulness in other healthcare settings or professions.

Chapter 4

This chapter explores the Safety Attitudes Questionnaire (SAQ), a tool used by caregivers to assess their work climate across six key areas, including collaboration, safety, and working conditions. The results help identify trends, such as improvements in teamwork or concerns about stress management, while also providing concrete suggestions – such as enhancing communication between doctors and nurses. Organizations are recommended to regularly administer the SAQ to identify areas for improvement and implement targeted improvements. Ultimately, the SAQ not only helps identify problems, but also stimulates strengthening patient safety and team collaboration. Future research may explore its practical application and comparing results across different healthcare settings.

Chapter 5

This chapter examines the impact of simulation-based 'proficiency checks' on paediatric intensive care nurses' cardiopulmonary resuscitation (CPR) skills and non-technical skills, such as leadership. This program consisted of three phases: an e-learning module, a practical assessment of technical skills, and scenario-based exercises where the lead nurse directed a resuscitation team. In addition to measuring performance outcomes, this chapter also explores nurses' experiences with the proficiency checks, based on interview data.

Results showed significant improvements in both CPR performance and teamwork, with 39% of nurses demonstrating substantial improvements. Many nurses reported not only improved skills but also increased confidence in their actions and enhanced team collaboration. However, interviews revealed that the assessment elements induced stress, which, for some nurses, hindered learning. These findings highlight the importance of regular, hands-on training to strengthen both technical and non-technical skills. Future research should focus on the long-term effect of proficiency checks on team functioning in other realistic situations and the role of stress during assessments. Additionally, examining how similar programs can support other healthcare professionals in complex clinical settings could provide valuable insights.

Chapter 6

This chapter examines the use of team training during the COVID-19 pandemic, drawing on insights obtained from surveys among teamwork experts. The survey results highlight that flexibility, adaptability, and proactive communication are essential in crisis situations. Lessons from this study suggest that future training should focus on resilience and adaptability. Healthcare organizations can improve their crisis preparedness by focusing teamwork training not only on adaptive capacity, but also on proactive collaboration. The pandemic has renewed global attention for collaboration and communication within teams in healthcare.

Overarching Implications.

The findings of this thesis highlight that the vital role of teamwork in ensuring safe, high-quality care. Healthcare organizations can benefit from:

- Integrating teamwork training into daily care practices.
- Using validated tools such as PATTI® or adapting/developing similar tools, to continuously assess team skills.
- Fostering culture change and implementing evaluation mechanisms at all levels.
- Utilizing simulations to optimize teamwork strategies.

Recommendations for Future Research.

- Examine the long-term structures and effects of team interventions across various healthcare settings.
- Find innovative ways to translate safety culture measurements into practical improvements.
- Design interventions that enhance team effectiveness in dynamic environments.

Conclusion:

Effective teamwork is essential for building a future-proof healthcare sector. This thesis highlights the importance of sustainably embedding teamwork interventions and fostering a proactive safety and learning culture to strengthen long-term care quality and patient safety. It also offers strategies for integrating these principles into daily care practices.

Samenvatting

De groeiende complexiteit en dynamiek van de gezondheidszorg vraagt om effectieve samenwerking tussen zorgprofessionals. Dit proefschrift gaat in op de vraag hoe samenwerking in de specialistische kinderzorg kan worden bevorderd.

Hoofdstuk 2 Onderzoekt hoe de positieve langetermijneffecten van Crew Resource Management (CRM)-training in een academisch kinderziekenhuis kunnen worden bestendigd. Uit de bevindingen van focusgroepen, observaties en individuele interviews met betrokkenen kon worden geconcludeerd dat naast ondersteuning op alle organisatorische niveaus, hiervoor open communicatie en herhaalde CRM-trainingssessies essentieel zijn. Tevens is reflectie op drie niveaus – individueel, team en organisatie – van belang, evenals het aanpassen van methoden om teamwerk te bevorderen aan een dynamische omgeving. Het zou zinvol zijn te onderzoeken hoe organisaties reflectie kunnen inbedden in de praktijk en CRM-training beter kunnen afstemmen op de lokale context.

Hoofdstuk 3

Dit hoofdstuk introduceert de *Professional Assessment Tool for Team Improvement* (PATTI®), een meetinstrument om zowel de technische als de niet-technische vaardigheden van kinder-intensive care verpleegkundigen te beoordelen. Het instrument is in meerdere fasen ontwikkeld en verfijnd met bijdragen van experts op dit gebied. In gesimuleerde reanimatiescenario's is getest of de PATTI® inderdaad deze vaardigheden betrouwbaar peilt. Toepassing van de PATTI® kan duidelijk maken hoe teams samenwerken en communiceren, maar ook hoe de professionele ontwikkeling van verpleegkundigen kan worden ondersteund. Het zou zinvol zijn na te gaan of het instrument ook kan worden toegepast in andere zorgomgevingen of voor andere beroepsgroepen.

Hoofdstuk 4

Dit hoofdstuk gaat in op de waarde van de toepassing van de *Safety Attitudes Questionnaire* (SAQ), een vragenlijst voor zorgverleners om hun werkklimaat te beoordelen op bijvoorbeeld samenwerking, veiligheid en werkomstandigheden. De resultaten kunnen bijvoorbeeld aangeven dat verbeteringen nodig zijn in het teamwerk, de aanpak van stress, of de communicatie tussen artsen en verpleegkundigen. Aan de hand hiervan kunnen organisaties doelgerichte verbeteringen ontwikkelen, zeker als de SAQ regelmatig wordt toegepast. Toekomstig onderzoek kan zich richten op een betere praktische toepasbaarheid van de aanbevelingen en het vergelijken van de resultaten in verschillende zorgomgevingen. Geconcludeerd wordt dat de SAQ niet alleen helpt om mogelijke problemen aan het licht te brengen, maar ook om concrete verbeteringen in patiëntveiligheid en samenwerking binnen teams door te voeren.

Hoofdstuk 5

Dit hoofdstuk beschrijft een programma van “bekwaamheidsproeven” betreffende de reanimatievaardigheden en niet-technische vaardigheden – zoals leiderschap – van kinder intensive care verpleegkundigen. Het programma kende drie fasen: een *e-learning module*, praktische beoordeling van technische vaardigheden, en scenario-oefeningen waarin een verpleegkundige de leiding nam over een reanimatieteam. Naast de toets resultaten zijn in dit hoofdstuk ook de ervaringen van verpleegkundigen met deze bekwaamheidsproof onderzocht, aan de hand van interviews.

Het bleek dat na de trainingssessies zowel de reanimatie- als de samenwerkingsvaardigheden waren verbeterd, bij 39% van de verpleegkundigen zelfs aanzienlijk. Daarnaast rapporteerden veel verpleegkundigen een groter vertrouwen in hun handelen en een betere samenwerking in het team. Uit interviews bleek echter ook dat de beoordelingselementen voor sommige verpleegkundigen stress opleverde en het leren in de weg stond. Regelmatige, praktijkgerichte training kan heel goed, indien nodig, zowel technische als niet-technische vaardigheden versterken. Toekomstig onderzoek zou zich kunnen richten op het langetermijneffect van het programma in andere realistische situaties, op de rol van stress tijdens beoordelingen, en de mogelijkheid om zorgprofessionals uit andere disciplines te ondersteunen.

Hoofdstuk 6

Dit hoofdstuk geeft een overzicht van de ervaringen van teamwerkexperts bij de teamtrainingen tijdens de COVID-19 pandemie. Uit enquêtes bleek dat men in crisissituaties waarde hechtte aan flexibiliteit, aanpassingsvermogen en proactieve communicatie. Deze observaties geven aan dat trainingsprogramma's zich zouden moeten richten op veerkracht, aanpassingsvermogen, samenwerking en communicatie binnen teams in de gezondheidszorg. Dit zou uiteindelijk kunnen bijdragen aan een betere kwaliteit van zorg in toekomstige crises.

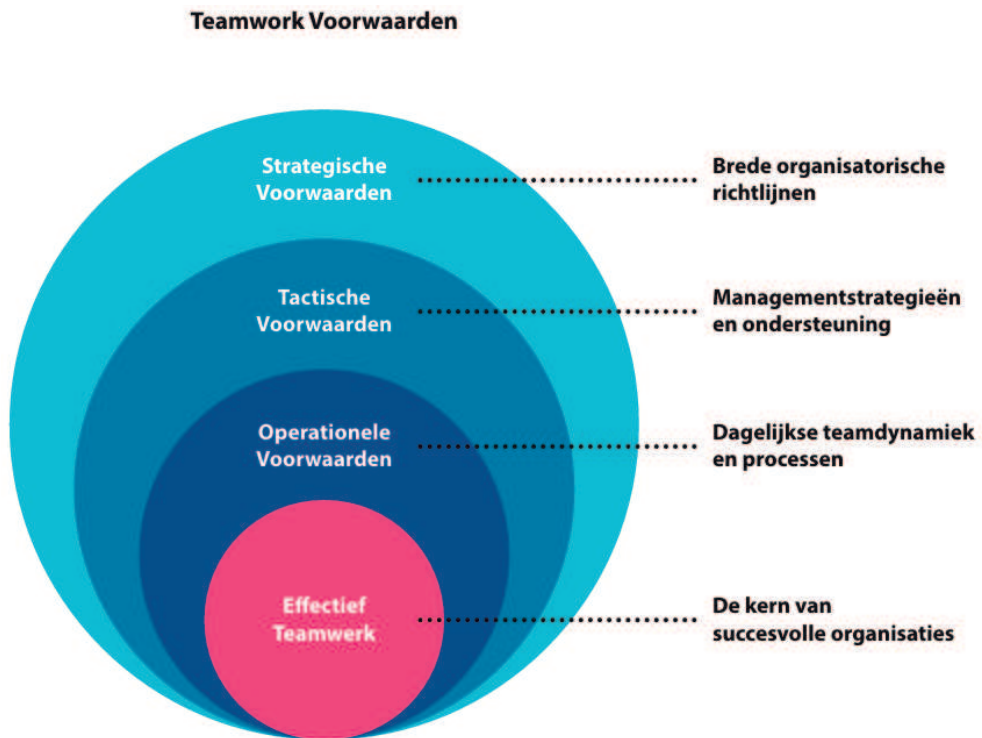
Ruimere betekenis.

De bevindingen van dit proefschrift benadrukken dat goed teamwerk hoogst belangrijk is voor een veilige en kwalitatief uitstekende zorgverlening. Gezondheidszorgorganisaties hebben baat bij onderstaande aanbevelingen:

- Integreer teamwerktraining in de dagelijkse praktijk.
- Ontwikkel en valideer instrumenten zoals de PATTI® om teamvaardigheden continu te evalueren.
- Streef naar een lerende cultuur op alle organisatorische niveaus.
- Gebruik simulatiescenario's om teamwerk te optimaliseren.

Aanbevelingen voor toekomstig onderzoek

- Onderzoek de langetermijnstructuren en -effecten van teaminterventies in verschillende zorgomgevingen.
- Vind creatieve manieren om veiligheidscultuurmetingen om te zetten in praktijkverbeteringen.
- Ontwikkel interventies gericht op teameffectiviteit in dynamische omgevingen.



Figuur: Teamwork voorwaarden

Dit figuur laat zien hoe effectief teamwork kan worden ondersteund door randvoorwaarden op drie niveaus binnen de organisatie: strategisch (zoals brede organisatorische richtlijnen), tactisch (zoals managementstrategieën en ondersteuning), en operationeel (zoals dagelijkse teamdynamiek en werkprocessen). Elke laag vormt een noodzakelijke bouwsteen voor de laag eronder en draagt zo bij aan de kern van succesvolle organisaties: effectief teamwork. Psychologische veiligheid is hierbij een cruciale onderliggende factor, die op al deze niveaus wordt beïnvloed. Strategische keuzes kunnen ruimte scheppen voor open communicatie, tactische interventies kunnen een

feedbackcultuur versterken, en operationele dynamieken bepalen in belangrijke mate hoe veilig teamleden zich voelen om zich uit te spreken in de dagelijkse praktijk.

Effectief teamwerk is onmisbaar voor een toekomstbestendige gezondheidszorg. Dit proefschrift onderstreept het grote belang van een duurzame inbedding van teamwerkinterventies en een proactieve veiligheids- en leercultuur voor versterking van de zorgkwaliteit en patiëntveiligheid op de lange termijn. Tevens wordt aangegeven hoe deze principes in de dagelijkse zorgpraktijk te integreren.

Epiloog: Beter teamwork, leidt tot betere zorg.

Wat begon als een persoonlijke zoektocht, kreeg via dit promotietraject een wetenschappelijke onderbouwing én een bredere roep om verandering. Dit proefschrift is een oproep om de kracht van teamwork, faciliterend leiderschap en vertrouwen in de expertise van zorgverleners, niet te laten versmelten tot abstracte beleidsdoelen, maar ze concreet te maken in de dagelijkse praktijk. Systemen en protocollen moeten niet leidend zijn, maar ondersteunend. Zorg mag niet worden gedomineerd door controlemechanismen, maar worden gestuurd door vertrouwen in de expertise van zorgverleners. Ik heb ervaren dat *dát* een onmisbare energiebron is voor een innovatieve, veilige en mensgerichte zorgcultuur.

Mijn passie voor het leveren van goed teamwork en daardoor goede zorg, mondde uit in dit promotietraject. Ik heb op de IC Kinderen mogen bijdragen aan het ontwikkelen van vele mooie initiatieven. We wilden simulatie toevoegen aan de teamtrainingen (CRM) die we sinds 2005 hadden. Samen met een team reisden we af naar Stanford, het *Center for Advanced Pediatric Education* om te leren simuleren en richtten daarna het *Sophia Simulatie Trainings Team* op. We ontwikkelden de Profcheck, zoals beschreven in dit proefschrift, en reisden naar Boston, waar we ons patiëntveiligheidsmanagementsysteem verder verfijnden via het *Patient Safety Executive Development Program* bij het *Institute for Healthcare Improvement*. Deze initiatieven vormden niet alleen een praktijkgerichte basis, maar ook de voedingsbodem voor de hoofdstukken in dit proefschrift.

Tegelijkertijd leerde ik dat duurzame verandering niet begint bij structuren, maar bij mensen. De studies in dit proefschrift laten zien dat veilige, veerkrachtige zorgculturen ontstaan als professionals de ruimte krijgen om te leren, te reflecteren en eigenaarschap te nemen. Niet door *nóg* meer controle, maar door vertrouwen en gezamenlijke verantwoordelijkheid.

Onderzoek doen bleek zelf ook een vorm van teamwork. Voor elk hoofdstuk moest ik bepalen wie en wat ik nodig had, welk type onderzoek het beste paste bij de onderzoeksvraag en hoe we dit samen zouden aanpakken. Samenwerken met collega-onderzoekers, zorgprofessionals en begeleiders was essentieel om dit proefschrift tot stand te brengen. Dit proces vergde niet alleen inhoudelijke keuzes, maar ook het vermogen om flexibel om te gaan met onverwachte wendingen.

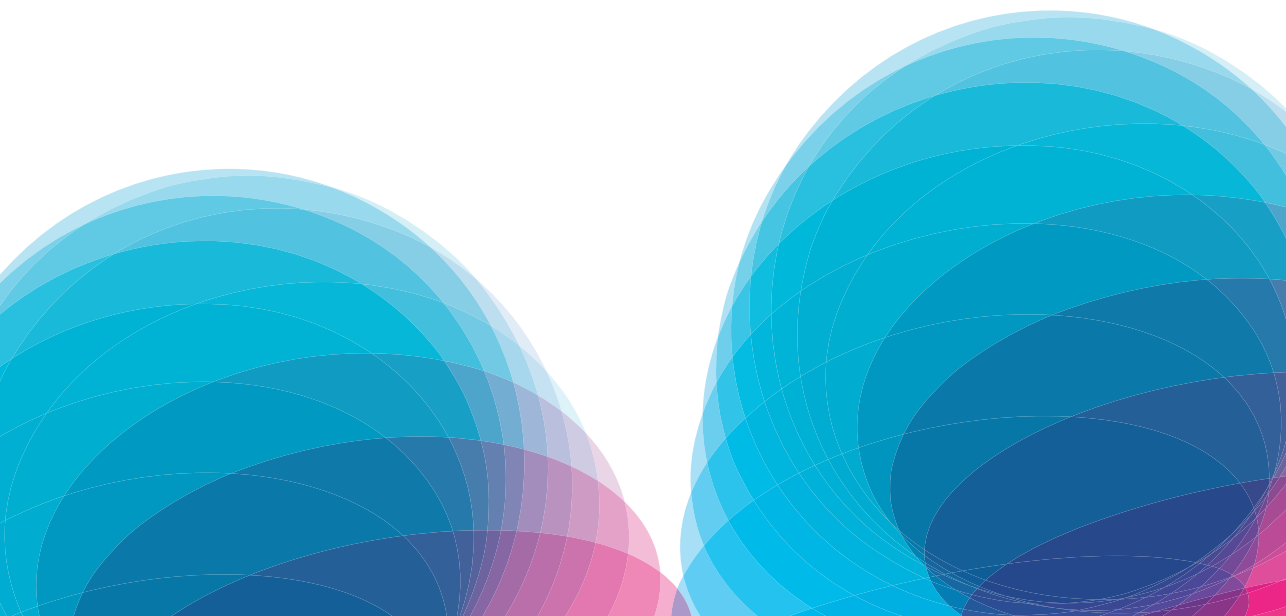
Net als in de praktijk betekende dit soms omgaan met teleurstellingen, zoals een afgewezen artikel, maar ook leren om de feedback die erbij zat te waarderen en te

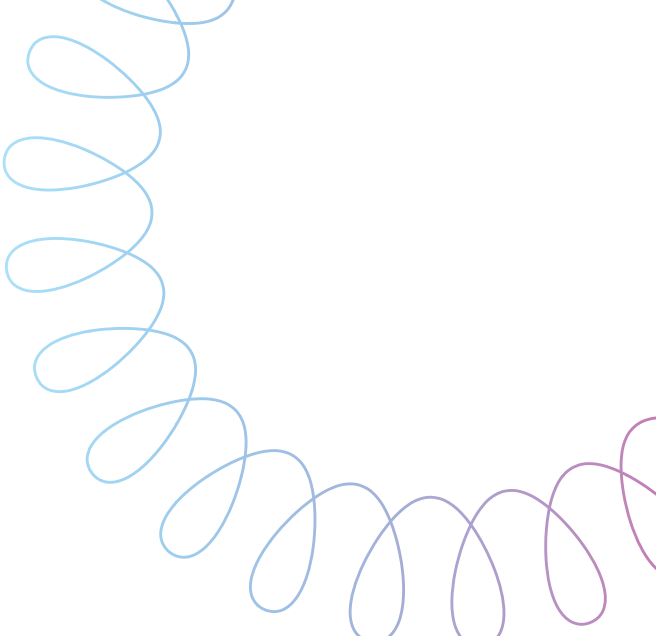
gebruiken voor verbetering. Er waren momenten waarop ik er geen gat meer in zag, waarop ik mezelf moest toespreken om door te gaan. Maar mijn drijfveren waren sterk genoeg om steeds weer aan de slag te gaan, om door te zetten en uiteindelijk deze reis tot een goed einde te brengen.

Een belangrijke rode draad in mijn werk was het leiderschap waaronder ik kon groeien. Inspirerende leidinggevers gaven ruimte om vragen te stellen en eigenaarschap te nemen. Ik leerde dat verandering altijd begint bij jezelf: je kunt vooruitgang stimuleren, of bewust of onbewust verandering afremmen. Dit besef riep vragen op: Wat vind *ik* belangrijk? Wat kan *ik* daaraan bijdragen? Wat en wie heb *ik* daarvoor nodig? Ik kreeg de ruimte om deze vragen te onderzoeken, om niet alleen te werken binnen een systeem, maar ook mee te bouwen aan verbetering ervan.

Daarnaast heb ik ervaren hoe essentieel zeggenschap is. In mijn eigen loopbaan voelde dit vaak als vanzelfsprekend, maar in de praktijk blijkt dat dit voor veel zorgprofessionals nog allerm minst het geval is. Tegelijkertijd wordt het belang ervan breed erkend, niet voor niets is er een landelijk programma 'Zeggenschap in de zorg' aan gewijd. Wat ik heb geleerd, is dat daar waar zeggenschap samenkomt met faciliterend leiderschap, een werkomgeving ontstaat waarin ideeën niet worden afgeremd, maar juist worden versterkt. Een omgeving waarin zorgprofessionals niet alleen zorg verlenen, maar ook actief bijdragen aan de vormgeving van betere zorg. Dat zag ik niet alleen als verpleegkundige, maar ook binnen het landelijke patiëntveiligheidsprogramma 'Tijd voor Verbinding', waar we merkten dat teams met een sterke leiderschapscultuur minder ziekteverzuim, minder verloop en zelfs wachtlijsten voor nieuwe medewerkers hadden. Zo ontstaat een voedingsbodem voor veerkrachtige teams: teams die niet alleen kunnen omgaan met uitdagingen, maar ook samen blijven bouwen aan veilige, mensgerichte zorg.

Mijn hoop is dat dit proefschrift een bijdrage levert aan dat gesprek, maar vooral aan de praktijk. Dat het zorgprofessionals en leiders inspireert om samen te bouwen aan een cultuur waarin veiligheid niet een set regels is, maar een manier van werken. Waarin fouten voorkomen worden door samen te leren, en waarin zorgprofessionals niet alleen zorg verlenen, maar ook de zorg vormgeven.





ADDENDUM 1

ADDENDUM 2

ADDENDUM 3

ADDENDUM 4

ADDENDUM 5

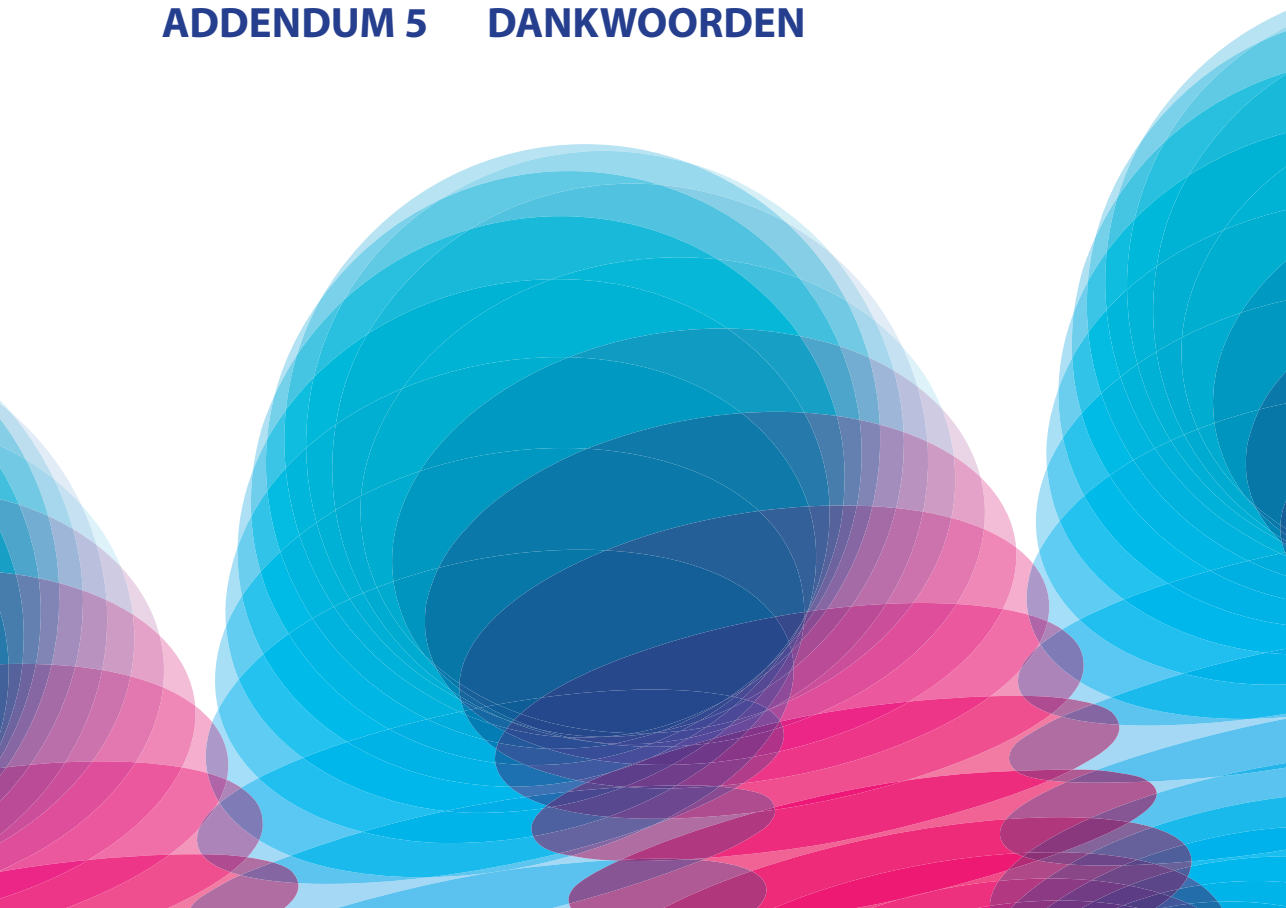
ABBREVIATIONS

LIST OF PUBLICATIONS

PHD PORTFOLIO

ABOUT THE AUTHOR

DANKWOORDEN



Abbreviations

ALS	Advanced Life Support
APLS	Advanced Pediatric Life Support Skills
CITO	Dutch Institute for Educational Measurement
COSMIN	CONsensus-based Standards for the selection of health Measurement INSTRuments
COVID	Coronavirus Disease
CPR	Cardiopulmonary resuscitation
CRM	Crew Resource Management
ECMO	Extra corporal membrane oxygenation
EUSIM	European Simulator
HRO	High Reliability Organizations
HSPSC	Hospital Survey on Patient Safety Culture
ICC	intraclass correlation coefficient
ICK	Intensive Care Kinderen
ICU	Intensive Care Unit
IHI	Institute for Healthcare Improvement
IPETT	Imperial Pediatric Emergency Training Toolkit
IQR	Interquartile range
KCN	Non-ICU Neurology
KPI	Key Performance Indicator
KTC	Paediatric Thoracic Surgery
NFU	De Nederlandse Federatie van Universitair Medische Centra
NTS	Non-technical skills
PATTI	Professional Assessment Tool for Team Improvement
PDPC	Pandemic & Disaster Preparedness Center
PDSA	Plan Do Study Act
PICU	Pediatric Intensive Care Unit
PSI	Psychological Safety Index
SAQ	Safety Attitudes Questionnaire
SBARR	Situation Background Assessment Recommendation Repeat
SBT	Simulation based training
SD	Standard deviation
SPSS	Statistical Packages for Social Sciences
SRQR	Standards of Reporting Qualitative Research
WMO	Dutch Medical Research Involving Human Subjects Act

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van den Bos-Boon A, Hekman S, Houmes RJ, Vloet L, Gischler S, van der Starre C, et al. Effectiveness of Simulation Training and Assessment of PICU Nurses' Resuscitation Skills: A Mixed Methods Study from the Netherlands. J Pediatr Nurs. 2021;59:e52-e60.

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te Beest H, van der Starre C, van den Bos-Boon A, Tibboel D, van Dijk M. Violations of nursing protocols: How often and how easy to correct? 2011, ESPNIC, Hannover, Germany.

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Phd portfolio: ada van den bos-boon

Summary of PhD training and teaching

Activity	Year	ECTS
General courses		
Qualitative Research methods K78	2017	1.5
Scientific writing	2017	0.7
Erasmus MC - ESP76 Value Based Healthcare	2018	0.7
Erasmus MC - BROK	2019	2.0
Erasmus MC - Scientific Integrity	2020	0.3
Clinical management and care redesign	2020	3.0
Writing Course – Arjenne Louter	2022	1.0
Leadership in Collaboration- Common Eye	2024	0.5
Teaching		
Crew Resource Management training – Erasmus MC Sophia	2017- 2021	8.0
Team collaboration and communication - bachelor & master medical students	2019 -2024	7.0
Clinical business administration - module quality - TIAS	2020	0.5
The multidisciplinary conversation vs. Safety II – national program Time to Connect	2023	1.5
Exam ‘working together’ master’s degree in medicine	2023	1.5
Clinical business administration - module quality – TIAS	2023	0.5
Learning through reflection on daily practice – Safety II -hospital teams	2024	1.5
Conferences -presentations		
‘Assessing (non)-technical skills in team performance’ – Risky Business - London	2017	0.3
‘Creating awareness on CRM principles’ – Forum Quality and Safety- Paris	2017	0.5
‘Let’s work together’ -Dutch Society of Simulation in Healthcare	2018	0.3
‘Crew Resource Management, a bottom-up approach’- NFU knowledge network	2019	0.3
‘Introduction to CRM principles’ - pediatric residents	2019	0.3
‘Presentation Safety II’ - Humanistic Systems- Edinburgh	2022	1.0
‘Multidisciplinary conversation as a Safety II approach’ – Forum Quality and Safety	2023	1.0
‘Team training: the influence of human factors’- Lustrum conference 10 years FMS	2023	0.5
‘From inspiration to action’ - National patient safety conference	2024	0.5
‘Learning through reflection on daily practice’- National patient safety conference	2024	0.5
Others:		
Deployment and further development of teamwork programs	2008- 2021	2.0
Establishing a learning network ‘zorgen voor teamwork’	2015- 2024	1.5
Participation developing e-learning / GAME teamwork	2018	0.5
Supervising bachelor & master students	2018- 2023	1.5
Establishing a learning network ‘Multidisciplinary conversations, ‘the how to’	2023	1.0
Development of a learning program ‘learning through reflection on daily practice’	2024	4.0
Abstract review for Forum Quality & Safety in Healthcare	2024	0.3
Working group committee conference on patient safety	2021- 2024	4.0

About the author



Ada van den Bos (Aartje Boon) was born on December 23, 1966, in Leiderdorp, the Netherlands. In 1986, she began her training as a general nurse (in-service A-) at the Diaconessenhuis in Leiden. Four years later, she specialized in pediatric nursing at the Sophia Children's Hospital in Rotterdam, where she also completed her intensive care pediatric and neonatology specialization in 1991. Ada worked as a pediatric ICU nurse until 2014.

From 1995 to 1997, she worked in French-speaking Switzerland on a pediatric cardio-surgical ICU, where she also trained nurses in pediatric intensive care. Back in the Netherlands, she held various roles at the pediatric ICU, focusing on research, quality, and patient safety. Together with physicians and nurses, she developed a patient safety management system in which team training (Crew Resource Management) was a driving force to improve collaboration and make teamwork a consistent topic of discussion.

To further expand her expertise, Ada completed several educational programs. In 1999, she obtained a post-bachelor's degree in research from the University of Applied Sciences, Rotterdam. In 2009, she attended the Patient Safety Development Program at the Institute for Healthcare Improvement (IHI) in Boston. In 2013, she completed a Healthcare Business Administration program at IBO in Leusden. In 2018, she earned a master's degree in quality and safety in Patient Care from Radboud University.

Since 2013, Ada has held various roles in quality and safety. Until 2019, she was Patient Safety Officer at the pediatric ICU. She then became Program Manager for Social Innovation within the Sophia Children's Hospital, part of Erasmus MC. From 2021, she worked as a Safety Advisor for the national patient safety program 'Tijd voor Verbinding' ('Time to Connect'), where she promoted multidisciplinary conversations in specialized medical care. As of July 1, 2025, she works as a Program Manager at Nictiz, a national knowledge institute for digital information exchange in healthcare. The urgency of effective data exchange in healthcare is growing, making this work increasingly vital for safe and coordinated care.

Dankwoorden

Zonder teamwork was dit proefschrift nooit van de grond gekomen, hoe passend. Niet alleen stond samenwerking centraal in mijn onderzoek, het was ook de drijvende kracht achter het hele traject. Van de werkvloer tot de schrijftafel: dit project is gebouwd op samenwerking, doorzettingsvermogen en gedeeld geloof in verbetering. Een aantal mensen wil ik in het bijzonder bedanken:

Prof. Dr. Van Dijk, Lieve Monique, Vanaf het prille begin van kwaliteitsverbetering op de IC was jij, op jouw eigen kenmerkende manier, altijd betrokken. Want waar ‘praatjes’ gegeven moesten worden, was jij nooit ver weg. Wat begon met wat hulp bij een congresposter, groeide uit tot serieuze analyses van kappa’s en andere statistische puzzels, en eindigde, tot mijn grote geluk, met jou als mijn promotor. Je bent een mens naar mijn hart: hulpvaardig, scherp, kritisch op de juiste momenten en altijd met een gezonde dosis humor. Wat ik van jou heb geleerd is ontzettend veel, maar vooral: “Neem mensen mee in je verhaal!” Wat een eer dat jij mijn promotor bent. Dank voor je inspiratie, je wijze lessen en je energie als supporter in deze reis!

Dr. Van der Starre, Lieve Cynthia, wat een reis hebben wij samen afgelegd. Jij promoveerde in 2011 op patiëntveiligheid, ik stond naast je als paranimf. Toen zei je al: “Het is leerzaam, leuk en nodig. Nu jij nog!” Ik zag het toen nog niet zitten. Maar na mijn master en twee artikelen zei je opnieuw: “Nu ben je er bijna!” Dankzij mijn drijfveren én jouw sturing durfde ik de stap te zetten. We realiseerden een aantal van onze dromen (zoals CRM Sophia), gaven presentaties, altijd multidisciplinair, en genoten van de reizen die daarmee gepaard gingen. We vergaarden kennis en brachten die terug naar de werkvloer. Van jouw promotie naar de mijne, met een soundtrack vol patiëntveiligheid, teamwork en eindeloos leren. Dank voor je onmisbare steun, aanmoediging en vriendschap in deze bijzondere reis.

Dr. Houmes, Beste Robert-Jan, jij bent de grondlegger, inspirator en drijvende kracht achter CRM, simulatie en alles wat daarmee samenhangt. Als Medisch Coördinator van de IC heb jij altijd het belang van teamwork benadrukt, niet alleen samenwerken, maar er écht samen voor gaan. Als CRM-team hebben we veel bedacht, opgezet en bijgestuurd. Jij was vaak degene met de visie: waar we naartoe moesten, hoe dingen anders konden, of hoe we een situatie vanuit een nieuw perspectief konden bekijken. We hebben samen heel wat ‘praatjes’ gegeven, waarin we met gepaste trots vertelden over ons werk op de IC. Dank je, Robert-Jan, voor je aanmoediging, inspiratie en het vertrouwen. En vooral ook voor de momenten waarop je me geruststelde: “Het komt goed.” Want je had gelijk.

De leescommissie en grote commissie, wat een bijzondere mix van mensen, ieder van jullie heeft op zijn of haar manier een raakvlak met teamwork of de kwaliteit van zorg. Ik ben dan ook enorm vereerd dat jullie deel uitmaken van mijn commissie.

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Dr. Erwin Ista, Dr. Martina Buljac, dank voor jullie bereidheid om in de grote commissie plaats te nemen. Ik waardeer jullie betrokkenheid en inhoudelijke bijdrage enorm.

In het bijzonder wil ik Prof. Dr. Anne Marie Weggelaar bedanken, met wie ik tijdens ‘Tijd voor Verbinding’ intensief samenwerkte. Over actieonderzoek, over hoe je onderzoek slim én praktisch maakt, en over wat er echt toe doet. Minstens zo waardevol waren jouw vriendschap, scherpe vragen, warme woorden en schrijfhulp (“kill your darlings...”) Je deelde ooit het lied Voor de zwijgers van Matthijn Buwalda met me. Sindsdien denk ik bij dit couplet aan jou: “Deze is voor de strijders, voor de niet-loslaters...” Jij staat op voor de inhoud, voor mensen, en laat anderen groeien. Dank voor je vertrouwen, energie, kennis en vooral: voor wie je bent!

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Beste Marten, dank voor het meedenken over passende onderzoeksvragen voor studenten en je begeleiding daarna, dat heeft maar liefst twee keer geleid tot een gezamenlijk artikel.

Beste Ko, jij gaf me mijn eerste schrijflessen en bleef ook daarna betrokken met steeds weer waardevolle feedback en kritische vragen, het werd er altijd beter van, dank daarvoor.

Lieve Inge, voormalig leidinggevende, dierbare vriendin, en als paranimf opnieuw mijn steun en toeverlaat. Als jij er toen op de ICK niet was geweest, weet ik niet of ik hier had gestaan. Jouw energie, visie en toewijding aan verpleegkundige professionalisering

hebben mij gevormd. Wat voor jou misschien vanzelfsprekend voelt, gun ik de rest van Nederland, en daarbuiten, evenzeer. Ik zag hoe jij de ICK-grond ploegde, zaaide en liet bloeien, met aandacht voor het kleine en betekenisvolle. Niet groots en meeslepend voor de buitenwereld (zeg jij), maar juist daardoor des te krachtiger. Wat jij bijdraagt aan het verpleegkundig vak is bijzonder. Dit proefschrift is daar, hoe bescheiden ook, een tastbaar gevolg van. Zonder jou was het er niet geweest. Dank voor je onvoorwaardelijke steun, vertrouwen en vriendschap. Het betekent meer dan ik ooit echt onder woorden krijg.

Saskia, We hebben samen veel meegemaakt en opgebouwd. Van onze reis naar de SSIH in Florida tot het bezoek aan Stanford met het hele team en later San Antonio met Robert-Jan. Telkens keerden we terug vol inspiratie om simulatie structureel te verweven in onze CRM-aanpak. Ook de intensieve IC-diensten staan me bij, vooral die ene die zich blijvend in ons geheugen heeft gegrift. Mede door die ervaring, én jouw vasthoudende aanmoediging, ligt dit proefschrift er nu. Dank voor alles: je tijd, scherpe feedback, doppió's, waardevolle gesprekken en je vriendschap.

Dick, jouw steun voor verpleegkundig onderzoek is altijd duidelijk en krachtig geweest en kijk eens waar dat toe heeft geleid. Onder jouw visie zijn we begonnen met het thema patiëntveiligheid, en is het bijzonder dat zowel een arts als een verpleegkundige op dit onderwerp promoveren. Na mijn terugkeer uit Zwitserland vroeg je me om als researchverpleegkundige aan de slag te gaan. Die rol gaf me de ruimte om me verder te ontwikkelen en de onderzoekskant écht te leren begrijpen. Dank voor alle kansen die je me geboden hebt en vooral voor je onvoorwaardelijke steun na de calamiteit. Dat heeft me letterlijk en figuurlijk op de been gehouden.

Lieve collega's van het CRM-team ICK, wat begon met een inspirerende training van Guus van den Elzen (Centrum voor Mens en Luchtvaart), groeide uit tot een stevige beweging in onze zorgpraktijk. Guus, jouw begeleiding als trainer en later als train-de-trainer was van onschatbare waarde. Samen ontwikkelden we een medische variant van de luchtvaarttraining, flexibel inzetbaar in elke zorgcontext. Jij bewaakte steeds de essentie van CRM, met oog voor detail en voortdurende verbeteringen, dank daarvoor. Met die stevige basis gingen we aan de slag als teamtrainers: eerst op de ICK, later ook binnen andere afdelingen van het Sophia. We leerden niet alleen trainen, maar ook volhouden. De CRM-werkgroep bracht verandering op gang, en zelfs nadat die ophield te bestaan, bleef het vuur branden. Want CRM bleek geen project, maar een manier van denken en werken. Dank aan iedereen die hieraan heeft meegebouwd. Jullie enthousiasme, inzet en volharding zorgen ervoor dat CRM leeft, niet als methode, maar als mindset.

Lieve collega's van het Sophia Simulatie Trainings Team (SSTT), de naam SSTT is niet meer weg te denken uit het Sophia, en het begon allemaal in 2007 met onze reis naar het

Centre for Advanced Pediatric Education. Wat een avontuur, samen met Jose, Han, Gabry, Alice, Saskia, Robert-Jan, Annemieke en Cindy – daar leerden we scenario's ontwikkelen die écht impact maakten, zelfs voor ECMO. De jaren daarna brachten mooie projecten: het opzetten van simulatieonderwijs, de Profcheck (hoofdstuk 3 en 5) en verdiepend onderzoek. En wat een verrijking toen Corinne, Natasja, Eric, Jan, Olga en Karin erbij kwamen, ieder met een eigen, waardevolle bijdrage. Ik ben oprecht trots op dit team. Jullie energie, toewijding en betrokkenheid maakten het verschil. Dank voor alles wat we samen hebben gedaan en geleerd.

Team SAT (Safety Action Team), we hebben in de afgelopen jaren een indrukwekkende ontwikkeling doorgemaakt. We analyseerden meldingen, doken in de achterliggende oorzaken en gaven richting aan verbetering. Vanuit die kracht wisten we projecten te initiëren en multidisciplinaire kwaliteitsbesprekingen structureel van de grond te krijgen. Dankzij jullie inspanningen werd veiligheid tastbaar én bespreekbaar op de werkvloer. En jullie waardevolle input werd gebruikt in de team trainingen. Dank: Olga, Angelique, Marjan, Helma, Jan, Monique, Gioya en Petra.

Aan de hele medische, verpleegkundige en ondersteunende staf van de ICK: wat een afdeling, wat een team! Ik ben oprecht trots dat ik met jullie heb mogen werken. Erik, jij verdient een erevermelding. Terwijl de personeelskrapte soms om creatieve acrobatiek vroeg, wist jij altijd weer een rooster in elkaar te puzzelen dat wél werkte. Dankzij jou konden de trainingen doorgaan, hoe ambitieus de planning soms ook was. En dan ook nog je scherpe blik bij het plannen van focusgroepen en 'profchecks': onmisbaar. Kortom, jij was de stille kracht achter de schermen die het mogelijk maakte dat wij voor de schermen konden trainen, leren en verbeteren. Andrea, Els en Marjan, jullie hulp bij het invoeren van de data was goud waard, secuur, geduldig en altijd met een glimlach. Chantal, jij was de reddende engel bij de soms ondoorgrondelijke Excel- en Word problemen. Ze namen mij geregeld in de maling, maar jou niet.

En Joke, dank voor al je hulp bij het indienen van de METC-aanvragen en het jaarlijkse bijwerken in de diverse systemen, jij wist altijd orde te scheppen in dat doolhof.

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Wichor Bramer, wat moeten promovendi zonder jou? Dank dat je altijd snel tijd maakte als het even niet meezat met endnote, zodat ik weer verder kon.

De vakgroep verplegingswetenschap, met name Laura, mijn maatje in de cursus proefschrift-schrijf-tweedaagse en heel fijn dat je mee kon lezen met de laatste versie van de 'general discussion'.

Het schrijverscluppie, wat was het fijn om samen af en toe in de 'schrijfbubbel' te duiken. Even weg van de waan van de dag, vol focus, koffie en goed gezelschap. Ik heb veel van jullie geleerd en genoten van het samen schrijven, steunen en sparren. En wie weet haak ik binnenkort weer eens aan... want dat ene artikel met Judith moet toch echt nog af. Gerrie en Annet, het samen af en toe (online) inchecken hielp enorm, even de frustratie van ons afpraten, de focus hervinden en weer doorpakken. En hoe toevallig (of juist niet?) dat we alle drie aan het promoveren zijn én op 23 december jarig zijn.

Mijn collega's van 'Tijd voor Verbinding', dank voor het respecteren van de inmiddels legendarische MONA-weken. En in het bijzonder: Gijs, mijn trouwe reis-, spar- en loopmaatje. In al die kilometers samen hebben we niet alleen patiëntveiligheid verbeterd, maar en passant ook het klimaatprobleem opgelost en de wereld een beetje mooier gemaakt. Wat een feest was het!

Al mijn lieve vrienden, dank voor al jullie morele support, het hielp echt!

Lieve Isabel, jouw scherpe vragen, rustige blik en nuchtere wijsheid waren mijn kompas in roerige tijden. Je coaching en steun waren van onschatbare waarde, steeds gaf je me precies wat nodig was: grond onder mijn voeten of vleugels om verder te gaan. Jij hield het vuur brandend om aan dit promotietraject te beginnen én het tot het einde vol te houden.

Lieve Marjanne, we gaan al meer dan dertig jaar terug, van het Sophia aan de Gordelweg en samen sporten bij Loek Hollander, tot ceremoniemeesters op elkaars bruiloften en vakanties met onze gezinnen. Wat een feest om jou als vriendin én paranimf naast me te hebben. Je was mijn praktische steunpilaar, mijn reality check en mijn vrolijke noot in één. Wat ben ik blij met zulke krachtige vrouwen om me heen!

Lieve ouders van Sky, dank jullie wel voor jullie openheid en vertrouwen. Het feit dat jullie aanwezig zijn bij mijn verdediging maakt dit moment extra bijzonder. Jullie verbondenheid en betrokkenheid raken me. Het is een eer om Sky in mijn proefschrift te mogen noemen.

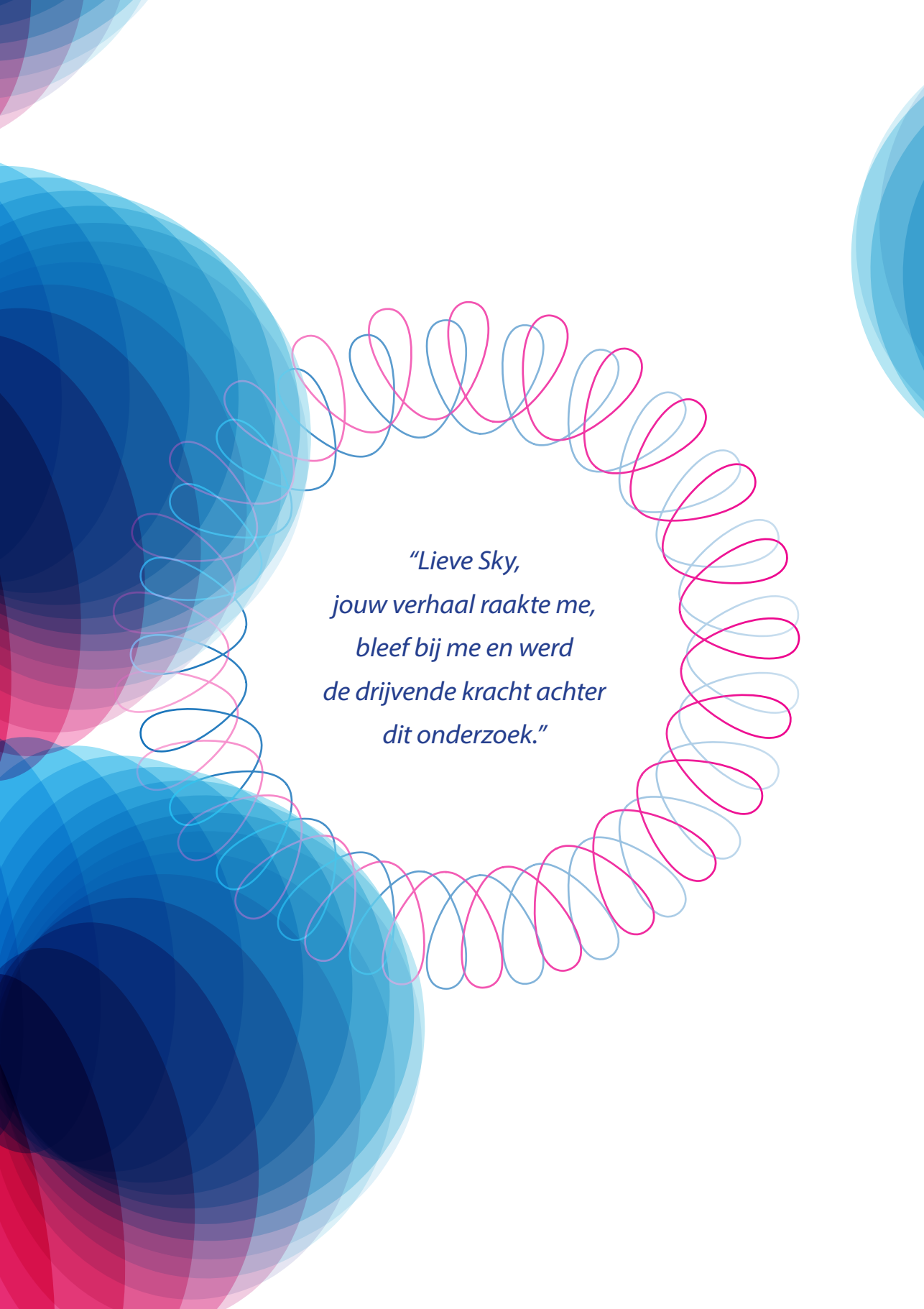
Mijn familie, dank voor jullie liefde en vertrouwde aanwezigheid. Wat een rijkdom om zo'n warme basis te hebben.

Lieve mamma, dank voor al uw wijsheid, nuchterheid en dat ongeëvenaarde relativiseringsvermogen. Maar vooral: dank voor uw vanzelfsprekende zorg en gastvrijheid. Bij u kon iedereen altijd aanschuiven, blijven slapen of zelfs mee op vakantie, zonder gedoe, gewoon omdat het kon. U liet me zien wat het betekent om er voor anderen te zijn, met open armen en een warm hart. Pappa, u hebt dit helaas niet meer mogen meemaken, tien jaar geleden moesten we u al missen. Maar in mijn hoofd en hart bent u er altijd bij. Uw geïnteresseerde belangstelling en betrokkenheid blijven voelbaar, ook nu.

Mijn lieve dochters, Sam en Jet, dank jullie wel voor de spiegel die jullie me regelmatig voorhouden. Jullie zijn enorm belangrijk geweest in dit proces en ik ben ongelooflijk trots op jullie! Ik hou van jullie!

Lieve Glenn, mijn steun, toeverlaat en onmisbare copiloot in dit hele avontuur. Zonder jou was het simpelweg niet gelukt. Je gaf me de ruimte om te groeien, te twijfelen, te verdwalen én de weg weer terug te vinden, als een echte 'Boswachter'. We zijn een ijzersterk team of het nu gaat om levenskeuzes of de vraag wie er boodschappen doet. Jouw creatieve humor en positieve blik zorgden voor lucht op precies de juiste momenten. Je wist steeds weer een draai te geven aan de situatie waardoor ik kon blijven lachen én doorgaan.

Love you to the moon and back.

The image features a white background with abstract, overlapping circular patterns in shades of blue and pink. A central quote is enclosed within a circular frame made of interlocking loops in blue and pink. The quote is in a dark blue, italicized serif font.

*“Lieve Sky,
jouw verhaal raakte me,
bleef bij me en werd
de drijvende kracht achter
dit onderzoek.”*