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Early Detection and Treatment for Children

Experiences and outcome of implementation at a pediatric hospital

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Abstract
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Early recognition of severely ill children is necessary to prevent serious adverse events and unexpected death. To promote patient safety the Early Detection and Treatment Program for Children (EDT-C) was developed at a University Children's Hospital in Sweden. This program consists of validated tools for communication and teamwork combined with the Pediatric Early Warning Score (PEWS) and guidelines for recommended actions. Ward specific guidelines were developed and EDT-C instructors were trained. The aims were to describe healthcare professionals' experience of caring for acutely, severely ill children (Study I) and to evaluate the implementation of EDT-C (Study II, III, IV). The Promoting Action on Research Implementation in Health Services (PARiHS) framework guided both implementation and the research study.

Before introducing the EDT-C, focus group interviews were performed to explore healthcare professionals' experience of caring for acutely, severely ill children. A context assessment, using the Alberta Context Tool (ACT) was also conducted. After implementation, a retrospective review of the electronic patient records (EPR) to assess adherence to guidelines were carried out. Instructors' and healthcare professionals' experiences from the implementation of EDT-C were gathered through individual interviews. To evaluate the introduction of EDT-C in relation to admission and stay at intensive care a retrospective before-after study using EPR data was performed. Interviews were analyzed using qualitative content analysis and descriptive statistical methods were utilized for quantitative data.

The caring for acutely severely ill children was described as being in a multifaceted area of tension with paradoxical elements where contradictory emotions emerged. According to documentation, children at a very high risk of clinical deterioration according to PEWS were identified. Adherence to actions prescribed in guidelines varied.

Healthcare professionals and instructors described EDT-C as suitable for clinical practice and that it created a more structured way of working. It was furthermore described that PEWS measurement had become routine practice at the hospital.

EDT-C can lead to increased knowledge about early detection of deterioration, strengthen the healthcare in their profession, optimize treatment and teamwork and thereby has potential to increase patient safety for children treated in hospitals.

Keywords: PEWS, Pediatric, Clinical deterioration, inter-professionell, teamwork, ACT, PARiHS

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List of papers

I   Almblad, AC., Målqvist, M., Engvall, G. (2016) Caring for the Acutely, Severely Ill Child-A Multifaceted Situation with Paradoxical Elements: Swedish Healthcare Professionals' Experiences. *Journal of Pediatric Nursing*. Sep-Oct;31(5)

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III   Almblad, AC., Brylid, A., Engvall, G., Målqvist, M. Increased Intensive Care Admission Rate after Introduction of Early Detection and Treatment program for Children and the Establishment of a Pediatric Intensive Care Unit at a Tertiary Hospital in Sweden. Submitted

IV   Almblad, AC., Målqvist, M., Engvall, G. From skepticism to assurance and control; implementation of a patient safety system at a pediatric hospital in Sweden. Submitted

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Contents

Preface

A children's hospital is a dynamic place in which many meetings take place. Meetings with patients, with relatives and with a large number of professionals that interact in a variety of ways. During my 23 years as a pediatric nurse in emergency pediatrics, I have never ceased to be fascinated by all these meetings and how much they affect me and my actions in my profession. More often than not, I meet an entirely healthy patient who is suffering from an injury or infection that can be treated without complications. Sometimes, I meet a patient who expectedly or unexpectedly has been affected by an acutely life-threatening condition that requires immediate efforts by an inter-professional team. I have noted that we can be strengthened through teamwork in a spirit of respect and humility for each other's knowledge and roles and we can gain new knowledge and better manage the emotional impact that arises in these situations. And on the contrary, the work is adversely affected by different approaches and goals within the teamwork.

I have gained experience through all the patients I have met and assessed and that makes it easier to identify severely ill patients. But I have also learned that experience alone is not enough to ensure safe care. Together with colleagues who share my interest, I have been involved in the training of teamwork in emergency situations and the introduction of a triage system for assessing the care requirements in patients seeking emergency care. It is not always easy to carry out training for large staff groups and to create the conditions for new work methods in an ongoing emergency care environment and it requires great efforts from all the coworkers. Looking back, one realizes that it is just these, sometimes toilsome, changes that mean that the care evolves and is improved in the longer perspective.

When I started out on my professional journey in pediatric care, it had been decided that infants should eat at certain times and learn to sleep by themselves. A decision that those concerned had neither participated in nor had any understanding whatsoever of, as they lay in their tiny tub-like beds yelling hungrily and longing for some closeness from someone who loved them. Often, it is the patients and their relatives who have given me the insight that care can be performed in a different way, and we must never forget the child's perspective when we design new routines and treatments.

Continuous progress is being made in childcare, but we are also constantly facing new challenges. We need to think to a greater extent from a global perspective; advanced technological innovations are being introduced, we are caring for increasingly complicated medical conditions, reorganizations take place and staff turnover is high. Together, these factors make implementation processes even more complex but they also mean that the need for structured working methods and evidence-based care has increased. This need caught my interest to study this in a scientific way and encouraged me to pursue doctoral studies

Introduction

Acutely, severely ill children

Sweden is among the countries with the lowest infant mortality in the world, 2.1 deaths per /1 000 live-born children, and the majority of the children who die during the first year of life die in conjunction with childbirth or during the newborn period. Childhood's 1-14 years are the period of life when the risk of death is lowest, 150 children/year and the most common causes of death are tumor and accidents involving suicide and external violence. Every year, approximately 150 000 children are admitted to hospitals in Sweden. The causes and conditions may vary from less severe states to acutely, severely ill (1). In Swedish health care, the term "acutely, severely ill children" refers to children who require immediate treatment defined as an acute care admission (2). The most common causes of hospitalization are injury and respiratory disease. Children 0-4 years, accounted for about 45% of all inpatient care, and for more than half of all care days in inpatient care. Survival has increased in many diagnosis groups such as premature births and children with cardiac, blood and tumor diseases. This also means increased specialist care with complex treatments and nursing needs (1).

Even if the child is hospitalized there is a risk of deterioration. It is known that children who die or deteriorate unexpectedly in the hospital setting will often have observable features in the period before the seriousness of their condition is recognized (3). Early recognition of severely ill children and appropriate intervention is imperative (4-6) and unrecognized clinical deterioration in pediatric wards can lead to severe adverse events, unplanned intensive care or even cardiopulmonary arrest and unexpected death (7-9). Prevention is dependent on the timely identification, referral and treatment of children who are deteriorating clinically (10). Children dying in pediatric care is no common occurrence and the causes may vary, including, e.g., acute trauma or illness, stillbirth or chronic disease (11). Early recognition of children at risk of cardiopulmonary arrest is often difficult due to the infrequent nature of such events and furthermore, children at the greatest risk for in-hospital cardiopulmonary arrest tend to be complex patients (12). Metabolism and thus oxygen demand is high for children, tissue perfusion and oxygenation is dependent on a functioning circulation. Cardiac output is relatively constant for children and they are therefore at greater risk of hypovolemic shock. One

of the most important measures aimed at reducing mortality is early cardiopulmonary resuscitation with ventilation as an essential maneuver (13, 14).

A report showed that 4.4% of children from birth to 15 years, who are cared for in hospital settings in Sweden suffer from health-related injuries, i.e. avoidable injuries caused by treatment rather than an underlying disease and this is most common in surgical care (15). Shortcomings in clinical judgment and communication are common causes of unsafe conditions for the patients (16).

Further factors such as stress and emotional climate can have an impact on medical decision-making in critical medical events. Clinical decision tools and simulation training are necessary steps in improving safe care (17).

Healthcare professionals

The healthcare team consists of people with different skills and roles. Delivery of high-quality care with optimal patient safety is dependent on effective inter-professional team management and strong leadership (18, 19). Inter-professional team collaboration has been defined as an activity in which healthcare professionals from different professions learn together with, from and about each other (20). Birkeland et al. describe teamwork as a way of work that generates deepened knowledge and a way to be able to handle the complexity of care needs (21). A mindset of individual responsibility and accountability embedded in a network representing equality among the partners, including the patient and their family members, is required to achieve optimal inter-professional care (22). Working competently as an inter-professional team is a learning process and may be an effective way of improving patient safety (23-25). Further, years of experience did not correlate with perceptions of teamwork climate (26).

Stressful situations can arise in health care and individuals respond to stressors in different ways. Even if healthcare professionals have adopted a professional approach and coping strategies when caring for severely ill or dying children, these situations still have an emotional impact to varying degrees (27). Healthcare professionals were reported to experience more symptoms of stress, and show less resilience, compared to published norms (28). In emergency situations there are high demands on cooperation and priority. A team-based training techniques can increase the ability to work in teams and identify latent safety threats and knowledge gaps (25, 29). The quality of teamwork significantly affects patient outcomes both generally and in emergency situations when coordinated actions are necessary to maximize

survival from cardiac arrest (30). Poor economic conditions and lack of time can affect the ability to take into account ethical considerations and reflection around the teamwork (21).

Early Detection and Treatment - Children

The Early Detection and Treatment Program for Children (EDT-C) was developed at Uppsala University Hospital and consists of Airway, Breathing, Circulation, Disability, Exposure (ABCDE), Crew Resource Management (CRM), Situation, Background, Assessment, Recommendation (SBAR), the Pediatric Early Warning Score (PEWS), and recommended action according to the EDT- Ladder for Children (31).

ABCDE is a structured tool to examine, treat and evaluate the patient's vital functions on the basis of a pre-determined order (32).

CRM is a model for teamwork acknowledging human error and human performance limitations, focusing on communication, situation awareness, leadership and resource management (32, 33).

SBAR is a standardized tool for clear and concise communication (34). It has been shown that structured communication can increase patient safety and reduce unexpected deaths (35, 36). Improved teamwork, communication and nursing satisfaction scores were demonstrated in a pediatric intensive care unit after implementation of SBAR (37).

The Pediatric Early Warning Score (PEWS) is a scoring system developed for children and focuses on three components: behavior, color/cardiovascular status and respiratory status (range from 0-9): behavior (0-3) color/cardiovascular status (0-3) and respiratory status (0-3), (4, 5, 38) see Figure 1. A retrospective evaluation of estimated PEWS showed that for 85.5% of the patients, the earliest indicator on a critical PEWS was approximately 11.5 hours before deterioration (38). However, in order for the tool to work properly it needs to be combined with ward specific guidelines and the EDT-Ladder for Children, the recommended actions based on measured PEWS (31).
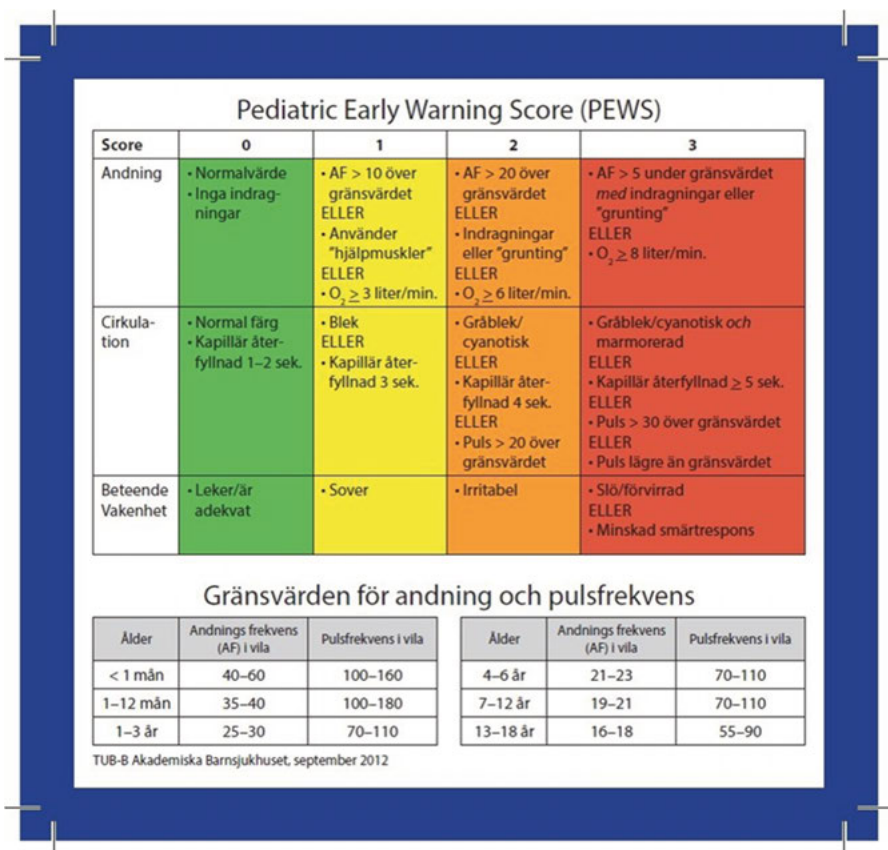
Pediatric Early Warning Score (PEWS)

Score	0	1	2	3
Andning	• Normalvärde • Inga indragningar	• AF > 10 över gränsvärdet ELLER • Använder "hjälpmuskler" ELLER • $O_2 \geq 3$ liter/min.	• AF > 20 över gränsvärdet ELLER • Indragningar eller "grunting" ELLER • $O_2 \geq 6$ liter/min.	• AF > 5 under gränsvärdet *med* indragningar eller "grunting" ELLER • $O_2 \geq 8$ liter/min.
Cirkulation	• Normal färg • Kapillär återfyllnad 1–2 sek.	• Blek ELLER • Kapillär återfyllnad 3 sek.	• Gråblek/cyanotisk ELLER • Kapillär återfyllnad 4 sek. ELLER • Puls > 20 över gränsvärdet	• Gråblek/cyanotisk *och* marmorerad • Kapillär återfyllnad ≥ 5 sek. ELLER • Puls > 30 över gränsvärdet ELLER • Puls lägre än gränsvärdet
Beteende Vakenhet	• Leker/är adekvat	• Sover	• Irritabel	• Slö/förvirrad ELLER • Minskad smärtrespons

Gränsvärden för andning och pulsfrekvens

Ålder	Andnings frekvens (AF) i vila	Pulsfrekvens i vila	Ålder	Andnings frekvens (AF) i vila	Pulsfrekvens i vila
< 1 mån	40–60	100–160	4–6 år	21–23	70–110
1–12 mån	35–40	100–180	7–12 år	19–21	70–110
1–3 år	25–30	70–110	13–18 år	16–18	55–90

TUB-B Akademiska Barnsjukhuset, september 2012

Figure 1. Swedish version of PEWS.

Implementation

As defined by Eccles and Mittman implementation research is the scientific study of methods to promote the systematic uptake of research findings and other evidence-based practices into routine practice and hence, to improve the quality and effectiveness of health services (39). It includes the study of influences on healthcare professional and organizational behavior. Implementation research that strives to attain both rigor and relevance is pragmatic and is the goal (40).

Implementation is described as the efforts made after the decision to introduce an innovation and the final phase occurs when an individual puts an innovation into use, makes a behavioral change and puts the new idea into practice. Experienced characteristics such as compatibility, complexity and observability of the innovation can affect the extent to which the innovation is used. An organization is a stable system of individuals working together to
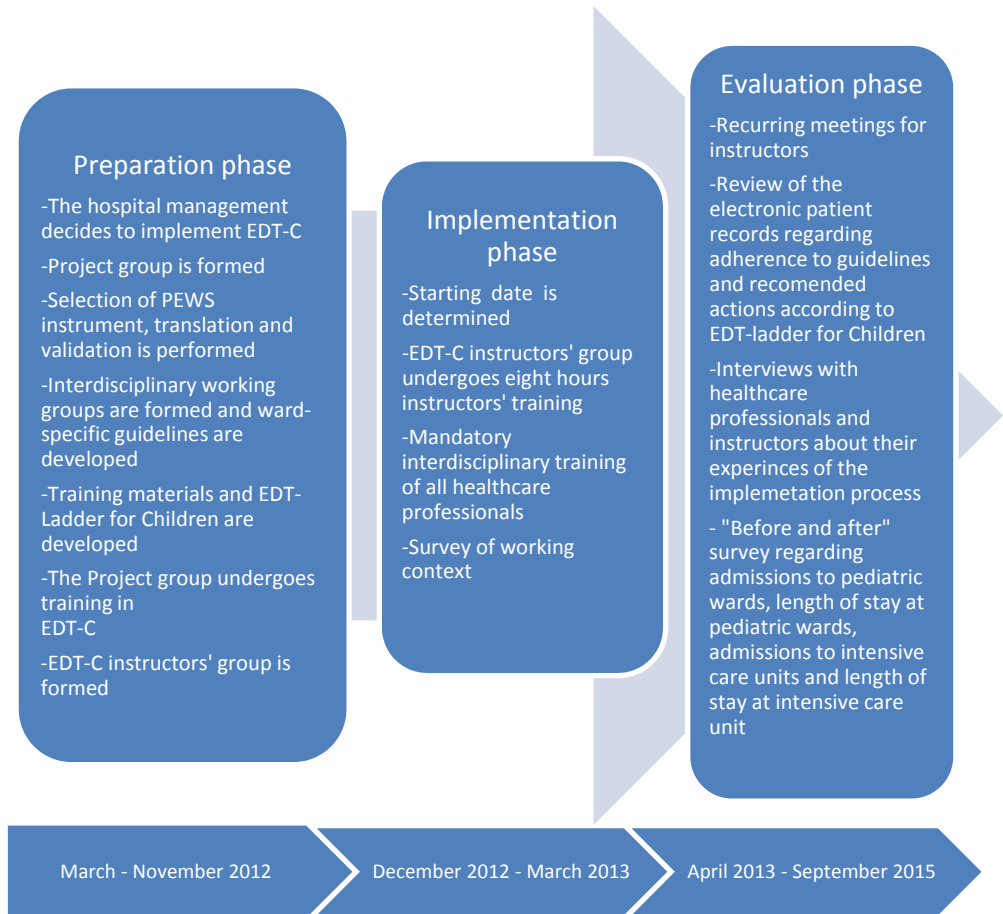
achieve common goals through a hierarchy of ranks and the division of labor. Predetermined goals govern the structure and the function of the organization. Positions are organized in an authority structure that specifies who is responsible for certain areas. A formal established system of rules and regulations exist but the organization is also formed by informal practices, norms and social relationships among its members. Even though processes with new innovations are ongoing in the organization it is complex and many barriers and resistances to change exist (41-43).

In health care, there is often a gap between what we know from research and what we do in practice. Demands have increased on delivering evidence-based care that is clinically effective for better patient outcomes (38, 44-46). The PARiHS framework (The Promoting Action on Research Implementation in Health Services) is a tool for planning, performing and evaluating the implementation process of evidence into practice. It is built on three components: Evidence, Context and Facilitators. Evidence is a combination of research, clinical experience, patient experience and local data and information. Context means the environment or setting in which people receive healthcare services, transforming evidence into practice or where the proposed change is to be implemented. Facilitation is the process of making the implementation easier through an individual carrying out a specific role, e.g. a facilitator whose aim is to help others. A successful implementation is described as a dynamic and simultaneous relationship combining these three elements (47, 48). PARiHS can identify barriers to research utilization in practice and by processing these barriers increase the susceptibility of the intervention (49).

A revised version called the integrated, or i-PARISH framework represents the dynamic and multifaceted nature of implementation in health care. The i-PARIHS framework focuses on facilitation as the active ingredient assessing and aligning the innovation to be implemented with the intended recipients in their local, organizational and wider system context. It considers the impact the recipients have, both as individuals and teams in supporting or resisting an innovation (50).

In March 2013, at The University Children's Hospital, Uppsala, the EDT-C was implemented according to the three components, Evidence, Context and Facilitation, using the PARiHS framework. Three inpatient pediatric wards participated, the Emergency Care Ward with general pediatrics and emergency care with 9 beds, the Elective Care Ward with mainly planned care within neurology and surgery with 22 beds, and finally the Oncology Ward with 12 beds mainly for planned care for children with blood and tumor diseases were included. Emergency conditions occur in all units, such as bleeding and infection after surgery, seizures, meningitis and serious brain

conditions, life-threatening sepsis and serious respiratory problems. The implementation process with the preparation phase, implementation phase and evaluation phase is briefly described in Flow Chart 1.

Preparation phase

-The hospital management decides to implement EDT-C

-Project group is formed

-Selection of PEWS instrument, translation and validation is performed

-Interdisciplinary working groups are formed and ward-specific guidelines are developed

-Training materials and EDT-Ladder for Children are developed

-The Project group undergoes training in EDT-C

-EDT-C instructors' group is formed

Implementation phase

-Starting date is determined

-EDT-C instructors' group undergoes eight hours instructors' training

-Mandatory interdisciplinary training of all healthcare professionals

-Survey of working context

Evaluation phase

-Recurring meetings for instructors

-Review of the electronic patient records regarding adherence to guidelines and recomended actions according to EDT-ladder for Children

-Interviews with healthcare professionals and instructors about their experinces of the implemetation process

- "Before and after" survey regarding admissions to pediatric wards, length of stay at pediatric wards, admissions to intensive care units and length of stay at intensive care unit

| March - November 2012 | December 2012 - March 2013 | April 2013 - September 2015 |

Flow Chart 1. The implementation process.

The preparation phase

The Brighton Pediatric Early Warning Score scoring system was chosen to be used (4, 38). Two translators, one with Swedish and one with English as their mother tongue, translated the PEWS instrument, first from English into Swedish and then back to English. A minor adjustment of the instrument was made regarding oxygen treatment and persistent postoperative vomiting, which was regulated in a separate document. A cross-sectional pilot study was conducted to investigate the inter-rater reliability of the Swedish version of

the PEWS. The PEWS scores were assessed 56 times by two independent observers at an oncologic ward at a University Hospital. Inter-rater reliability for the total PEWS was good to excellent: Cohen's kappa was 0.80 and ICC was 0.96 (51).

The recommendations for actions to be performed on the basis of measured PEWS and/or concern for the patient's health are described in the EDT-Ladder for Children (Panel 1).

Panel 1. Recommended actions for different PEWS according to EDT-Ladder for Children

PEWS 1-2: Inform the nurse in charge, evaluate treatment, consider contact with physician in charge, continue to monitor as prescribed or according to standard procedures.

PEWS 3-4: Inform the nurse in charge, contact physician in charge who must examine the patient within 3 minutes and assess whether contact with intensive care physician is required, treatment according to ABCDE, further evaluation and monitoring as prescribed.

PEWS 5-6: Inform the nurse in charge, contact physician in charge and intensive care physician who should both assess the patient within 10 minutes, treat and evaluate according to ABCDE, continuous monitoring, do not leave the patient alone.

PEWS 7-9: Inform the nurse in charge, alert physician in charge and intensive-care physician, treatment according to ABCDE, continuous monitoring, do not leave the patient alone.

Cross-professional reference groups consisting of physicians, assistant nurses and nurses, were established on each ward to perform the adapted guidelines. These guidelines determine which patients should be assessed according to PEWS based on the ward's specific needs (Panel 2).

Panel 2. Guidelines for Oncology ward; Elective care ward; and Emergency care ward

Oncology ward
- Blood pressure at PEWS >3
- Saturation should be measured in patients whose breathing is affected
- Pain measurement should be performed in all patients, PEWS should be measured:
- For all patients who return from the intensive care unit
- After anesthesia
- According to medical prescription
- All patients admitted to the ward
- All patients with a suspected or ongoing infection

Elective care ward
- Blood pressure at PEWS >3
- Saturation should be measured in patients whose breathing is affected
- Pain measurement should be performed in all patients, PEWS should be measured:
- For all patients admitted acutely
- Postoperatively
- Preoperatively in patients with severe mental retardation, cerebral palsy and muscular disease
- For all patients who indicate reduced general condition
  According to medical prescription

Emergency care ward
- Blood pressure at PEWS >3
- Saturation should be measured in patients whose breathing is affected
- Pain measurement should be performed in all patients, PEWS should be measured:
- All patients admitted to the ward
- Postoperatively
- For all patients who indicate reduced general condition
- According to medical prescription

Training materials for EDT-C were developed in collaboration with nurses and physicians from the hospital's Clinical Training Center and from various pediatric care wards. The working group underwent EDT-C head instructor training.

Implementation phase

An eight-hour training program for EDT-C-instructors was conducted, in which a total of 12 instructors (9 nurses and 3 physicians) were trained. The instructors then trained staff on the ward to which they belonged. Cross-professional, mandatory three-hour training sessions were conducted for all

employees at the three wards where EDT-C was to be introduced. Context was measured by using the Alberta Context Tool (52).

Evaluation phase

Recurring meetings for instructors were provided approximately three times during the first year. These meetings included discussion and feedback about the teaching and implementation of EDT-C on each ward. The instructors' function was, in addition to training staff, to facilitate during the implementation phase on their respective wards to inform, support and to capture the staff's views. Interviews were held with healthcare professionals (n=11) and instructors (n=5) about their experiences of the implementation process of Early Detection and Treatment Program for Children. The interviews took place between April and June 2013, which was about 2-3 months after the implementation start-up. A before-after evaluation was performed, "before" (April 2010-September 2012) and "after" (April 2013-September 2015) the introduction of EDT-C regarding admissions to pediatric wards, length of stay at pediatric wards, admissions to intensive care units and length of stay at intensive care unit. Data were collected from the EPR.

Rationale

In specialized, complex care contexts where the role of healthcare professionals with various forms of experience and knowledge is to ensure and optimize the care of acutely, severely ill children, a structured approach that promotes patient safety and teamwork is required. Studies on healthcare professionals' experiences of caring for acutely, severely ill children have been performed but have rarely been described from an inter-professional perspective and from different specialties in pediatric care. The importance of teamwork is often highlighted in emergency situations such as cardiac arrest but few studies discuss the importance of effective teamwork to detect clinical deterioration. In this thesis we study whether the implementation of The Early Detection and Treatment program for Children, consisting of evidence-based tools for an objective assessment and structured treatment, can improve teamwork and promote patient safety.

The aim was to evaluate the implementation of several different aspects to investigate which have worked and led to an improvement and also, on the contrary, what did not work optimally. We wanted to identify obstacles and facilitation factors, and the implementation outcome using a structured framework. Children in pediatric care are particularly vulnerable due to their physiological and cognitive conditions; consequently scientific methods are required to evaluate methods and guidelines affecting children. By evaluating the implementation process both from the healthcare professional's perspective and by using statistics analysis we can gain more knowledge of how to implement evidence-based care, increase patient safety and strengthen the healthcare professionals in their role. The implementation process and its complexity have been examined in several studies, but few describe the evaluation of an intervention and implementation in pediatric care.

Aim

The aims of this thesis were to describe healthcare professionals' experience of caring for acutely, severely ill children (Study I) and to evaluate the implementation of the patient safety system Early Detection and Treatment – Children (Study II, III, IV), which was implemented at three wards at a University Children's Hospital in Sweden.

Paper I

To describe healthcare professionals' experience of caring for acutely, severely ill children at a University Children's Hospital in Sweden.

Paper II

To describe data of Pediatric Early Warning Score (PEWS) registrations and to evaluate the implementation of PEWS by examining adherence to clinical guidelines based on measured PEWS, and to relate findings to the work context at a University Children's Hospital in Sweden.

Paper III

To evaluate the introduction of an Early Detection and Treatment - Children (EDT-C) program including Pediatric Early Warning Score (PEWS) in relation to admission and length of stay at an intensive care unit (ICU) at a University Children's Hospital in Sweden.

Paper IV

To describe the instructors' and the healthcare professionals' experience of the implementation process of the Early Detection and Treatment Program for Children at a University Children's Hospital in Sweden.

Method

The studies in this thesis include both qualitative and quantitative methods (Table 1).

Paper I. Focus group interviews before implementation regarding healthcare professionals' experiences of caring for acutely, severely ill children were conducted from November 2012 to January 2013. Data were analyzed using qualitative content analysis.

Paper II. Data of total PEWS registrations and adherence to each ward's specific guidelines for PEWS were collected from Electronic Patient Records during the first ten months after the implementation of the EDT-C. Descriptive and comparative data about contextual influences between the three wards were based on staff responses to the Alberta Context Tool (ACT). Student's T-test was used to analyze dimensions from ACT. Chi-square was used to analyze differences between groups.

Paper III. Before-after study regarding admission and length of stay at intensive care unit utilizing data from the Electronic Patient Record system, comparing outcomes over a total time period of 60 months between April 2010 and September 2015. Descriptive statistics, Student's T-test, Chi Square test and ANOVA were used for group comparisons.

Paper IV. Individual interviews with healthcare professionals and instructors regarding their experiences of the implementation process were conducted two to three months after implementation start-up. Data were analyzed using qualitative content analysis.

Table 1. Summary of the design of study I-IV.

Study	Design	Data collection	Sample	Data analysis
I	Qualitative interview study	Focus group interviews	Healthcare professionals (n=20)	Qualitative content analysis
II	Retrospective review study	Electronic Patient Records	PEWS-registrations (n=4865)	Descriptive and comparative statistic: Student's T-test, Chi Square
		Alberta Context Tool (ACT)	Healthcare professionals (n=109)	
III	Before and after study	Electronic Patient Record	Admissions to ward (n=19 025)	Descriptive and comparative statistics: Student's T-test, Chi Square, ANOVA
			Admissions to ICU (n=1794)	
IV	Qualitative interview study	Individual interviews	Healthcare professionals (n=11) Instructors (n=5)	Qualitative content analysis

Paper I

Data collection

Focus group interviews were conducted with participants representing different professionals and experiences in pediatric care. Focus groups usually stimulate discussion and lead to deep expressions about the topic since members react to what is being said by others (53).

Sample

A convenience sampling technique was used and five focus groups were formed consisting of a total of 20 respondents: nine nurse assistants, five registered nurses and six physicians of which four were pediatricians and two were pediatric surgeons (Table 2). The professional experience of all the nurses in pediatric care ranged from 1 to 38 years, and of the pediatricians from 0.6 to 13 years. The age of all the respondents ranged from 27 to 60 years.

Table 2. Informants with profession

Profession	Participants (n)
Registered nurses	5
Nurse assistants	9
Pediatricians	4
Pediatric surgeons	2

Procedure and Data collection

The selection was done to obtain a mixed group regarding gender, age, education, and experience. Nurses/nurse assistants formed three groups; one from each ward, and the physicians formed two groups. Each group consisted of two to seven participants. An interview guide with open-ended questions was used and the participants were first asked to share their experiences and thoughts about caring for acutely, severely ill children: "Can you please tell us about your experiences of caring for acutely, severely ill children?" Follow-up questions were posed. The interviews were recorded and notes were taken.

Data Analysis

Data was analyzed using qualitative content analysis (QCA) (54) as described by Graneheim and Lundman (55). The transcribed interviews were read and listened to several times to grasp a sense of the whole. Meaning units were identified, condensed, abstracted, and coded. The process went backwards and forwards several times through discussion and reflection on the content and the labeling of the preliminary subcategories and categories. All authors participated in the discussion. Finally, consensus was reached and three categories and nine subcategories were formulated. The underlying meaning, the latent content of the categories, was formulated into a theme. To achieve trustworthiness, Lincoln and Guba's framework was used (47), as described by Polit and Beck (48).

Paper II

Data collection and sample from electronic patient records

Data was gathered through the Electronic Patient Record (EPR). Variables collected were: time for PEWS measurement, PEWS, social security number of inpatients, age, gender and healthcare contact number. Data from the total PEWS registrations included all inpatients from the 4th of March 2013 for the Elective Care ward and the 18th of March 2013 for the Oncology ward and the Emergency Care ward, up until the 31st of December 2013 when EDT-C was implemented. To be able to achieve a structured review of the data from the EPR, a random sample was also drawn from the total sample.

Each registered PEWS in the random sample, was studied to ascertain whether blood pressure, saturation and pain assessment had been conducted according to specified guidelines (Panel 2) and documented in the EPR or scanned part of the EPR at the specified time and this was determined as having been performed when documentation was found. In the cases of no documentation of any actions it was determined as "not performed".

Furthermore, the documentation in the EPR or scanned part of the EPR for each PEWS was studied to evaluate if any actions according to the EDT-Ladder for Children (Panel 1) had been performed. Statistical comparisons between the wards were performed regarding the presence of documentation of actions performed according to EDT-Ladder for Children.

Data collection and sample from the work context

The Alberta Context Tool (ACT) is developed to describe the conditions in the work environment in health care (52). The ACT reflects the following contextual dimensions: leadership, culture, evaluation, social capital, formal and informal interactions, structural and electronic resources and organizational resources of staffing, time and space. The items describing each dimension are presented as statements and measured on a scale from 1 to 5, where five indicates most consistent with the statement. It also adds information about the respondent's working hours, experience, education and age. All who participated in the EDT-C training received an ACT questionnaire.

In this study nurses and nurse assistants are included (n=109). Questionnaires were also collected from the physicians, but since many of the doctors rotate between wards the full category of doctors was excluded.

Analysis

Data obtained from electronic patient records were processed in Microsoft Excel and the statistics management software IBM SPSS Statistics 22, IBM, New York, US. Data from the questionnaire ACT were processed in IBM SPSS Statistics 20 (IBM, New York, US) according to the Alberta Context Tool User Manual (56). Student's T-test was used to analyze dimensions from ACT. Chi-square was used to analyze differences between groups. A p-value <0.05 was considered significant.

Paper III

Data collection

Data was gathered from EPR and were retrieved for the period of January 2010 to September 2015. In total this amounted to 19 025 admissions at the three wards and 1 794 admissions to the intensive care units. For the purpose of comparison the data was divided into two periods of 30 months each, "before" (April 2010-September 2012) and "after" (April 2013-September 2015) the introduction of EDT-C. The introduction of EDT-C was six month after the opening of a Pediatric Intensive Care Unit (PICU).

Sample

The following variables were extracted from the EPR data:

- Admissions to pediatric wards

- Length of stay at pediatric wards

- Admissions to intensive care units

- Length of stay at intensive care unit

- Diagnosis

Analysis

Descriptive statistics were used. Student's T-test, Chi Square test and ANOVA were used for group comparisons. All analyses were conducted in SPSS 24. A p-value of <0.05 was considered significant.

Paper IV

Data collection

Individual, face-to-face interviews with healthcare professionals.

Sample

A purposive sampling technique was used. The sample consisted of 16 participants, two men and 14 women (Table 3).

Table 3. Informants with profession and groups.

Education	Healthcare professionals	Instructors
Pediatrician	1	
Resident doctor	1	1
Registered nurse	5	1
Pediatric nurse	2	3
Nurse assistant	2	

Analysis

Data were analyzed using qualitative content analysis (54). During the preparation phase the data were first analyzed using an inductive approach (57, 58). Meaning units that responded to the aim were identified and condensed (55). The condensed meaning units were then grouped using a deductive approach (57, 58) with the i-PARIHS framework as the analysis matrix (50). Data were organized according to the five dimensions of i-PARIHS: Innovation, Recipients, Context, Facilitation and Implementation outcomes. Thereafter preliminary categories and subcategories within the five dimensions were identified. To achieve trustworthiness, Lincoln and Guba's Framework was used (59), as described by Polit and Beck (60).

Ethical Considerations

The studies were approved by the Regional Ethical Review Board, at the Faculty of Medicine (Dnr: 2012/407) Uppsala, Sweden. The participants in the interviews received an information letter by email, stating the aim of the interviews, that participation was voluntary, and that they would be free to withdraw from the interviews at any time, in line with the declaration of Helsinki (61). The results need to be presented in such a manner as to make

identification of any participants impossible and ensure confidentiality of the data (53).

The EPR system is governed by the Personal Data Act: SFS 1998:204 and 2008:355 (62, 63). All who received the ACT questionnaire signed a written informed consent form in which it was stated that the participation was voluntary, and that result could not be linked to any person.

Results

Study I

An overarching theme emerged that captured healthcare professionals' experiences of care for acutely, severely ill children namely that of: being in a multifaceted area of tension with paradoxical elements. The theme is based on the categories and subcategories (Table 4).

Table 4. Theme, categories and subcategories of what it means for healthcare professionals when caring for acutely, severely ill children.

Theme	Categories	Subcategories
Being in a multifaceted area of tension with paradoxical elements	Proficiency of the individuals and the team is the fundamental base	Building on different levels of training and preparation
		Building on experience, and being intuitive
		Being efficient and resourceful in multifaceted and complex situations, and maintaining focus on the child
	Interactions are crucial in an area of tension	Building on ability to engage in two-way communication
		Building on ability to cooperate in confidence with each other
		Needing structure as well as flexibility in communication and cooperation
	Wellbeing of the individual is a balance of contradictory emotions	Being affected by challenges and feelings of inadequacy
		Being affected by demands, frustration, and vulnerability
		Being affected by gratitude and satisfaction

The respondents included nine nurse assistants and five registered nurses. Furthermore, six physicians, four pediatricians and two pediatric surgeons participated.

In the category "Proficiency of the individuals and the team is the fundamental base" participants describe that proficiency consists of the competence based on experience and education - a fundamental base. Further, that multifaceted and complex situations could arise where it was important to be resourceful and efficient while still maintaining focus on the child. Participants expressed a strong desire to do their best in emergency situations and had high demands on themselves to handle the situation optimally even though the patient sometimes had complex medical conditions: *"Nothing must go wrong: You don't want to look back with regret, you want to be one step ahead."* (Nurse Assistant 8).

In the category "Individual's interactions are crucial in an area of tension" participants described that communication provides the basis for assessments and actions. Further, that they felt supported and gained confidence when working with others and often consulted colleagues: *"I find someone, that feels good, having someone who may not do much, but just to get acknowledged, what I see, he/she sees the same thing"* (Physician 1). The ability to interact through cooperation, trust and communication was essential for optimal teamwork and made emergency situations feel less problematic. There could also be different approaches and they had to be flexible when treating a patient. Participants stressed that interdisciplinary collaboration is necessary to meet the needs of the child and the family.

The paradoxes in caring for acutely, severely ill children are illustrated in the category: "Wellbeing of the individual is a balance of contradictory emotions". Examples of this are being worried about not being able to handle the situation and at the same time wanting to be involved in order to gain experience and knowledge. Even if you had to handle stress and anxiety in emergency situations, feelings of satisfactions could arise when you felt that everything turned out well or even in a situation when a child died but had been provided with dignified care: *"It feels good when you are doing everything you can and it cannot be done better"* (Nurse 4). Furthermore, the informants described that a structured approach as well as tools to facilitate the care of acutely, severely ill children are needed in all wards where children receive care. *"If you know what to look for you can detect it earlier. So it doesn´t deteriorate any further"* (Nurse 1).

Study II

The results consist of: 1) Descriptive data from the total PEWS registrations, 2) Descriptive data about adherence to each ward's specific guidelines for PEWS and 3) Descriptive and comparative data about contextual influences

between the three wards based on staff responses to the Alberta Context Tool (ACT).

PEWS Measurement

In total, 4 865 PEWS were recorded, divided into 875 unique social security numbers for children from 0 to 19 years of age. In 1 160 of these admissions at least one PEWS score recorded. The majority of PEWS were between 0-2 whereas PEWS of 3-9 were registered on 505 (10.4%) occasions.

The randomized sample consisted of 166 patients and 981 PEWS recorded. PEWS 0 and PEWS 1-2 were measured on 444 (45.3%) and 401 (40.9%) occasions respectively. PEWS of 3-4 were measured on 108 (11%) occasions and 28 (2.9%) scored PEWS of 5-9, of which 12 were for children less than one year old. In the age group 16-17 years, 63 PEWS were measured and 3 of them were PEWS of 5-9. In the age group 7-15 years, no PEWS of 5-9 were measured (Table 5).

Table 5. Distribution of total PEWS according to age groups in the randomized sample (n=981).

PEWS	0yr		1-2yrs		3-6yrs		7-9yrs		10-12yrs		13-15yrs		16-17yrs		18yrs	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
0	113	11.5	76	7.7	81	8.2	67	6.8	20	2.0	54	5.5	27	2.7	6	0.6
1-2	113	11.5	98	9.9	85	8.6	45	4.5	9	0.9	20	2.0	26	2.6	5	0.5
3-4	27	2.8	31	3.2	29	3.0	12	1.2	0	0	2	0.2	7	0.7	0	0
5-6	9	0.9	5	0.5	5	0.5	0	0	0	0	0	0	2	0.2	0	0
7-9	3	0.3	3	0.3	0	0	0	0	0	0	0	0	1	0.1	0	0

Adherence to ward-specific guidelines to PEWS

Regarding the ward-specific guidelines, adherence to PEWS score at admission to ward and saturation in respiratory distress were both high whereas adherence to measured pain was low (Table 6).

Table 6. Adherence to ward-specific guidelines according to the documentation.

	Oncology		Elective		Emergency	
	n	%	n	%	n	%
When to perform PEWS						
All admissions to the ward	41	65	-	-	51	88
Back to ward after intensive care	1	25				
Acute admissions to the ward		-	6	67	-	-
Postoperative for certain diagnosis			3	60		
Postoperative	-	-	29	81	4	33
Ongoing infection	89	62	-	-		-
Measuring pain	27	10	16	7	36	13
After anesthesia	13	50				
Saturation in respiratory distress	57	84	19	83	69	92
At deterioration		-	5	45	0	0
According to medical prescription	68	79	44	56	202	87
Action after PEWS						
Blood pressure at PEWS >3	19	51	2	8	6	13

Adherence to Early Detecting and Treatment Ladder for Children

There were 536 registered measures of PEWS of 1 or higher which were compared to the recommended actions according to EDT-Ladder for Children (Table 7).

Table 7. Documentation of adherence to measures (n=536) according to EDT-Ladder for Children per ward: Oncology ward (n=137), Elective care ward (n=113) and Emergency care ward (n=286).

	Oncology		Elective		Emergency	
	n	%	n	%	n	%
Full adherence	32	23.4	45	39.8	105	36.7
Partial adherence	44	32.1	34	30	20	6.9
No adherence	61	44.5	34	30	161	56.2

Alberta Context Tool

There were no differences in Culture, Internal processes, Relationships, Staffing and time between the three wards. For Leadership there was a difference between Elective Care and Emergency Care revealing higher levels of satisfaction in Elective Care. There was also a difference in the "Evaluation" dimension between Elective Care and Emergency Care, where

the staff reported that evaluation and feedback occurred to a greater extent in Elective Care compared to Emergency Care.

Study III

During the study period a total of 16 283 pediatric patients were admitted to the three wards of the hospital, 8 746 before and 7 537 after program introduction. Most patients came for a planned admission in both time periods, but in the period after there was a substantial increase in patients being admitted directly from the emergency room (ER) (Table 8).

Table 8. Patients admitted to the pediatric hospital divided by the two study periods.

Description of data	Before (2010/04-2012/09)	After (2013/04-2015/09)	P-value
Total number of patients admitted	8746	7537	
Boys	4956	4434	
Girls	3790	3103	p<0.01
Mean age (years)	7.10	6.70	p<0.01
Mean admittance time (days)	3.77	3.97	p<0.05
Max admittance time (days)	154	134	
Reasons for admission	n (%)	n (%)	
Admitted from emergency room	1650 (18.8)	2324 (30.8)	p<0.01
Referred from other hospital or care unit	2099 (24.0)	1400 (18.6)	p<0.01
Planned admission	4997 (57.1)	3813 (50.6)	p<0.01
Wards			
Emergency care	2441 (27.9)	2052 (27.2)	p=0.46
Surgical and neurology care	4396 (50.3)	4188 (55.6)	p<0.01
Oncology	1909 (21.8)	1297 (17.2)	p<0.01

During the study period, in September 2012, a new intensive care unit for pediatric patients (PICU) was opened at the hospital, six months before the introduction of EDT-C. A marked increase in pediatric patients being admitted to intensive care from the three wards could be seen over the study period, from a total of 440 in the first period to 772 in the latter period (Figure 2).
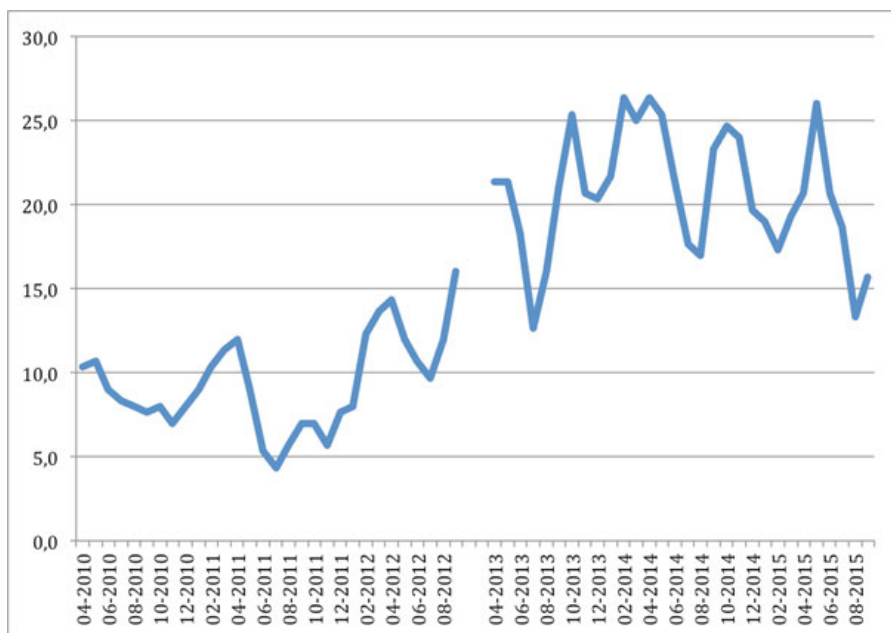
Figure 2. Number of patients admitted to intensive care from the pediatric hospital before and after introduction of EDT-C (Moving 3-year averages).

Admittance increased significantly from all three wards (Table 9). The number of intensive care admissions per in-patient also increased from a mean of 2.11 before to 2.20 after introduction of EDT-C (p<0.001). There was however no significant difference in the mean length of stay once admitted to the ICU (Table 9). The proportion of children referred for intensive care at other hospitals remained the same in the two periods, with 14/8 746 (0.16%) before and 15/7 537 (0.20%) after introduction of EDT-C (p=0.56). In total, 24 in-patients died at the hospital during the study period, 10 before and 14 after EDT-C was introduced (p=0.23).

Table 9. Intensive care admissions from the pediatric hospital divided into the two study periods.

	Before (2010/04-2012/09)	After (2013/04-2015/09)	p-value
Admissions from the wards	n (%)	n (%)	
Emergency care	114/2441 (4.6)	236/2052 (11.5)	p<0.01
Surgical and neurology care	303/4396 (6.9)	474/4188 (11.3)	p<0.01
Oncology	23/1909 (1.2)	62/1297 (4.8)	p<0.01
Total number of admissions to intensive care	440/8746 (5.0)	772/7537 (10.2)	p<0.01
Mean length of stay at ICU (hours)	41.0	48.3	p=0.23

Study IV

The combined inductive and deductive process resulted in eight categories and 17 sub-categories (Table 10). An overarching theme was synthesized based on the respondents' descriptions of the implementation process; "From uncertainty and skepticism towards assurance and control".

Quotations from healthcare professionals and instructors, as well as their profession, physician, registered nurse and nurse assistant, with the study number illustrating the content.

Innovation

In the category "An innovation suitable for clinical practice" the recipients described that the training material could easily be applied to the clinical practice and further that to learn a structured way to examine and treat the patient was experienced as positive. The training material from the authentic patient case used as a starting point created a greater understanding how EDT-C could increase safety. *"You understood why one wanted to introduce PEWS, that you can detect changes much earlier with objective parameters. We also talked about SBAR at the same time. You need to think about it a bit"* (Healthcare Professional - Physician-1). Some uncertainties in assessing PEWS in the start-up phase were described but overall the PEWS was perceived as an objective instrument.

Table 10. Categories and subcategories describing the healthcare professionals' and instructors' experiences of the EDT-C program.

Categories within the dimensions	Subcategories
Innovation	
An innovation suitable for clinical practice	An objective and structured instrument
	An ambiguous instrument
Recipients	
Differing conditions for change	Positive attitudes towards new routines
	Skepticism towards new routines
	Differing knowledge among staff
Context	
Lack of organizational slack	Lack of time and personnel resources
Complex situations	Heterogeneous patient group
	High level of specialization
Facilitation	
A pragmatic implementation strategy	Inter-professional training
	Realistic and clear training
Delegated responsibility	Ward-specific guidelines
	Stakeholder support
Implementation outcomes	
Experiences of control	Perceptions of increased patient safety
	Increased level of confidence
	Changes in motivation
	Perceptions of improved communication
Successful implementation	Innovation as routine

Recipients

Both skepticisms and positive attitudes towards new routines emerged in the category "Differing conditions for change". The instructors described it as fun and challenging to teach and that their impression was that EDT-C could make a positive contribution to the healthcare work. *"I thought it seemed good, and then I liked to teach and it felt fun, a good project, so to say ..."* (Instructor - Physician 3). Informants recounted that attitudes towards new routines and how to take them on board were influenced by factors such as whether the innovation was considered to improve the working situation, if you had an open mind to new ways of working, and level of experience. As less experienced you more willingly embrace what could lead to improvement whilst on the other hand as experienced you feel comfortable with the old routine *"If you've been working for a long time, you've learned your routines and you think it's good to know that they work, so why should you bring in new ones?"* (Healthcare Professional - Registered Nurse 5). Some related that there was constant pressure to learn new routines and that it was stressful.

Context

In the category "Lack of organizational slack" the instructors described how the lack of time and personal resources was the biggest obstacle to training, supporting and developing EDT-C in an optimal way. *"Even though we had booked the sessions, the staff couldn't get away because of the heavy workload, someone has to work"* (Instructor - Registered Nurse 2). Heavy workload and not being freed from regular duties made the instructor feel that it was difficult to take on the role of facilitator. This factor also often led to curtailed training sessions in the physicians' group. The complexity of developing guidelines with a heterogeneous patient group and the various specific specialist areas is described in the category "Complex situations".

Facilitation

In the category "A pragmatic implementation strategy" recipients describe the importance of an inter-professional approach in order to gain an understanding of each other's professions; that while working towards the same goal, one focuses on different things. This is also strengthened in that it was perceived as positive that both the training sessions and the instructor group were inter-professional. *"I also think it was good that they had mixed the training groups, nurses, assistant nurses and doctors. Because then you saw what different tasks you have, but at the same time it's important that everyone does their part well"* (Healthcare Professional - Registered Nurse 1).

Both the instructors and the healthcare professionals experienced that the instructors had a supportive and informative role and that the development of ward-specific guidelines was important for the introduction of EDT-C in daily work to run smoothly, as described in the category "Delegated responsibility".

Implementation outcomes

The category "Experiences of control" comprises recipient's descriptions of perceptions of increased patient safety and level of confidence; also that communication in the team had improved after the introduction of EDT-C. The healthcare professionals felt that they received more guidance and had more control concerning what was actually assessed and what it meant for the patient's state of health. *"I think you have better control actually. In seeing a change. You think that bit more perhaps. A little extra"* (Healthcare Professional - Nurse Assistant 1). The informants in the physicians' group expressed that there was confidence in knowing that structured, objective controls were carried out according to guidelines even if this was not actively prescribed and furthermore that the workload, as estimated, had not increased after the introduction of EDT-C. In the category "Successful implementation"

the informant's stated objective assessment, not influenced by personal characteristics or experience, was essential both for the patient and the healthcare professionals. Furthermore, that EDT-C was now used in their daily work and that measuring PEWS had become a routine *"It's quite simply a routine now"* (Instructor - Registered Nurse 2).

Discussion

Both professional knowledge and emotional commitment is needed to be able to care for severely ill children. Study I describes the experiences among healthcare professionals working in the multifaceted and stressful field of caring for acutely, severely ill children – a field full of paradoxes. The paradoxes may simultaneously include positive and negative experiences. The participants described feelings of security versus insecurity, positive challenging feelings versus negative feelings of being inefficient, and frustration versus satisfaction. It is clear from the interviews that caring for acutely, severely ill children is a multifaceted and complex task. It is a balancing act between personal feelings and professionalism, a finding that is supported by other authors (11, 27, 64). The contradictory feelings that may occur as both wanting to be involved in the care of the acute, severely ill child and at the same time feeling worried about not being able to handle the situation require coping strategies (27, 65, 66). There is a complexity, even if it is related to the professional efforts, in being able to feel satisfaction in difficult and sad situations such as when children are acutely, severely ill or die.

The importance of well-functioning teamwork in emergency situations has been shown in previous studies (67) but few studies discuss the importance of effective teamwork to detect clinical deterioration. The participants in study I recounted that they relied on each other and that they often supported each other. Uncertainty was experienced when different approaches to the patient's care emerged or there was a lack of understanding of each other's expertise, also described by Schaik et al. (68). The actions and reactions in the care of acutely, severely ill children depend on the health personnel's education and training as well as their experiences, and this is also described by the participants in study IV.

The respondents indicated that inter-professional education, and the fact that both physicians and nurses led the education, increased their understanding of different professionals' specific knowledge and approaches and that this was positive for the teamwork. Inter-professional collaboration has been stressed as an effective method to enhance the delivery of patient care (69) and inter-professional educational programs with real-life material can improve patient safety in pediatric care (7, 70). This is supported by earlier findings indicating

that different professions learn together with, from and about each other (20). Further, inter-professional teamwork was seen to be important and required to manage the complexity of children's care (21). According to Birkeland et al., good communication, each team member's awareness of and ability to handle their own responsibility as well as a holistic approach are necessary elements to feel trust and support in the team (21). Our findings also stress the need for inter-professional teamwork when managing the complexity of children's care.

An implementation process based on inter-professional involvement can increase understanding of each other's levels of knowledge (7). Study II describes the implementation process of EDT-C and the adherence to guidelines. EDT-C consists of ABCDE, CRM, SBAR and PEWS, all validated instruments, and furthermore, of EDT-C Ladder for Children, recommended actions based on measured PEWS.

The purpose of PEWS is to detect patients at risk of deterioration and thereby optimize treatment to avoid further deterioration and death. PEWS is a tool used worldwide and the use of it is increasing (71-74). Unfortunately, a number of variants of PEWS appears to be more or less validated and can lead to 'false negatives', where treatment of children who do not trigger PEWS may be delayed and from 'false positives', by overtreatment of children who would not have gone on to develop a critical illness. Consequently, a coordinated evaluation is necessary in line with earlier findings (75, 76). A validated PEWS was chosen in this EDT-C program (4, 38) that best meet the needs of the patients. Study II shows frequent use of PEWS and that the majority of the estimated PEWS scores were 0-2, signifying that the majority of hospitalized patients were stable in behavior, cardiovascular status and respiratory status according to PEWS. Further, that PEWS of 5–9 occurred 28 times in this study indicating that patients with a very high risk of deterioration are identified at the wards using PEWS.

Recommended actions presented in the EDT-C Ladder for Children is a new step forward to increase patient safety and improve teamwork. Reflecting and being forced to take a stand for the assessments made can lead to measures and treatments that prevent further clinical deterioration or death as described in study IV, and also supported in other studies (38, 77).

Many factors distinguish patient safety during critical pediatric medical events from general patient safety issues such as heightened high-stress and emotional climate (78-80). Consideration of this concept is essential when discussing safety improvements in critical medical events in pediatric care. Even if the implementation process does not vary, the intervention may have different effects in different contexts (81, 82). Adherence to ward-specific

guidelines varied in all three wards and this result, together with the demonstrated high number of PEWS 0, may indicate that ward-specific guidelines need to be evaluated.

There were significant differences in documented recommended actions between wards, with the highest compliance, according to the documentation, in Elective Care. Analysis of ACT also showed the highest score in the dimensions "Leadership" and "Evaluation at Elective Care". These two results may indicate that work context influences adherence to guidelines, in line with another Swedish implementation study in pediatric care (83). A positive finding in this study is that the healthcare professional scored the work context as being good in all three wards.

In study III we saw a sharp increase in the number of intensive care admissions but no change in length of stay for pediatric patients at the ICU during the period after introduction of EDT-C compared to before its introduction. It is challenging to evaluate the effect of an intervention over such a long time perspective and in a complex healthcare environment as is whether patient safety has in fact increased. Many factors in addition to intervention can affect outcomes (84, 85) and one major confounding factor is the opening of a pediatric intensive care unit at the hospital six months before the EDT-C introduction.

The fact that children are dying is no common occurrence in pediatric care (1, 11, 64). Measurement of morbidity is complicated and mortality in this setting is very low, consequently it would require a much larger sample than it is possible to get from the present study setting.

The complexities in emergency clinical care of children necessitate effective communication at all levels, as well as teamwork strategies (23, 86). The use of evidence-based practice among healthcare professionals directly correlates with better outcomes for patients and higher professional satisfaction (87-90). This is also described by the informants in study IV as perceptions of increased patient safety and level of confidence, moreover that communication in the team had improved after the introduction of EDT-C. In study IV positive responses as well as skepticism towards new routines occurred when working within complex care situations. Despite a lack of organizational slack, a pragmatic implementation strategy and delegated responsibility facilitated the healthcare staff in gaining a sense of assurance and control when EDT-C became a routine tool to assess health status among patients.

Implementation can be seen as the efforts made after deciding on the introduction of an innovation (41). In implementation processes such as this one with complex interventions in complex settings, planning and structure is

required. The PARiHS framework for implementation of evidence-based care in different healthcare settings (47, 50, 91) was used as a guide during the implementation process. PEWS was considered by the informants to be an objective, structured instrument, although it did include some more subjective assessment. There are several different variants of PEWS (38, 46, 92) and it is a balancing process to choose a variant that is both validated and suited to the needs of the patients and context. The informant perceived the material as clear and that it could easily be applied to the clinical practice and that it was positive to learn a structured way to examine and treat the patient. Moreover, that it was easier to adopt to an intervention that you felt could improve your work. This is in line with previous research finding that the likelihood of successful implementation increases if the intervention both has a strong scientific basis and is applicable and useful in the context in which it will be implemented (40, 93).

The importance of the recipient's attitudes and actions for the implementation outcome has recently been very much highlighted in implementation research (42, 50, 94). In a complex organization with ongoing adaptions to new methods, learning new things may invoke negative attitudes, and recipients have varying levels of innovativeness and ability to adopt an innovation, from "innovators" to "laggards" (41). This is also shown in study IV where both skeptical and positive attitudes emerged to some extent, but also that skepticism could transform into a more positive attitude during the implementation phase. Implementation of evidence-based care requires careful planning, definition of roles and responsibilities, and supportive team dynamics. Additionally, a leadership structure that provides the appropriate resources both at local and organizational level is important (50, 95, 96). The healthcare professionals felt that they could ask the instructors if they had questions about EDT-C, and the instructors described their role as instructors as that of motivating and encouraging their employees in the wards, and acting as a stakeholder. The instructors stated that lack of time was one of the biggest obstacles to optimally fulfilling their mission as a facilitator and that self-critical thoughts arose. These findings are in line with other Swedish resources regarding the impact of context on the facilitator's role (97). Conditions regarding time and flexibility in the work schedule need to be taken into account in implementation processes, since if they only lead to additional workload and a sense of insufficiency there is a risk that healthcare professionals will avoid assuming responsibility as facilitators. According to Iver and Grimshaw (98) this can have very negative effects on the evolution of evidence-based care and patient safety, and should have been noted to a greater extent both at the organizational level and local level as well as being more highlighted by project managers.

In the physician group, it was experienced by some that there was no planned time for training, resulting in curtailed training sessions, which may have influenced the fact that a variation in attitudes and knowledge of EDT-C occurred in that group. This is in line with earlier findings where costs, lack of resources and faculty interest are barriers to the implementation of training and assessment programs (99).

Participants in study I stated that they made high demands on themselves to handle emergency situations optimally which sometimes led to inner stress. Focused training and training in emergency situations was perceived as necessary to acquire better skills. According to Andersson and Willson the knowledge of caring is based on practical knowhow and evidence-based knowledge (100). Implementation of a structured, validated tool such as PEWS and a structured action plan like the EDT- Ladder for Children can lead to enhanced skills and preparedness for emergency situations and thus to decreased stress levels among healthcare personnel. Gjengedal and coworkers describe vulnerability as a characteristic among healthcare professionals, due to either witnessing or experiencing suffering to a greater extent compared to the general population (101). However, vulnerability can also be a strength when guidance and increased knowledge can lead to healthcare professionals feeling assurance in their profession and in the team, which is in line with participants' experiences in study IV.

Modern pediatric care needs patient safety systems based not only on healthcare professionals' experiences (102, 103) and patient safety must be seen as a chain in which each link is a team member and together they work towards a common goal - to identify clinical deterioration and provide optimal care for the child at the correct level of care.

Methodological considerations

Study I and IV

By carrying out interviews, a deeper understanding and knowledge of the informants' experiences can be achieved (54, 58, 104) and the groundwork for the credibility initiates when the planning of the study begins (60). Qualitative research, based on data from interviews requires understanding and co-operation between the researcher and the participants so that texts based on interviews are mutual, contextual and value bound (59). Although the sampling in study I was convenient, and in study IV a purposive sampling technique was used, efforts made to ensure credibility included selection of a range of healthcare professionals, such as nurses/nurse assistants and physicians, with a range of age, gender, and experience. Participants came from different wards caring for children with different diagnoses.

Respondents may feel vulnerability in sharing their feelings and experiences with a group of colleagues. For this reason, we clearly stated that the material would be treated confidentially and participants were committed to not sharing with others what had been discussed during the interview. A face-to-face interview such as in study IV can invite the informant to share the experiences. On the other hand, some informants may feel uncomfortable expressing certain views to the interviewer. Data rich in expressions of both positive and negative perceptions (study IV), and deep emotional experiences (study I) revealed that respondents felt comfortable about sharing their experiences.

Qualitative content analysis can be implemented at different levels of abstraction (54, 55). The abstraction level is determined by the purpose (55). A closeness to the text was adopted in the design of categories and subcategories, while maintaining an awareness of avoiding surface descriptions and general summaries (105). Since all the authors have knowledge of both caring for severely ill children and the implementation process, they also have an understanding of the issues discussed, which may have influenced the interpretation of the results. An open mind to the data minimizes pre-knowledge bias and a reflective approach was pursued during the process until consensus was reached.

A challenge in the interpretation process is to refrain from drawing the interpretation too far, as it could become so general as to fit into almost any context (105). However, the intention to first apply a manifest approach may have reduced the risk of over-interpreting the results. The goal of the analysis in study I was then to highlight the contents to a higher level of abstraction in order to find the underlying meaning, presented in the theme. In study IV we initially analysed the material using an inductive approach (105) instead of directly applying the i-PARiHS framework. This secured that all data in the material that related to the objective were captured. With the subsequent deductive approach, grouping all condensed meaning units according to the theoretical framework ensured that all dimensions of the implementation process were investigated (57, 106). All the authors participated in the discussions of, and reached consensus on, the categories, subcategories, and the themes both in studies I and IV. This procedure strengthened the credibility by keeping similarities within, and differences between, the categories.

Evaluating the quality of qualitative research can be influenced by multiple factors such as the assessor's attitude towards the subject and method (107) One criticism that has been leveled in all qualitative approaches is that they lack credibility associated with traditionally accepted quantitative methods (108). In these studies, credibility was strengthened by the use of the same open questions during all interviews so that the same area was covered. Dependability was ensured by the fact that one author analyzed the data and then discussed the findings with all the other authors on several occasions, thereby maintaining similarities within, and differences between the categories, and further through a clear description of the analysis process. Conformability was strengthened by the result being based on the material as shown by quotes. Transferability was promoted by a clear and distinct description of the sampling procedure, the culture and context and by including participants with different degrees of education. Finally, authenticity was achieved by working closely to the text but with a degree of abstraction and interpretation to make the results meaningful and understandable (59, 60).

Study II and III

Once you have identified a problem the most important thing is to ask how to do the right things and to try to find research that is sufficiently valid and relevant to change practice. Implementation of evidence-based care is complicated, and good conditions for using evidence in clinical work must be created. Akenroye and Starck found that the keys to success were strong leadership, support and local presence of guidelines, selection of motivated

facilitators, development of practical process for guidelines, and implementation and further frequent feedback to stakeholders (109). A structured framework can facilitate an understanding of the dynamic nature of implementation (50). The application of frameworks to implementation projects and research can aid in the evaluation and interpretation of the outcomes and results (110). A framework provides structure and increases the chances that all dimensions are considered and examined from the preparation of the implementation process to its evaluation (87). Therefore, PARiHS was used in the implementation process to identify facilitations and obstacles, thus strengthening the implementation phase. Later in the evaluation phase we used the i-PARiHS framework which is refined and to a greater extent highlights facilitation and the role of respondents. Further interdisciplinary working groups were formed to develop guidelines suitable for the context in which they were to be implemented.

Effective identification of children at risk of clinical deterioration is crucial. Inter-professional training, objective validated tool like PEWS together with a recommended response system is a strategy to promote patient safety (7, 46, 111). This is supported by real-life cases and using a cross-professional approach to EDT-C education was described by informants in study IV as stimulating a heightened sense of situation awareness and open communication among healthcare professionals regarding children at risk of clinical deterioration. A validated version of PEWS was chosen and a strength of it is the investigation of the Swedish version of the PEWS instrument for inter-rater reliability, which was good to excellent (51). The informants' perception of the program as clear strengthened the usability and acceptability of EDT-C and it was further strengthened by the fact that it could easily be applied to the clinical practice (study IV).

ACT was used to examine the work context, which is a validated instrument used both international and nationally in different healthcare settings (112-114). Distribution of ACT in close proximity to educational opportunity may have affected the response rate, which was high, between 74%-83%. The ACT manual was used for distribution and analysis (56).

In study II we saw a frequent use of incomplete PEWS documentation regarding recommended actions and a wide variation in adherence to guidelines. The result in this study is based on material from output data and the documentation that has been available in the EPR, and does not give any indication of measurements and assessments that may have been carried out without being documented, which sometimes might have been the case. How well the documentation of actions according to EDT-Ladder for Children has been carried out is even more difficult to assess. An observation study (115) may provide an answer to what is conducted and thereafter documented.

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Emergency situations, lack of time and staff resources can be a contributing factor to inadequate documentation. Deficiencies in the ordering and management of data may have occurred when comprehensive material collection and documentation has been done on different devices in the EPR. However, additional examination of the records, in the EPR and the scanned part of EPR, has reduced the risk of missing data in the randomized sample.

Study III showed that the introduction of EDT-C in conjunction with the establishment of a pediatric intensive care unit at the hospital, resulted in an increased intensive care admittance rate among pediatric in-patients. Thus the introduction of PEWS as part of the EDT-C could contribute to an increased ICU admittance rate not only by detecting more patients in need but also through the admission of patients that would otherwise not have been admitted. From the results we note that the patient flow changed before and after the introduction of EDT-C, with a larger proportion of patients being admitted straight from the pediatric emergency room in the latter period, while both planned admissions and referrals from other health facilities decreased, both in actual numbers and as proportions of the whole. A reason for this could be that the patient population presents itself with more severe conditions, which in turn might affect admission to intensive care.

The implementation of multi-facetted interventions in complex settings is influenced by a variety of factors, a complexity also described in implementation science (41). Factors that may have an effect are, for example, new treatment methods, organizational structural changes and new documentation strategies. Inter-professional education among healthcare professionals at PICU, and complex chronic conditions (116) also affects the outcomes for critically ill children (117). Although data from the Electronic Patient Journal system allowed for a large and comprehensive data set, studying the outcome of an intervention regarding mortality in a well-developed healthcare context with high quality of care is difficult. Despite the known difficulties in evaluating the impact of the implementation of EDT-C regarding intensive care, morbidity and mortality, the results obtained by the study are valuable both as a description of current conditions and for future research.

Conclusion

- When providing care for acutely, severely ill children proficiency is the fundamental base, interactions are crucial and awareness of contradictory emotions is necessary. The interplay between these factors may influence assessments and treatments.

- Implementation of evidence based care in complex settings requires an identification of enablers and barriers and there is a need for clear definitions of roles and responsibilities, both at local and organizational level.

- Estimated PEWS 5-9 occurred according to documentation, which may indicate that patients at a very high risk of deterioration were identified at the wards through the use of EDT-C.

- Inter-professional education including material from authentic patient cases promotes knowledge about skills and responsibilities of different professions and could strengthen teamwork.

- EDT-C with evidenced-based material adapted to the context is suitable for the clinical practice at hand and can give the healthcare professional a structured and objective tool with which to assess and treat patients, giving them a sense of control and assurance.

- The introduction of EDT-C including PEWS indicated an increased intensive care admittance rate among pediatric in-patients.

- Healthcare professionals expressed that using EDT-C had become routine in their daily work, showing that this innovation has good relevance and usability in real-world practice contexts in the wards at a pediatric hospital.

- EDT-C can lead to increased knowledge about early detection of deterioration, strengthen the healthcare in their profession, optimize treatment and teamwork and thereby has the potential to increase patient safety for children treated in hospitals.

Future research

To follow the development of the implementation process and refine the intervention further research is needed. Several variants of PEWS have been developed and continuous improvement work is necessary to refine the PEWS instrument. To enhance the understanding of the complex process of implementation, further studies are needed in which healthcare professionals' experiences of implementation are captured. A review of Electronic Patient Records for the patients transferred from the ward to PICU would give information regarding estimated PEWS, compliance to guideline and EDT Ladders for Children. A longitudinal study would provide knowledge of how adherence to guidelines developed over time.

Förord

Ett barnsjukhus är en dynamisk plats med många möten. Möten med patienter, anhöriga och en mängd människor med olika professioner som tillsammans interagerar på olika sätt. Under mina 23 år som barnsjuksköterska inom akutpediatrik har jag aldrig slutat att fascineras av alla dessa möten och hur mycket det påverkar mig och mitt agerande i min profession. Oftast möter jag en i grunden frisk patient som drabbats av en skada eller infektion som kan behandlas komplikationsfritt. Ibland möter jag en patient som väntat eller oväntat drabbats av ett akut livshotande tillstånd som kräver direkta insatser av ett inter-professionellt team. Jag har noterat att genom ett teamarbete med respekt och ödmjukhet för varandras kunskaper och roller kan vi bli styrkta, få ny kunskap och hantera den emotionella påverkan som uppstår i dessa situationer. Tvärtom kan vi också påverkas negativt av olika synsätt och mål med teamarbetet.

Genom alla patienter jag mött och bedömt skaffar man sig en erfarenhet som gör det lättare att identifiera svårt sjuka patienter. Men jag har också lärt mig att enbart erfarenhet räcker inte för en säker vård. Jag har tillsammans med kollegor som delat mitt intresse varit delaktig i utbildning av teamarbete vid akuta situationer och införandet av ett triagesystem för bedömning av vårdbehovet hos patienter som söker akut. Att utbilda stora personalgrupper och skapa förutsättningar för nya arbetsmetoder i en ständigt pågående akutverksamhet är inte alltid enkelt och kräver stora insatser från alla medarbetare. Om man ser bakåt så inser man att det är just dessa ibland slitsamma förändringsarbeten som gör att vården utvecklas och förbättras i ett långt perspektiv.

När jag startade min professionella bana inom barnsjukvården hade man beslutat att spädbarn skulle äta på bestämda tider och lära sig att sova själva. Ett beslut som de berörda varken hade varit delaktiga i eller hade någon som helst förståelse för där de låg i sina små baljliknande sängar och skrek av hunger och längtade efter lite närhet från någon som älskade dem. Ofta är det just patienter och anhöriga som gett mig insikten om att vården kan utföras på ett annat sätt och vi får aldrig glömma bort barnperspektivet när vi utformar nya rutiner och behandlingar.

Inom barnsjukvården görs det kontinuerligt nya framsteg, men vi ställs också hela tiden inför nya utmaningar. Vi behöver i större utsträckning tänka utifrån ett globalt perspektiv, avancerade tekniska innovationer införs, vi vårdar alltmer komplicerade sjukdomstillstånd, det sker omorganisationer och det är stor omsättning i personalgrupper. Detta tillsammans gör implementeringsprocesser än mer komplexa men innebär också att behovet av just strukturerade arbetssätt och evidensbaserad vård har ökat. Ett behov som väckte mitt intresse för en forskarutbildning och att studera detta på ett vetenskapligt sätt.

Svensk sammanfattning

Varje år vårdas ca 150 000 barn på sjukhus i Sverige. De vanligaste enskilda orsakerna till inläggning på vårdavdelning är sjukdomar i andningsorganen och skador. Barn i åldern 0-4 år är den största patientgruppen och svarar för mer än hälften av alla vårddagar på sjukhus. Barnsjukvården har blivit alltmer specialiserad där många patienter har svåra sjukdomstillstånd som kräver avancerad behandling och omvårdnad. Även om barnet vårdas på sjukhus kan hälsotillståndet snabbt försämras och för att undvika allvarliga skador och dödlig utgång krävs att tecken på ett försämrat hälsotillstånd snabbt upptäcks och åtgärdas.

Ett vårdteam består av människor med olika roller och kunskaper och inter-professionellt teamsamarbete har definierats som en aktivitet där sjukvårdspersonal från olika yrken lär sig tillsammans med varandra, från och om varandra. Ett väl fungerande teamarbete är en förutsättning för att kunna hantera komplexa vårdbehov och för ökad patientsäkerhet.

Implementering beskrivs som de ansträngningar som gjorts efter beslutet att införa en innovation, exempelvis ett nytt arbetssätt, och slutfasen uppstår när en individ gör en beteendeförändring och börjar använda sig av det nya arbetssättet. Implementeringen kan påverkas av flera faktorer såsom hur väl det nya arbetssättet passar den verksamhet man arbetar i, vilka hindrande och underlättande förutsättningar som kan identifieras i arbetsmiljön och individernas inställning till nya arbetsmetoder.

Med målet att öka säkerheten för inneliggande patienter implementerades ett program, Tidig Upptäckt och Behandling – Barn kallat TUB-B vid Akademiska barnsjukhuset under våren 2013. Programmet består av vetenskapligt beprövade arbetssätt för att kunna bedöma patientens vitala funktioner, arbeta tillsammans i team och kommunicera med varandra på ett tydligt och korrekt sätt. I programmet finns även ett bedömningsinstrument specifikt för barn, Pediatric Early Warning Score (PEWS) där man kontrollerar barnets andning, cirkulation och medvetande. Varje bedömning ger en till tre poäng där höga poäng signalerar att barnet är påverkat i sitt hälsotillstånd. Utifrån de poäng som uppmätts finns rekommenderade åtgärder att följa, såsom exempelvis att tillkalla läkare, ge syrgas eller mäta blodtryck. Vid införandet utarbetade varje avdelning specifika riktlinjer för hur TUB-B

skulle användas på just den enheten. Varje avdelning utbildade också TUB-B instruktörer som sedan ansvarade för att utbilda personalgruppen samt stödja och informera medarbetare om TUB-B programmet.

Syftet med denna avhandling var dels att beskriva sjukvårdspersonalens erfarenheter av att vårda akut svårt sjuka barn och dels att utvärdera implementeringen av programmet Tidig Upptäckt och Behandling – Barn, som implementerades på tre vårdavdelningar på Akademiska barnsjukhuset, Uppsala.

Före implementeringen intervjuades totalt 20 stycken läkare, sjuksköterskor och undersköterskor från olika avdelningar om sina erfarenheter av att vårda akut svårt sjuka barn. Intervjuerna skedde i fem fokusgrupper (studie I). För att undersöka följsamheten till avdelningsspecifika riktlinjer samt rekommenderade åtgärder granskades dokumentation i patientjournaler. Data om vårdpersonalens uppfattning om sin arbetsmiljö samlades in via frågeformuläret "Alberta Context Tool" (studie II). Hur antalet inläggningar och vårddagar på intensivvårdsavdelningar påverkats av implementeringen av TUB-B studerades genom information från patientdata både före och efter implementeringen (studie III). Genom enskilda intervjuer med vårdpersonal från olika professioner samt TUB-B instruktörer samlades synpunkter och erfarenheter av implementeringsprocessen in (studie IV). Data från patientjournaler och frågeformulär bearbetades med statistiska analyser och materialet från intervjuerna med kvalitativ innehållsanalys.

Att vårda akut svårt sjuka barn beskrevs av vårdpersonalen som att befinna sig i ett spänningsfält där motsägelsefulla känslor kunde uppstå. Som att både känna en lockelse till att medverka i akuta situationer och göra en värdefull arbetsinsats, samtidigt som man kände en rädsla för att inte kunna hantera situationen. Vidare framkom att man kunde känna sorg när ett barn gick bort men samtidigt en tillfredställelse om man visste att man gjort allt rätt och gett barnet och de anhöriga ett värdigt slut. Journalgranskningen visade att följsamheten till riktlinjer varierade och att majoriteten av de inlagda barnen var stabila i andning, cirkulation och medvetande enligt PEWS, men också att man uppmätt höga PEWS vilket kan visa på att man identifierat barn med mycket hög risk för akut försämring. Personalen på samtliga avdelningar skattade hög nöjdhet med sin arbetsmiljö även om vissa skillnader förekom gällande ledaskap och återkoppling. Antalet intensivvårdsinläggningar ökade i samband med öppnandet av en intensivvårdsavdelning sex månader innan införandet av TUB-B samt senare implementeringen av TUB-B. Vårdpersonalen och instruktörer beskrev att flera till en början varit skeptiska till programmet men även att TUB-B utbildningen gett en ökad förståelse för och förbättrat teamarbetet. Innehållet i TUB-B programmet upplevdes väl anpassat till den kliniska verksamheten och att TUB-B hade blivit en del i det

dagliga arbetet som gav bättre struktur och personalen en känsla av ökad säkerhet. Instruktörerna upplevde brist på tid och resurser som ett stort hinder för att utföra sitt uppdrag på ett optimalt sätt.

Vid implementering av nya arbetssätt är det viktigt att planera, samordna och avsätta resurser samt att utvärdera effekterna av det man implementerat. I modern barnsjukvård är det nödvändigt med strukturerade arbetsmetoder och objektiva bedömningar av patientens hälsotillstånd. TUB-B är uppbyggt av vetenskapligt beprövade arbetssätt och är väl anpassat till klinisk verksamhet. Genom interprofessionella utbildningar i TUB-B kan man öka kunskapen hos varje individ i teamet, stärka teamarbetet, optimera omhändertagandet och ge patienten vård på rätt vårdnivå. Patientsäkerhetsarbete måste ses som en kedja där varje medlem i teamet är en länk och gemensamt arbeta mot målet att kunna identifiera och vårda patienter som är på väg att försämras. Genom att arbeta enligt TUB-B kan man öka förutsättningarna för en patientsäker vård och stärka vårdpersonalen i sin yrkesroll.

För att öka förståelsen för komplicerade implementeringsprocesser behövs ytterligare studier där vårdpersonalens erfarenheter och synpunkter fångas och för att säkerställa korrekta bedömningar av patienters hälsostatus är fortsatt förfining av bedömningsmetoder nödvändigt.

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