



Barriers and Enablers to Implementing the Children's Hospital Early Warning Score: A Pre- and Post-Implementation Qualitative Descriptive Study

Christine E. Cassidy, RN PhD^{a,b,*}, Lauren MacEachern, MA^a, Shauna Best, RN^a, Laura Foley, RN BScN^a, Mary Elizabeth Rowe, RN BN^a, Katherine Dugas, RN BScN^a, Jessica L.A. Mills, MD FRCS^{a,c}

^a IWK Health Centre, Halifax, Nova Scotia, Canada

^b Dalhousie University School of Nursing, Halifax, Nova Scotia, Canada

^c Dalhousie University Faculty of Medicine, Halifax, Nova Scotia, Canada

ARTICLE INFO

Article history:

Received 16 October 2018

Revised 6 February 2019

Accepted 6 February 2019

Keywords:

Nursing practice

Early warning score

Implementation

Qualitative methods

Theoretical Domains Framework

ABSTRACT

Purpose: The purpose of this study was to identify and compare barriers and enablers to the implementation of the Children's Hospital Early Warning Score (CHEWS) on a pediatric inpatient unit pre- and post-implementation.

Design and methods: A qualitative descriptive design, guided by the Theoretical Domains Framework, was used to conduct semi-structured focus groups and individual interviews with nurses on a pediatric inpatient unit to identify barriers and enablers in the pre- and post- CHEWS implementation phases. Data were analyzed using a directed content analysis approach followed by inductive thematic analysis.

Results: Two pre-implementation focus groups ($N = 15$) and 8 post-implementation individual interviews with nurses were conducted. We identified pre- and post- CHEWS implementation barriers related to clinical decision making, interprofessional relationships, the unit context, and negative emotions, and enablers related to quality of care and patient safety. The identified barriers and enablers to implementation were categorized within 13 TDF domains.

Conclusions: Our findings illustrate a range of barriers and enablers to CHEWS implementation during the pre- and post-implementation phases. Tailored strategies are needed to overcome barriers related to nurses' perceptions of CHEWS impeding clinical decision-making and interprofessional collaboration. By addressing the identified barriers, we can leverage nurses' motivations for using CHEWS to improve the quality of patient care and enhance patient safety.

Practice implications: The barriers and enablers identified in this study can be used to select implementation strategies to support the use of early warning systems in pediatric nursing practice.

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Background

Early warning systems have seen widespread implementation in an effort to prevent cardiopulmonary arrests and other critical events among hospitalized patients (Downey, Tahir, Randell, Brown, & Jayne, 2017). Early warning systems are predictive tools that detect clinical deterioration in patients and prompt the necessary steps to intervene (Alam et al., 2014; Almlad, Siltberg, Engvall, & Målqvist, 2018; Jensen, Nielsen, Olesen, Kirkegaard, & Aagaard, 2018). Pediatric-

specific early warning systems have been developed, such as the Brighton Pediatric Early Warning System (PEWS), to consider the unique characteristics of the pediatric population (Monaghan, 2005). Support for the use of pediatric early warning systems in practice is gaining momentum and many benefits have been outlined in the literature (Lambert, Matthews, MacDonell, & Fitzsimons, 2017), including decreases in significant clinical deterioration events (i.e., late admission to pediatric intensive care unit; Parshuram et al., 2018), decreased morbidity (Bunkenborg, Samuelson, Poulsen, Ladelund, & Åkeson, 2014), enhanced patient safety (Alam et al., 2014; Downey et al., 2017), and improved interprofessional communication (Downey et al., 2017).

More recently, the Children's Hospital Early Warning System (CHEWS) was developed by a team at the Boston Children's Hospital in Boston, MA (McLellan & Connor, 2013). This scoring system was adapted from the original PEWS system and encompasses five domains (behaviour/neurological, cardiovascular, respiratory, family concern,

* Corresponding author at: IWK Health Centre, Halifax, Nova Scotia, Canada.

E-mail addresses: christine.cassidy@iwk.nshealth.ca (C.E. Cassidy), lauren.macheachern@iwk.nshealth.ca (L. MacEachern), shauna.best@iwk.nshealth.ca (S. Best), laura.foley@iwk.nshealth.ca (L. Foley), mary.rowe@iwk.nshealth.ca (M.E. Rowe), katherine.dugas@iwk.nshealth.ca (K. Dugas), jessica.mills@iwk.nshealth.ca (J.L.A. Mills).

and staff concern). To use CHEWS in practice, nurses conduct their assessment, total the score from each of the five domains, and are guided to follow a three-tiered escalation of care algorithm based on the patient's CHEWS score. Preliminary CHEWS validation studies have demonstrated higher discrimination, higher sensitivity, and longer early warning time than PEWS for identifying children at risk for critical deterioration (McLellan, Gauvreau, & Connor, 2017).

Despite support for pediatric early warning systems in the literature, challenges remain with its implementation into routine clinical practice (Almblad et al., 2018). Few studies have explored health care providers' experiences with using pediatric early warning systems (Fox & Elliott, 2015; Jensen et al., 2018; Lydon, Byrne, Offiah, Gleeson, & O'Connor, 2016). While these studies found that many health care providers have positive attitudes toward early warning systems, several factors impede their use in practice, including: a lack of interdisciplinary awareness; negative impact on nurses' clinical judgment (Jensen et al., 2018); and a lack of standardized documentation (Murray, Williams, Pignataro, & Volpe, 2015). Previous research has identified the need for pediatric early warning system implementation studies to understand the complexities of the implementation process as part of a wider safety culture (Almblad et al., 2018; Lambert et al., 2017). In response to this call, the goal of this study was to gain a more comprehensive understanding of the barriers and enablers to implementing CHEWS on a pediatric inpatient unit.

An assessment of barriers and enablers is a critical step in successfully implementing evidence to practice (Grol & Grimshaw, 2003). The Theoretical Domains Framework (TDF) is a synthesized framework of theoretical constructs used to understand key behavioural determinants to target when implementing evidence-based practice changes (Cane, O'Connor, & Michie, 2012). The framework is comprised of 14 domains and has been widely used in implementation studies across diverse health care settings to identify potential barriers and enablers to implementation (Atkins et al., 2017). The TDF can be used both pre- and post-implementation to identify behavioural determinants influencing practice change. A pre-implementation theory-based investigation of potential behavioural determinants allows for the development of implementation strategies that target the identified barriers and enablers (Atkins et al., 2017). Subsequently, a post-implementation theory-based investigation of barriers and enablers clarifies why and how the intervention works or does not work as intended and informs potential adaptations to implementation to promote continued use (Atkins et al., 2017). The purpose of this study was to use the TDF to identify and compare barriers and enablers to

the implementation of CHEWS on a pediatric inpatient unit pre- and post-implementation.

Methods

The present study is part of a larger program of research, guided by the Knowledge to Action (KTA) Framework (Graham et al., 2006), that aims to implement and evaluate CHEWS in a pediatric tertiary hospital. The KTA Framework is a synthesis of 31 planned action theories that outlines the dynamic and iterative process of applying knowledge to practice. It describes distinct activities to move evidence to action including: synthesizing existing knowledge; adapting knowledge to the local context; assessing barriers to use; and evaluating outcomes and sustainability of knowledge use (Graham et al., 2006). Following several components of the KTA Framework, the research program objectives are to: (1) Identify pre-implementation barriers and enablers to implementing CHEWS at a pediatric tertiary hospital, (2) Implement CHEWS into practice, (3) Identify barriers and enablers post-implementation, and (4) Measure the impact of CHEWS on patient outcomes and resource utilization. This paper will focus on the first three objectives across three phases (Fig. 1).

Design

We used a qualitative descriptive design, as described by Sandelowski (2000), with semi-structured focus groups and individual key informant interviews to identify barriers and enablers to CHEWS implementation during the pre- and post-implementation phases.

Setting

This study was conducted on an inpatient unit in a pediatric tertiary hospital on the East Coast of Canada. The 28-bed unit employs approximately 44 registered nurses who care for an average of 1950 patients and families a year across 12 services.

Participants and recruitment

Nurses were invited to participate in semi-structured focus groups and individual interviews. We used a purposive sampling technique to recruit interview participants with the assistance of the unit manager and clinical leaders, who invited staff to take part during working hours in meeting rooms on the unit.

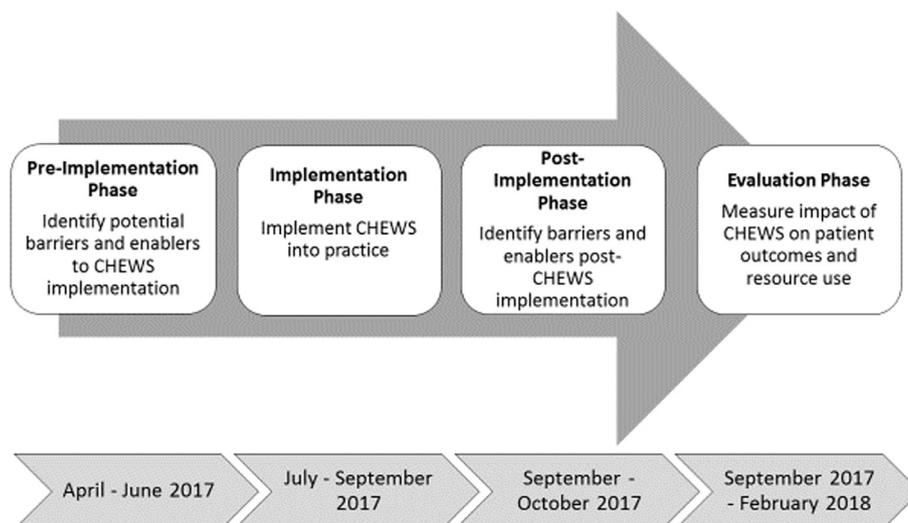


Fig. 1. Flow diagram of study phases, objectives, and timeline.

Materials

We developed a semi-structured interview guide for pre-implementation focus groups based on the 14 domains included in the TDF (Atkins et al., 2017). We developed two to three questions per TDF domain and prepared additional prompts to use as needed. For the post-implementation interviews, we modified the tense of existing questions and added additional probes based on analysis of results from the pre-implementation phase.

Pre-implementation phase

Prior to implementing CHEWS, semi-structured focus groups with nurses were conducted in-person by the implementation lead (CC) to identify potential barriers and enablers to implementation. Focus groups were audio-recorded and transcribed verbatim.

Implementation phase

Nursing education

In June 2017, the physician lead (JM) and Clinical Leader of Development (MER) led an hour-long CHEWS education session with nursing staff. The educational intervention included a Powerpoint presentation outlining the purpose, history and development of CHEWS. The nursing staff practiced using the CHEWS scoring tool with interactive case studies of previous de-identified patients from the unit. The implementation lead (CC) explained the rationale and goals of the implementation phase.

Physician outreach

We employed a series of physician outreach strategies, including face-to-face meetings with all attending physicians, presentations at a weekly multidisciplinary rounds, and education days for the rapid response team. Each presentation included a Powerpoint presentation tailored to each of the sub-specialities followed by an open question and answer session in which all of the physicians were encouraged to ask questions about how CHEWS might affect their patient populations. Further, a one-page information sheet outlining the CHEWS tool was distributed electronically to all attending and resident physicians.

Resources

The nursing education day Powerpoint presentation was also uploaded to the unit desktop computers for nursing staff to review during their shifts. We placed the CHEWS scoring assessment form and escalation of care algorithm at the nursing station in a clear sign holder and in each patient’s chart in a clear sleeve (Figs. 2 and 3). Further, the clinical leaders developed age-based vital sign reference guides and placed them with the CHEWS escalation of care algorithm. We developed paper-based documentation forms that allowed for multiple assessments on one sheet. Lastly, we placed coloured magnets that corresponded with patient’s CHEWS scores on the patient assignment whiteboard in the nursing station.

Roll-out

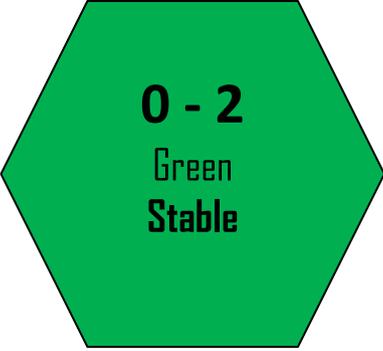
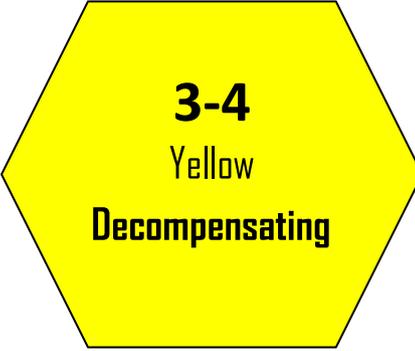
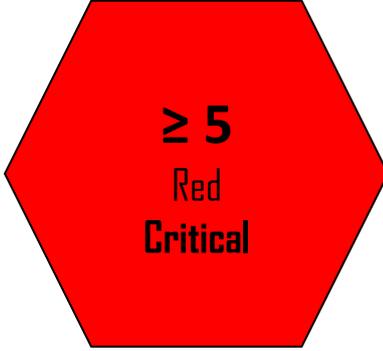
For one week at the end of June 2017, we began a ‘soft roll-out’ of CHEWS, whereby nurses started to practice using the scoring tool but did not follow the escalation of care algorithm. On July 4th, 2017, the full roll-out of CHEWS commenced our trial period; nurses began to

CHEWS Scoring Assessment

	0	1	2	3
Behaviour/Neuro	<ul style="list-style-type: none"> Playing/Sleeping Appropriately Alert, at patient’s baseline 	<ul style="list-style-type: none"> Sleepy, Somnolent when not disturbed 	<ul style="list-style-type: none"> Irritable, difficult to console Increase in patient’s baseline seizure activity 	<ul style="list-style-type: none"> Lethargic, confused, floppy Reduced response to pain Prolonged or frequent seizures Pupils asymmetric or sluggish
Cardiovascular	<ul style="list-style-type: none"> Skin tone appropriate for patient Capillary refill ≤ 2 seconds 	<ul style="list-style-type: none"> Pale Capillary refill 3-4 seconds Mild* Tachycardia Intermittent ectopy or irregular HR(not new) 	<ul style="list-style-type: none"> Grey Capillary refill 4-5 seconds Moderate* Tachycardia 	<ul style="list-style-type: none"> Grey and mottled Capillary refill >5 seconds Severe* Tachycardia New onset bradycardia New onset/increase in ectopy, irregular HR or heart block
Respiratory	<ul style="list-style-type: none"> Within normal parameters No retractions 	<ul style="list-style-type: none"> Mild* Tachypnea/increased WOB (flaring, retracting) Up to 40% supplemental oxygen Up to 1L NC > patient’s baseline need Mild* desaturations < patient’s baseline Intermittent apnea self-resolving 	<ul style="list-style-type: none"> Moderate* Tachypnea/ increased WOB (Flaring, retracting, grunting, use of accessory muscles) 40-60% oxygen via mask 1-2L NC > patient’s baseline need Neb q1-2hr Moderate* desaturations < patient’s baseline Apnea requiring repositioning or stimulation 	<ul style="list-style-type: none"> Severe* Tachypnea RR < Normal for age Severe increased WOB (i.e. head bobbing, paradoxical breathing) >60% oxygen via mask >2L NC > patient’s baseline need Neb q30 minutes-1hr Severe* desaturations < patient’s baseline Apnea requiring interventions other than repositioning or stimulation
Staff Concern		Concerned		
Family Concern		Concerned or Absent		
		MILD*	MODERATE*	SEVERE*
Respiratory Rate and Heart Rate	Infant	≥10%↑ for age	≥15%↑ for age	≥25%↑ for age
	Toddler and Older	≥10%↑ for age	≥25%↑ for age	≥50%↑ for age
Desaturation from patient’s baseline O2 saturation	All Ages	5 points	10 points	15 points

Fig. 2. CHEWS Scoring Assessment Tool (McLellan et al., 2017).

CHEWS Children's Hospital Early Warning Score

		
<ul style="list-style-type: none"> • Continue Routine Assessment 	<ul style="list-style-type: none"> • Increase frequency of vital signs* / CHEWS assessment (Minimum Hourly) • Notify Team Lead • Notify Resident • Resident or designate to assess at bedside • Discuss treatment plan with team • Place patient on cardiac monitor • Consider higher level of care • Document interventions <p style="text-align: center;">Consider activating SPOT</p>	<ul style="list-style-type: none"> • Activate SPOT • If score =3 on any domain Consider Code Blue • Notify Team Lead • Notify Attending Physician • Resident, NP or Attending to assess at bedside • Discuss treatment plan with team • Increase frequency of vital signs* / CHEWS assessment • Place patient on cardiac monitor • Consider higher level of care • Document interventions

SPOT / CODE BLUE CAN BE ACTIVATED AT ANYTIME
***RN responsible for immediate interpretation of Vital Signs**

Adapted from McLellan et al., 2017

Fig. 3. CHEWS Escalation of Care Algorithm (Adapted from McLellan et al., 2017).

score their patients with every vital signs assessment and followed the escalation of care algorithm as indicated. The full implementation trial took place over a six month period (July–December 2017). A clipboard for CHEWS-related questions was placed at the nursing station on the unit; the Clinical Leader of Development reviewed the questions daily and provided a written response to each question. Further, the Clinical Leaders acted as local nursing champions and were available for informal question and answer sessions during the day shifts. Lastly, the physician lead acted as the CHEWS physician champion, whereby any physician concern was directed to them to discuss and clarify how CHEWS was to be used.

Post-implementation phase

At the end of the first two months, semi-structured qualitative interviews with nurses were conducted in-person by either the implementation lead or research assistant (RA) together or the RA alone. Interviews were audio-recorded and transcribed verbatim.

Ethical considerations

As this was a quality improvement study, research ethics board approval was not required. At the onset of each focus group/interview, all participants were informed of the study purpose, the voluntary and confidential nature of their participation, and the contact information of the implementation lead should they have any follow-up questions. To mitigate any concerns of consent and anonymity, verbal consent was obtained from all participants, all transcripts were anonymized, and statements were amalgamated, categorized, and paraphrased into common belief statements.

Analysis

Data were analyzed using a directed content analysis approach (Hsieh & Shannon, 2005) followed by inductive thematic analysis (Atkins et al., 2017; Braun & Clarke, 2006). First, one reviewer (LM)

read the transcripts and categorized similar statements into the 14 TDF domains. This initial coding scheme was reviewed by a second reviewer (CC). Second, an inductive coding approach was used to generate subcategories of participants' specific beliefs within the initial coding scheme of the 14 TDF domains. A specific belief is a group of similar responses that suggest the belief may influence the target behaviour (Atkins et al., 2017). Third, the coded data were further inductively examined to generate themes that represent the barriers and enablers perceived to influence CHEWS implementation. Lastly, the research team reviewed the themes and used discussion to achieve consensus on the final themes.

Results

In the pre-implementation phase, we conducted two focus groups with a total of 15 nurses from the inpatient unit at the participating hospital (range 35–45 min) and eight nurses participated in the post-implementation individual interviews (range 15–25 min). The findings highlight pre- and post-implementation barriers and enablers that align with 13 of the 14 TDF domains. Table 1 outlines the pre- and post-implementation barriers and enablers, presented across six themes: i) *Compatibility with Nursing Practice*, ii) *Influence on Clinical Decision-Making*, iii) *Interprofessional Relations*, iv) *Unit Context*, v) *Quality of Care and Patient Safety*, and vi) *Influence of Emotions*. In the pre-implementation phase, the majority of belief statements presented by participants were classified as enablers, with statements identified across all themes excluding *Influence of Emotions*. In the post-implementation phase, there was an increase in the number of barriers and enablers, which were often a new thought or feeling that had not been previously described in the pre-implementation phase.

Compatibility with nursing practice

In the pre-implementation phase, nurses idealized the CHEWS tool as being easily amenable for routine use due to its relevance and similarity to standard practice. Nurses saw this tool as a continuation of

Table 1
Barriers and enablers to use of CHEWS pre- and post-implementation.

Themes	Sub-themes	Implementation phase		TDF domain (Cane et al., 2012)
		Pre	Post	
Theme 1: compatibility with nursing practice	Consistent with current practice	E		Behavioural regulation
	Greater reflexivity		E	Behavioural regulation
	No new skills needed		E	Skills
	Request for hands-on practice	E		Skills
	Uncertainties around patient baseline	B	B	Knowledge
Theme 2: influence on clinical decision-making	Useful as a double check or source of back-up		E	Beliefs about capabilities
	Enhanced confidence in nursing decisions	E		Beliefs about consequences
	Takes away nurses' judgment, accountability, and critical thinking		B	Social professional role & identity
	CHEWS is not prioritized		B	Memory, attention, and decision-making processes
Theme 3: interprofessional relations	Legal repercussions during trial period		B	Beliefs about consequences
	Physicians' response to CHEWS	B		Social influences
Theme 4: unit context	Impact on interprofessional communication		B/E	Social influences
	Brings physician to the bedside		E	Reinforcement
	Diverse patient population	B		Environmental context & resources
Theme 5: quality of care and patient safety	Ease of streamlined documentation	E	E	Environmental context & resources
	Potential to overuse hospital resources		B	Environmental context & resources
	Use of magnet prompts	E		Memory, attention, and decision-making processes
	Need for reiteration of CHEWS rationale		E	Intentions
Theme 6: influence of emotions	Enhanced patient care	E	E	Beliefs about consequences
	Has potential to be useful		E	Optimism
	Negative emotions associated with CHEWS		B	Emotion

Note. B = Barrier; E = Enabler.

their current practice, with the addition of a visual aid to identify levels of critical deterioration. To streamline the implementation process, nurses expressed a desire for hands-on practice scoring patients with the CHEWS tool and further knowledge of the CHEWS' definition of 'patient baseline'. Post-implementation, nurses continued to see the advantages of using CHEWS, as this tool helped to facilitate greater reflexivity in their practice and led the nurses to consider the subtleties of detecting early warning signs. Further, in the post-implementation phase, nurses confirmed that using the CHEWS tool in practice did not require them to learn any additional skills, which was also seen as an enabler to implementation. However, nurses continued to express concern regarding the definition of 'patient baseline'; they feared some patients would have falsely elevated scores due to differences between patient baseline and normal for age criteria (e.g., seizures and oxygen therapy).

Influence on clinical decision-making

Pre-implementation, nurses expected that CHEWS would increase their confidence in clinical decision-making by identifying patients at risk of critical deterioration as early as possible. Post-implementation, several participants recognized benefits of using the CHEWS tool as a useful double-check or source of back-up to justify a decision in care. However, many nursing participants felt that the CHEWS escalation of care algorithm impeded their clinical judgment and the opportunity for critical thinking. Nurses felt that they were not able to use their advanced critical thinking skills because they were forced to follow a "cookie-cutter" protocol (i.e., a rigid flowchart of actions), even if they believed the situation was under control. Further, concern regarding the legal repercussions of the CHEWS tool was also expressed as a post-implementation barrier since there was no policy that accompanied CHEWS during the trial period. Nurses were concerned about the legal and professional repercussions of not following the step-by-step action items outlined in CHEWS escalation of care algorithm during the trial period, even if they knew in their "gut" how to resolve a clinical issue. Due to these issues surrounding clinical decision-making, nurses voiced a lack of prioritization of CHEWS in their practice; when presented with a critical situation in patient care, nurses were not likely to prioritize using the CHEWS tool and would consider it an afterthought to their own clinical judgment and decision-making.

Interprofessional relations

Nurses interpreted the relationship between CHEWS and interprofessional collaborations as both positive and negative. In the pre-implementation phase, nurses felt that CHEWS could enhance interprofessional relationships between health care providers on the unit, including nurses, physicians, and the hospital-wide rapid response team. However, there was concern that conflicting opinions and perceptions among different health care providers could negatively impact the usefulness of CHEWS. Nurses expressed concern with physician buy-in and the impact this would have on the usability and sustainability of CHEWS in practice. If physician buy-in was lacking, or if physicians did not understand the scoring system, then its usefulness in practice would be greatly reduced. Post-implementation, the CHEWS tool was found to influence interprofessional communication as both a barrier and enabler. Concern regarding interactions with physicians persisted post-implementation. Initially, nursing participants perceived a general lack of support for CHEWS by other clinicians outside their unit. However, not all interprofessional experiences were identified as barriers; Nurses found that the CHEWS tool helped to bring physicians to the bedside in a more efficient and timely manner and also enhanced collaboration and familiarity with members of the rapid response team.

Unit context

The diverse patient population on the participating unit receive care under one of twelve different services, which was anticipated as a barrier during the pre-implementation phase. Further, the level of care required by patients on this unit is extremely varied, with some patients remaining primarily stable throughout their visit and others requiring more frequent monitoring and intervention. As such, during the pre-implementation phase, nurses were concerned with the repetitive nature of CHEWS and perceived it as unnecessary for a large proportion of their patient population. Nurses raised additional concerns regarding the overuse of hospital resources (i.e., more frequent rapid response team activations) as a barrier in the post-implementation phase. Several context-specific enablers were suggested in the pre-implementation phase, including streamlined documentation in accordance with existing procedures and the use of coloured magnets to act as a visual prompt of a patient's acuity. Streamlined documentation was recognized as being particularly useful in the post-implementation phase.

Influence of emotions

An emotional response to the use of CHEWS emerged in the post-implementation phase. Different negative emotions associated with the use of the CHEWS tool included frustration, anxiety, and feeling "not good enough". Some nurses felt the tool was demeaning, which represented a highly negative perception of the CHEWS tool and its implementation. Nurses described a tense and anxious feeling throughout the unit when CHEWS was brought up or discussed.

Quality of care and patient safety

Despite the negative emotions described above, nurses recognized the CHEWS tool as an enhancement to the delivery of quality care and patient safety. Both pre- and post-implementation, nurses acknowledged that CHEWS helps to enhance patient care by recognizing patients at risk of deterioration sooner. Nurses expected quality of care would continue to improve with increased use and familiarity with the tool. Recognizing the negative emotions associated with CHEWS on this unit, nurses in the post-implementation phase noted the importance of reiterating the rationale for CHEWS. Nurses thought that a reminder of the intentions behind CHEWS implementation may act as an enabler and lead to greater success in its sustained use in practice.

Discussion

In this exploratory study, we used the TDF to conduct a pre- and post-implementation assessment of barriers and enablers to using the CHEWS tool in practice on a pediatric inpatient unit. Our findings illustrate barriers and enablers at the individual health care provider, interprofessional, and organizational levels. Based on the nursing participants' positive reception during the pre-implementation assessment, we expected that the implementation of CHEWS would run smoothly with minimal challenges. However, several unanticipated barriers were identified in the post-implementation phase. The discrepancy in perceived barriers and enablers between the two phases highlights the importance of conducting theory-based explorations before and after implementation to examine the influence of behavioural determinants once the tool is used in daily practice. This multi-phased process evaluation is critical to identify what helps and hinders the success of intervention implementation and provides direction for tailoring implementation strategies to overcome the barriers and enhance the enablers.

One major discrepancy between the pre- and post-implementation findings was nurses' perceptions of the impact of CHEWS on their clinical decision-making. During the pre-implementation phase, nurses

were receptive to a standardized tool to enhance their decision-making and were supportive of implementing CHEWS into practice. Contrarily, during the post-implementation phase, nurses perceived the CHEWS tool to be too rigid, thus impeding their clinical judgment and critical thinking. The inflexibility of clinical practice guidelines is known to be a barrier to implementation (Woolf, Grol, Hutchinson, Eccles, & Grimshaw, 1999); Nurses describe the use of standardized tools as “cookbook” nursing, as they do not take into consideration unique patient characteristics and nurses’ clinical expertise (Melnyk, 2002). Previous research on the implementation of early warning systems has found similar results (Benner, Hughes, & Sutphen, 2008; Jensen et al., 2018; Lydon et al., 2016). Nurses report not following early warning system algorithms because they feel their clinical judgment is more appropriate than early warning systems (Jensen et al., 2018). Further, nurses fear that standardized clinical decision tools are too rigid and can contribute to the de-skilling of practitioners (Downey et al., 2017).

In contrast, other studies have found that early warning systems can lead to enhanced nursing confidence and authority in decision-making (Jensen et al., 2018; Maiocco, 2006). Studies have shown that early warning systems empower nurses to make independent decisions and take actions to intervene with their deteriorating patients based on a predetermined interdisciplinary plan (Tucker, Brewer, Baker, Demeritt, & Vossmeier, 2009). Such systems are viewed as a tool to supplement critical thinking rather than replace clinical judgment (Jensen et al., 2018). Interestingly, enhanced confidence in decision-making was identified as an enabler in the pre-implementation phase of our study but not during post-implementation. Instead, the challenges related to impeding nurses’ judgment and critical thinking minimized this potential benefit to using CHEWS.

Efforts are needed to address nurses’ concerns of clinical judgment before we can tap into the benefits of CHEWS on nursing confidence and feelings of empowerment. We recommend moving the discussion away from a dichotomous ‘one versus the other’ mentality, as it is clear that early warning systems cannot replace clinical judgment. Instead, our findings stress the need for clinical judgment and early warning systems to be complementary to one another, with early warning systems assisting but not replacing clinical judgment (Downey et al., 2017; O’Neill & Dluhy, 2000). This recommendation is supported by previous research, as studies report that combining early warning systems with clinical judgment results in a more effective response to deterioration than the use of a CHEWS score alone (Bonafide et al., 2013). Further work is needed to explore ways to ensure early warning systems remain complementary to clinical decision making; this is critical to facilitate the seamless integration of CHEWS into clinical practice.

Safe, high quality care relies on teamwork and collaboration across multiple health care providers (Rosen et al., 2018). However, research shows that negative attitudes or limited support from colleagues and/or superiors can negatively impact the implementation of new guidelines (Francke, Smit, de Veer, & Mistiaen, 2008). Our study findings highlight the impact of social influence on nurses’ clinical decision-making and use of CHEWS. In our pre-implementation findings, we identified nurses’ perceptions of how physicians would react to a patient’s CHEWS score as an important barrier to implementation. Previous research has identified similar nursing concerns regarding difficulty in having physicians follow an escalation of care algorithm and present to the bedside to see the patient (Cherry & Jones, 2015). Interestingly, this barrier was not identified during the post-implementation phase. Instead, some nurses were concerned that the physicians and the rapid response team would deem the CHEWS activation to be inappropriate, which would lead to potential conflict.

Previous research on early warning systems report similar concerns with interprofessional collaboration (Bunkenborg, Poulsen, Samuelson, Ladelund, & Åkeson, 2016; Fox & Elliott, 2015; Jensen et al., 2018; Lydon

et al., 2016). In a qualitative study exploring nurses’ experiences with PEWS, Jensen et al. (2018) identified a lack of interdisciplinary awareness of the information offered by the early warning system as a significant barrier to implementation. To address this barrier, targeted implementation efforts, such as additional physician engagement, are needed to ensure an appropriate interdisciplinary response to the CHEWS’ escalation of care algorithm (Downey et al., 2017). Additionally, we recommend that CHEWS implementation efforts prepare nurses to not only state the patient’s score but to also describe the rationale behind the CHEWS score when discussing with an interdisciplinary team member. We recognize that physicians and other allied health professionals play a critical role in the use of an early warning system on this unit. Further work is needed to understand their experience with CHEWS to provide a more complete understanding of the barriers and enablers to implementation.

While some tension between members of the interdisciplinary team was experienced, many nursing participants felt that CHEWS was a useful communication tool that enhanced their confidence when communicating with the interdisciplinary team, including physicians and rapid response team clinicians (physicians, RTs, and intensive care nurses). Other studies have also found that early warning systems improve interprofessional collaboration and help to avoid conflict, as they help to remove barriers to communication and facilitate dialogue among health care providers (Maiocco, 2006; Neary, Regan, Joyce, McAnena, & Callanan, 2015). More specifically, early warning systems are easy to use and interpret, which provides a common language across health care providers (Jensen et al., 2018). This is particularly useful for the participating pediatric unit, as nurses interact with physicians and other health professionals from 12 different services with their own unique approach to patient care. Building on these positive outcomes, implementation efforts are needed to enhance interprofessional engagement with CHEWS so that it can be used to its greatest potential as a communication tool.

Previous implementation research on early warning systems in the adult care setting has found that adherence to using an early warning system was strongly related to nurses’ perceptions of its clinical relevance and meaningfulness in practice (Bunkenborg et al., 2016). Moving forward, it will be important to leverage the enablers identified in this study to overcome the barriers to implementation. Study participants highlighted consistently that this tool will improve patient care and enhance patient safety. As such, to ensure the success of CHEWS implementation into pediatric care, it is critical to reiterate the rationale for the use of the CHEWS tool and leverage nurses’ motivations toward improving patient care.

Next steps

A growing body of evidence from the implementation science literature recommends a theory-based approach to designing implementation interventions aimed at changing clinician behaviour (Craig et al., 2013). The use of theory allows for a detailed understanding of behavioural influences in the context in which they occur (Atkins et al., 2017). As such, the formative work described in this paper provides a strong foundation for future implementation and evaluation studies. We used the TDF to identify key behavioural determinants that can help and/or hinder the successful implementation of CHEWS on a pediatric inpatient unit. To build on this work, we will continue to follow the KTA Framework to: 1. Adapt our implementation strategy to overcome the barriers and enhance the enablers, and 2. Conduct a pilot study to measure the impact of CHEWS on patient outcomes and resource utilization (Fig. 1). We will continue with our process evaluation alongside the pilot study to assess the fidelity of CHEWS implementation, describe causal mechanisms, and identify contextual factors associated with variation in outcomes (Craig et al., 2013). This process evaluation will also allow us to examine whether the barriers identified in this study continue to be concerns or if new challenges arise.

Study limitations

Study findings should be considered with the following limitations in mind. First, the findings reflect only the perspectives of nurses. Future research should explore barriers and enablers to CHEWS from the perspective of physicians, allied health professionals, and patients/families as each of these groups are important members of a high-functioning early warning system. Moreover, a barriers assessment with physicians and members of the rapid response team would clarify whether additional implementation strategies are needed to support the use of CHEWS in their practice. Second, this study was conducted on one unit at a single tertiary hospital and as a result, the findings may not be applicable to other settings. Further investigation should be conducted on other nursing units and tertiary care centres to explore the transferability of study findings. However, this study identified similar findings to a recent 2018 study on PEWS from Denmark (Jensen et al., 2018), indicating that many of the barriers and enablers to using early warning systems are similar across pediatric settings. Third, this study would have been strengthened by recruiting the same nurses in the pre- and post-implementation phases to explore how their perceptions of CHEWS changed over time. This was not feasible due to nursing availability and scheduling. Lastly, this study identifies initial barriers and enablers only two months post-implementation. This is recognized to be a short period of time to examine implementation barriers and enablers, as it often takes time for a new change to become embedded into practice. Additional process evaluation work is needed over a longer period to explore the factors influencing the adoption and sustainability of CHEWS in practice.

Conclusion

Our findings illustrate a range of barriers and enablers that have helped and hindered the implementation of CHEWS on a pediatric inpatient unit from the perspective of nursing staff. The pre- and post-implementation assessment of barriers and enablers allowed for a detailed examination of how nurses' perceptions of a practice change evolved once the tool was used in practice. An early warning system is meant to empower nurses and promote communication between health care providers; however, our findings highlight the disempowerment nurses felt with having to use this tool in practice. Although nurses see the value of CHEWS to improve patient care and patient safety, tailored strategies are needed to overcome this barrier, including the integration of CHEWS with nurses' decision-making and clinical intuition. Further, implementation efforts are needed to ensure all interdisciplinary team members are aware of CHEWS in order to leverage the potential for improved interprofessional communication and collaboration. Addressing these implementation challenges will enhance the integration of CHEWS into practice and as a result, may lead to improved patient and health system outcomes.

CRedit authorship contribution statement

Christine E. Cassidy: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft. **Lauren MacEachern:** Formal analysis, Investigation, Project administration, Writing - original draft. **Shauna Best:** Conceptualization, Resources, Validation, Supervision, Writing - review & editing. **Laura Foley:** Conceptualization, Resources, Validation, Project administration, Writing - review & editing. **Mary Elizabeth Rowe:** Conceptualization, Resources, Validation, Project administration, Writing - review & editing. **Katherine Dugas:** Resources, Validation, Writing - review & editing. **Jessica L.A. Mills:** Conceptualization, Validation, Supervision, Project administration, Writing - review & editing.

Acknowledgements

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

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