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Clinical paper

Implementation of a critical care outreach team in a children's hospital

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Abstract

Introduction: Proactive surveillance by a critical care outreach team (CCOT) can promote early recognition of deterioration in hospitalized patients but is uncommon in pediatric rapid response systems (RRSs). After our children's hospital introduced a CCOT in 2019, we aimed to characterize early implementation outcomes. We hypothesized that CCOT rounding would identify additional children at risk for deterioration.

Methods: The CCOT, staffed by a dedicated critical care nurse (RN), respiratory therapist, and attending, conducts daily in-person rounds with charge RNs on medical-surgical units, to screen RRS-identified high-risk patients for deterioration. In this prospective study, observers tracked rounds discussion content, participation, and identification of new high-risk patients. We compared 'identified-patient-discussions' (IPD) about RRS-identified patients, and 'new-patient-discussions' (NPD) about new patients with Fisher's exact test. For new patients, we performed thematic analysis of clinical data to identify deterioration related themes.

Results: During 348 unit-rounds over 20 days, we observed 383 discussions – 35 (9%) were NPD. Frequent topics were screening for clinical concerns (374/383, 98%), active clinical concerns (147/383, 39%), and watcher activation (66/383, 17%). Most discussions only included standard participants (353/383, 92%). Compared to IPD, NPD more often addressed active concerns (74.3% vs 34.8%, $p < 0.01$) and staffing resource concerns (5.7% vs 0.6%, $p < 0.04$), and more often incorporated extra participants (25.7% vs 6%, $p < 0.01$). In thematic analysis of 33 new patients, most (29/33, 88%) had features of deterioration.

Conclusion: A successfully implemented CCOT enhanced identification of clinical deterioration not captured by existing RRS resources. Future work will investigate its impact on operational safety and patient-centered outcomes.

Keywords: Critical Care Outreach, Rapid Response System, Clinical Deterioration, Pediatric, Proactive, Patient safety, High reliability organizations

Introduction

Unrecognized clinical deterioration poses a significant risk of preventable harm to hospitalized children.[1] To reduce this risk for patients hospitalized outside of the intensive care unit (ICU), North American children's hospitals commonly rely on rapid response systems (RRSs)—comprehensive hospital programs aimed at promoting identification, mitigation, and escalation of concerns for deterioration.[2,3] RRSs vary widely but are typically comprised of an afferent arm focused on prediction and detection of deterioration, and an efferent arm capable of deploying ICU resources to patients with identified risk for either subacute or acute deterioration.[1,2]

Importantly, in most RRSs, deployment of ICU resources relies entirely on successful detection of deterioration by ward teams.[2,3] Hospitals have developed a variety of strategies to facilitate this process, such as use of semi-automated risk prediction tools (e.g., pediatric early warning scores) and situation awareness processes (e.g., 'Watcher' huddles) that aim to promote early identification of critical illness;[3–10] However, these detection mechanisms are vulnerable to a number of failure modes, including cognitive biases such as anchoring bias or confirmation bias, that may hinder appropriate diagnostics processes and deterioration risk assessments. Indeed, in a recent study at our institution, we used a diagnostic improvement framework to analyze emergency transfers (ETs) to the PICU—escalation events in which patients require initiation of inotropes, intubation, and/or ≥60 cc/kg of intravenous fluid boluses within 1

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hour of transfer from a ward to an ICU.[11–13] We demonstrated that diagnostic errors were common among ETs and thus may contribute to both delayed recognition of deterioration and adverse patient outcomes associated with this delay.[1,13]

Given these potential failure modes, children's hospitals must identify resilient safety systems that can provide timely critical care interventions at the first signs of critical illness, while also ensuring judicious use of scarce ICU resources. Critical care outreach services offer one potential strategy for accomplishing this goal. Widely adopted in the United Kingdom and other countries, critical care outreach services typically involve ICU-led surveillance of ward patients, as well as ICU support for ward teams in their recognition and management of early signs of deterioration. This care model also enables some degree of continuity for patients transferring to the ward from an ICU. As such, it has been described as a holistic, supportive approach to the care of hospitalized patients both before and after transfer to an ICU. [14–16] However, critical care outreach services are relatively rare in children's hospitals,[2,3] and implementation of this care model has not previously been described in North America.

In 2019, our academic, free-standing children's hospital developed a Critical Care Outreach Team (CCOT) as part of an organizational safety strategy to prevent patient harm from unrecognized clinical deterioration outside of the ICU. The goal of this prospective, observational study was to characterize the CCOT's early implementation outcomes to inform iterative process improvement, with a secondary goal of providing contextual information for future patient-centered outcomes analysis. We hypothesized that daily rounding by the CCOT would identify additional children with risk factors for clinical deterioration not otherwise detected by our hospital's RRS.

Methods

Study design

We performed a prospective observational study of CCOT rounds to characterize CCOT implementation within routine operations at our hospital. This study was deemed exempt from review by our institutional review board.

Setting

We conducted this study at the Philadelphia campus of the Children's Hospital of Philadelphia, which has approximately 590 inpatient beds, inclusive of ~ 300 general medical/surgical ward beds and 75 PICU beds. The hospital also has a dedicated cardiology unit, cardiac ICU, and neonatal/infant ICU. These units are out of scope for the CCOT and were therefore excluded from this study.

Ward units are organized by clinical service and by a local team of nursing and physician leaders. On a given clinical shift, a charge nurse (RN) is primarily responsible for unit safety operations, such as leading unit safety huddles and reporting out situation awareness updates at enterprise briefings. Frontline care is provided by a mix of advanced practice providers (APPs), resident physicians, and pediatric hospitalists.

Our hospital has a multifaceted RRS to detect and respond to clinical deterioration outside of the ICU for patients admitted to general medical/surgical ward units **(**Fig. 1**)**. This includes an early warning system (EWS) for promoting early recognition of critical illness and a dedicated ICU team for early response. All team members, including trainees and ancillary staff, are involved in the RRS and play a vital role in patient safety operations.

Critical care outreach team Overview

In 2019, hospital leaders implemented the Critical Care Outreach Team (CCOT) to improve patient safety, capacity management, and family satisfaction. The CCOT provides a dedicated ICU resource to support existing RRS processes, provide care continuity for patients transferring from ICU to ward, expedite care escalation in times of high volume and/or acuity, and foster collaboration with ward clinicians.

CCOT structure and operations

The CCOT is comprised of ICU RN and ICU respiratory therapist (RT) roles that are staffed 24/7 as well as an ICU attending physician role that has dedicated staffing on weekdays, and cross-coverage by an on-call physician on nights and weekends.

The CCOT's primary clinical responsibilities include daily review of and rounding on 'high-risk' patients outside of the ICU **(**Fig. 2**)**. 'High-risk' patients are identified and incorporated into a CCOT rounding list through two mechanisms: (1) RRS triggers (e.g., when ward teams identify patients as 'watchers' and/or when bedside nurses document a high concern for deterioration as part of a novel 'clinician concern' process to separately capture subjective assessments of a patient's risk of deterioration.) **(**Fig. A1**)**; and/or (2) Critical care identification (e.g., patients transferring out of the ICU that meet certain triggers **(**Fig. A2**)**, critically ill patients awaiting a bed, or patients recently evaluated by the ICU rapid response team). RRS-triggered patients are tracked in the electronic health record and automatically populate a rounding list **(**Fig. 3**)**. Critical care identified patients are added manually by the CCOT.

After reviewing high-risk patient clinical data, CCOT conducts in-person rounds on all general medical-surgical wards in scope for the RRS. Rounds occur on these wards each day at 9am, 4 pm, and 2am and may also flex to other care areas that have patients awaiting an ICU bed in times of high capacity (e.g., Emergency Department and the Post-Anesthesia Recovery Unit). During weekdays, the CCOT attending physician, RT, and RN all join rounds in person. On weeknights and weekends, the CCOT physician role is covered by an on-call physician – a second in-house attending with primary clinical responsibilities in the ICU. During these hours, the CCOT RN and RT round in-person and the on-call physician is immediately available to discuss patients and/or join rounds if requested.

Standard CCOT rounds involve a huddle with the unit charge RN to (1) screen pre-identified high-risk patients for clinical deterioration concerns; and (2) coach on use of the RRS if there is subjective concern about a patient. If a patient is identified as a watcher, the bedside RN also participates in the huddle. Providers from the primary care team are not required to participate in CCOT rounds but are encouraged to do so. They are not notified of CCOT rounds; however, CCOT rounds occur in a consistent location on each unit at regularly scheduled times to provide a consistent cue for involvement. Additionally, the CCOT is encouraged to seek out providers to discuss any patients that may have been discussed with the unit charge RN if there were concerns.

Notably, the CCOT is not an ICU consult service and is not contacted by providers on the unit outside of CCOT rounds. It coaches on care escalation and supports critical care interventions for escalating patients (e.g., providing respiratory support on the ward for patients awaiting transfer to the ICU). The CCOT does not examine RRS-triggered patients, and ward teams are asked to activate the rapid response team (Fig. 1**)** if they have concerns about a patient

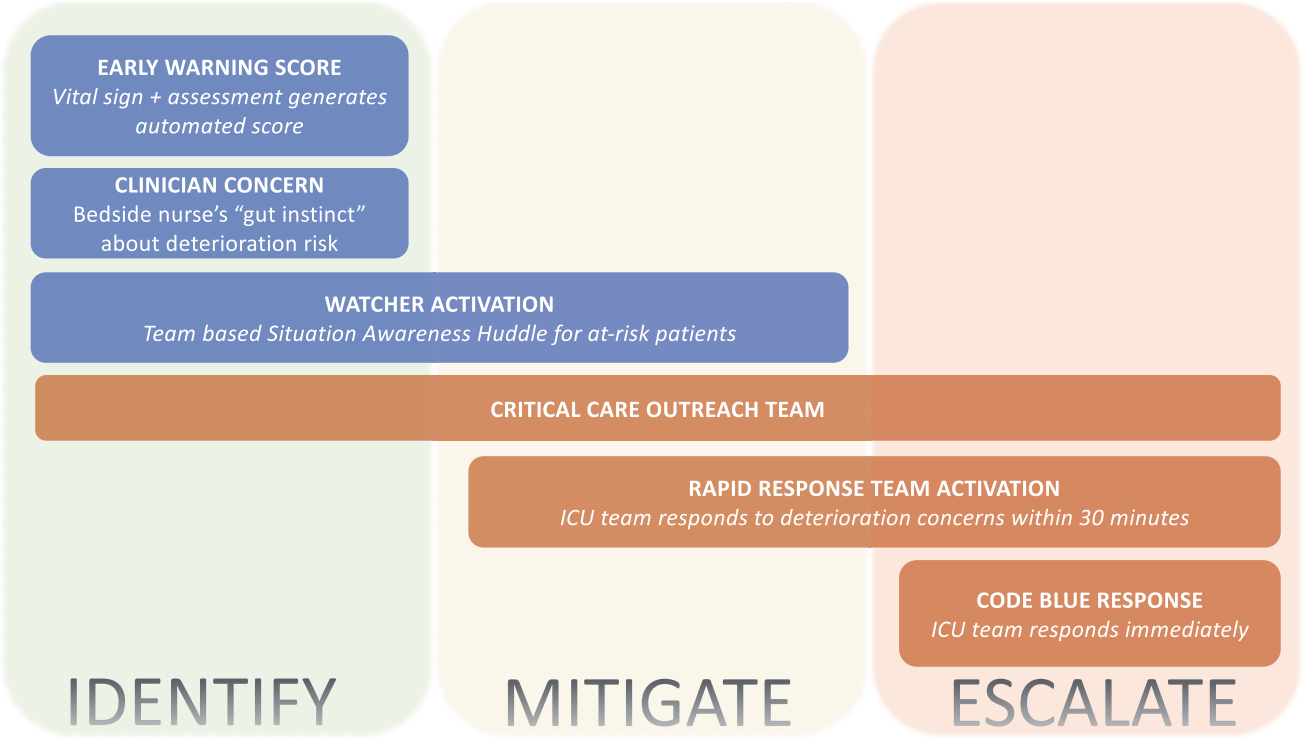

Fig. 1 – The Rapid Response System for Clinical Deterioration (COLOR). The rapid response system employs a multifaceted approach to identify, mitigate, and escalate children with risk of or evidence of clinical deterioration. Ward based systems (blue) support early identification of deterioration with mitigation strategies and escalation plans identified during watcher activations. ICU based systems (orange) are activated by ward providers and respond in designated timeframes. The critical care outreach team bridges these systems by proactively engaging with ward providers based on ward and ICU triggers.

warranting ICU evaluation. For critical care identified patients, the CCOT attending physician examines the patient and communicates with the ward team based on follow-up needs identified during transfer out of the ICU or in anticipation of transfer into the ICU.

When not rounding, the CCOT supports early escalation and situation awareness for high-risk patients outside of the ICU by supporting various enterprise safety processes for children at risk of deterioration **(**Table 1**)**. Through these additional 'flex' activities, the CCOT maintains shared awareness of potential system vulnerabilities and proactively addresses these gaps to bolster patient safety.

The CCOT is financially supported by the institution as part of its investment in patient safety operations. The CCOT attending physician also writes a note and bills for patients that are examined (all critical care identified patients).

Data collection

Two trained researchers (KTL, CC) observed CCOT morning rounds over 20 weekdays between August and December 2021. They used a standardized observational tool developed in REDCap to track participants and discussion content during rounds. Data was collected at the unit level (i.e., 1 observation tool was completed or each unit rounds). Rounding observations were conducted independently.

To evaluate rounding content, observers assessed for the following discussion topics: screening for clinical concern; active clinical concerns about patients; warning signs of deterioration; escalation strategies; watcher activation(s); staffing resource concerns; and tips/troubleshooting (e.g., how to ensure respiratory clearance was maximally effective). These categories were intentionally chosen to inform future improvement work. To evaluate rounding participants, observers assessed for clinician participation beyond the roles expected to participate in rounds (e.g., whether a front-line provider was incorporated into a conversation).

Observers also monitored for instances in which CCOT rounds prompted discussion of additional patients not previously identified as high-risk by RRS and ICU triggers. If additional patients were identified on a unit, observers recorded the discussion content, participant involvement, and patient identifiers (i.e., medical record number) specific to those patient discussions.

For analysis, we distinguished observational data related to discussions of pre-identified high-risk patients, referred to as *'Identified Patient Discussions'* (IPD), from observational data related to discussion of additional patients raised by the ward team, referred to as *'New Patient Discussions'* (NPD). Thus, the unit of analysis was a single unit rounding discussion and a single unit could have both an IPD and NPD during a single CCOT rounds.

For all patients identified during NPD, we performed a patient-level thematic analysis, as outlined below. We excluded any patients who (i) had a missing patient identifier, and/or (ii) were not on medical-surgical wards in scope for RRS processes (e.g., patient in the Emergency Department who was ultimately admitted to the PICU).

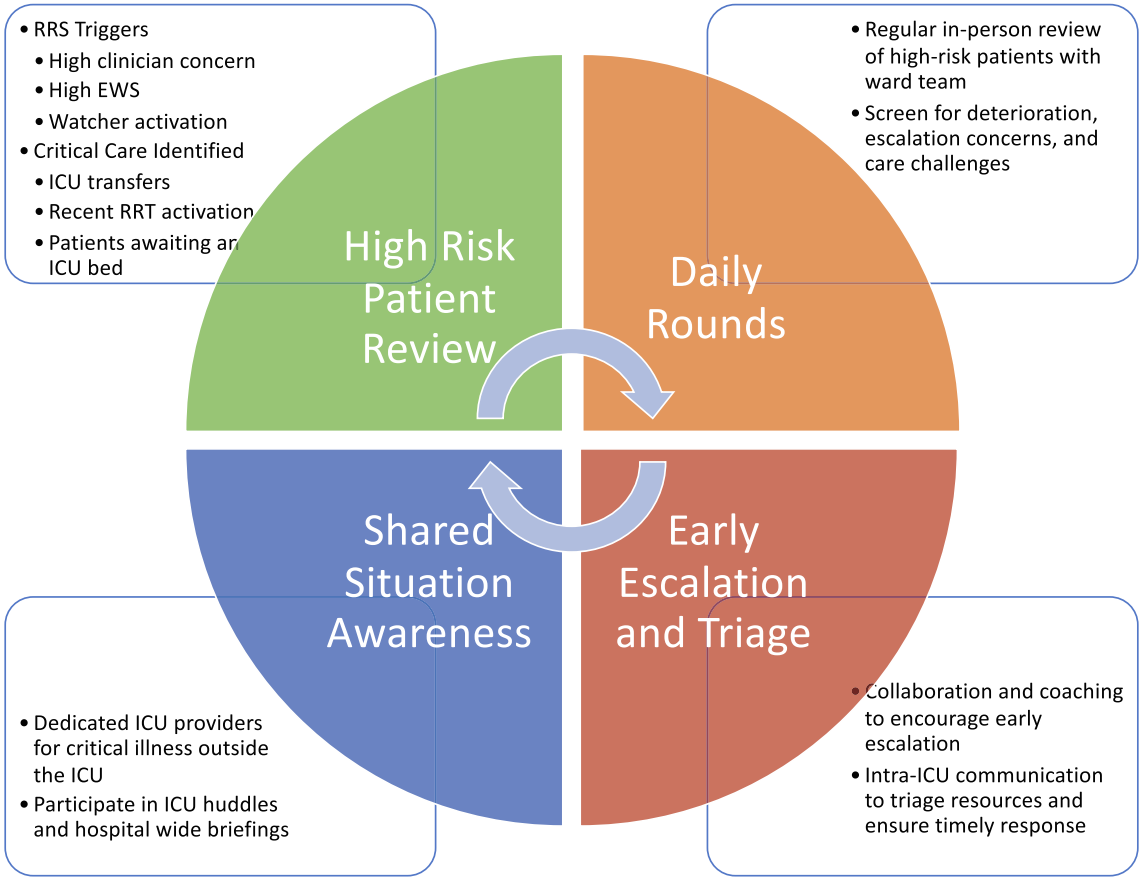

Fig. 2 – The Critical Care Outreach Team Model (COLOR). The critical care outreach team (CCOT) engages in proactive surveillance and collaboration with ward providers to augment our rapid response system (RRS) for identifying, mitigating, and escalating children with clinical deterioration. The CCOT engages in high-risk patient review, daily in-person rounding, and coaching on early escalation to support a shared situation awareness between the ICU and ward providers for children with critical illness outside the ICU. EWS = early warning score (in our hospital this is supported by an automated version of the bedside pediatric early warning score). RRT = Rapid Response Team (an ICU based team that responds to active deterioration concerns within 30 minutes of activation.).

Data analysis

Descriptive analysis

We used descriptive statistics to characterize CCOT rounds, and Fisher's exact test to compare the content and participation between IPD and NPD.

Thematic analysis

Using both observer field notes and chart review, two researchers (SM, MG) worked together to perform a thematic analysis of patients identified in NPDs to elicit key factors affecting patient care in the 24–48 hours surrounding the index rounding observation. We screened for documented clinical concerns by members of the primary clinical team, activation of any elements of the RRS, and preceding or subsequent transitions of care to or from the ICU. We also screened for any significant changes in vital signs and laboratory data. We then applied a grounded theory approach to identify key emergent themes related to clinical deterioration for each new patient discussed in NPD.[17–19] In this approach, coders worked together to assign codes to the qualitative data that reflected the key themes that emerged from a close reading of the qualitative data related to the patients clinical state at the time of CCOT rounds. They then used constant comparative coding to iteratively refine the codes and ensure they reflected the same concepts.

Results

Descriptive analysis

A total of 348 unit-rounds were observed during the study period, averaging 17.4 unit-rounds per day of observation. During these rounds we tracked 383 discussions. All unit-rounds included IPD about pre-identified high-risk patients (348/383 discussions, 91%) and 35 unit-rounds had an additional NPD about patients not previously identified by RRS or ICU trigger mechanisms (35/383 discussions, 9%).

In terms of rounding content, most rounds discussions involved screening for clinical concerns, as per standard CCOT rounding processes (374/383 discussions, 98%). The most frequent additional topics discussed were active clinical concerns about a patient (147/383 discussions, 39%) and new watcher activation (66/383 discussions, 17%). Most rounding discussions only included standard participants (charge RN and bedside RN for watcher patients)

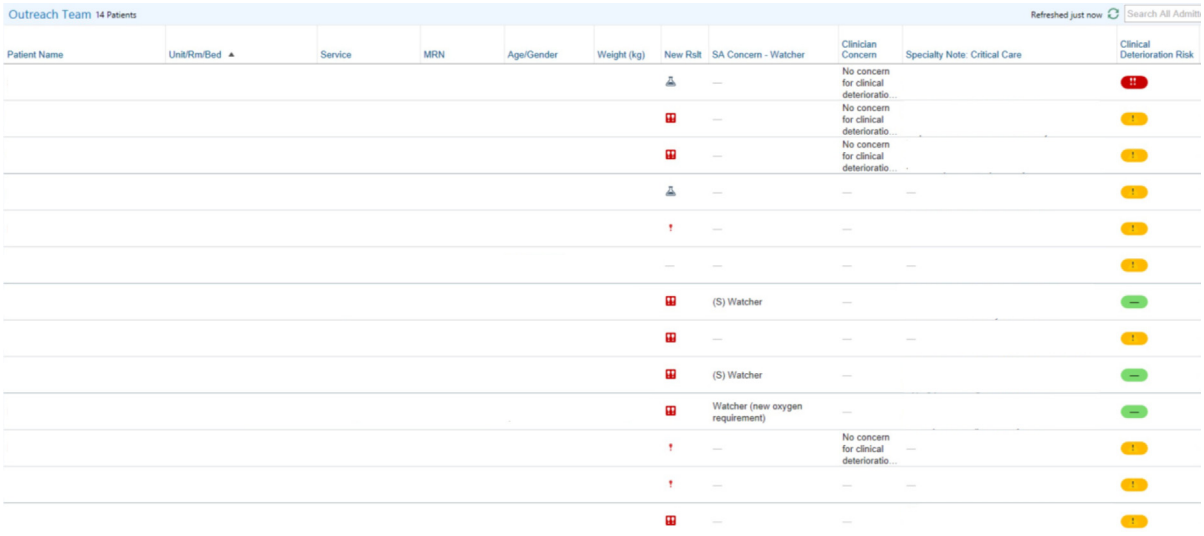

Fig. 3 – The Critical Care Outreach Team Live Rounding List (COLOR). A screenshot of the critical care outreach patient list with patient identifiers removed. Columns on the right indicate various rapid response system (RRS) processes that provide clinical context for a patient that may have been automatically added to the patient list. The *SA concern-Watcher* column provides details on watcher activation or resolution. The *clinician concern* column provides information on the most recent documented clinician concern for clinical deterioration by a bedside nurse. The *Clinical Deterioration Risk* column provides information on the most recent automated calculation of bedside pediatric early warning score. The *Specialty Note Critical Care* column allows for an ICU physician to write notes about the patient or designate pertinent follow-up items for patients transferring out of the ICU that they have requested critical care outreach team follow-up for. The patient list is instantiated in our electronic health record:

Table 1 – Critical Care Outreach Team Involvement in Enterprise Safety Processes. Along with daily review of and rounding on eligible patients, the critical care outreach team (CCOT) serves as a flexible and proactive resource to address needs and vulnerabilities in existing enterprise safety processes for supporting children at risk for deterioration.

Enterprise Safety Process	Overview of CCOT Role	Intended Benefits
Rapid response team (RRT) evaluations	a. Members of the CCOT are also core members of the RRT. b. The CCOT attending physician staffs RRT evaluations.	Intentional overlap of roles for CCOT and RRT supports continuity for ward providers accessing ICU resources and discussing high-risk patients.
Code blue activations	a. The CCOT supports crowd control and acts as liaison between in-room and outside of the room communication, particularly during infectious disease outbreaks (Fig. A3) b. The CCOT serves as a back-up code response team if needed for simultaneous code blue activations.	The CCOT provides a flex resource that supports existing ICU response systems and serves as an intentional layer of redundancy to ensure timely and reliable provision of critical care resources in emergent settings.
Transitional care for children awaiting ICU admission and transfer during periods of high volumes/acuity	a. The CCOT evaluates and provides care recommendations for ICU patients awaiting a bed (e.g., complex patients held in the emergency department while awaiting ICU admission) b. The CCOT provides critical care interventions care when needed (e.g., escalated respiratory supports outside of the ICU for patients awaiting ICU transfers)	The CCOT delivers ICU level care to children outside of the ICU during periods of high volumes/acuity to ensure they receive timely and safe critical care therapies.
Enterprise Safety Briefings and ICU Safety Huddles	a. Team members of the CCOT are active participants in daily situation awareness forums and are available for patient-specific conversations if necessary.	The CCOT can proactively identify and potentially mitigate evolving concerns outside of the ICU.

(353/383 discussions, 92%). Beyond standard participants, the most frequent additional participants were other ward clinicians (e.g., APPs or residents).

There was no difference in the types of units that had NPD (Table 2). Compared to IPD, NPD more often addressed active clinical concerns about a patient (74.3% vs 34.8%, $p < 0.01$) and staffing resource concerns (5.7% vs 0.6%, $p < 0.04$). These conversations were more likely to include additional participants beyond the charge RN (25.7% vs 6%, $p < 0.01$).

Thematic analysis

In 35 NPD, 33 unique patients were identified by ward teams and included for thematic analysis. 2 patients had incorrect or missing patient identifiers and their clinical data was not available for review. Among these patients, subsequent RRS involvement and care escalation was relatively common. For example, within 48 hours of being raised on CCOT rounds by the ward team, 9 patients (27%) were newly identified as watchers, 5 patients (15%) had an activation of the rapid response team, and 5 patients (15%) were transferred to the PICU. Patients transferred to the PICU required intubation (2 patients), vasoactive medications (1 patient), or ICU level monitoring (2 patients). Using principles of grounded theory, we found that 29 (88%) of the 33 unique patients had identifiable features of clinical deterioration or risk for clinical deterioration, corroborating the ward team's assessment and timely discussion during CCOT rounds (Table 3).

Discussion

To our knowledge, this is the first description and implementation assessment of a CCOT in a North American children's hospital. We evaluated the CCOT's rounds, given its central role for achieving outreach objectives of proactive surveillance and care continuity. While maintaining high fidelity to standard processes, the CCOT's rounds frequently adapted to include concerns about additional patients raised by ward providers. Interestingly, most of these patients had clinical risk factors for deterioration or went on to require additional RRS resources including ICU transfer – suggesting that the CCOT can augment identification of high-risk patients beyond those captured through other situation awareness systems (e.g., watcher program).

Despite widespread adoption of various RRS processes in pediatric institutions, critical care outreach is rarely included.[2,3] Low implementation may be attributed to few descriptions of successful pediatric programs in the literature and limited evidence for its benefit.[14,20–22] In this study, we describe the core features of a successfully implemented critical care outreach team within a fully resourced RRS. Core features of our CCOT include dedicated personnel for managing critical illness outside of the ICU, close integration with existing RRS processes to identify at-risk children, and in-person rounds to foster collaboration between ward and ICU teams.

Outreach is hypothesized to improve outcomes by early application of ICU resources to mitigate or escalate clinical deterioration

Table 2 – Critical Care Outreach Team Rounds Discussions. Data is presented as sample size with percent, n (%). All statistical comparisons between new patient and identified patient discussion use Fisher's exact test. New patient discussions are rounds discussions that involve patients not pre-identified as high-risk for CCOT evaluation. Identified patient discussions are rounds discussions about patients that were pre-identified by rapid response system triggers or critical care providers. Mixed medical unit refers to units that had a subspecialty and general pediatrics service. Mixed surgical units refer to units with patients from multiple surgical services. Watcher activation refers to a use of a rapid response system component consisting of team-based situation awareness huddles for patients on the ward at high risk of deterioration. Additional clinicians include attending physicians and front-line clinician roles filled by resident physicians, hospitalist physicians, and advanced practice providers.

	All Discussions	New Patient Discussions	Identified Patient Discussions	p
Sample (N)	383	35 (9.1)	348 (90.9)	
Unit Type				0.21
General Pediatrics	112 (29.2)	9 (25.7)	103 (29.6)	
Mixed Medical Unit	139 (36.3)	13 (37)	122 (35.1)	
Mixed Surgical Unit	43 (11.2)	4 (11.4)	39 (11.2)	
Oncology	48 (12.5)	9 (25.7)	39 (11.2)	
Other	47 (12.3)	2 (5.7)	45 (12.9)	
Discussion Topics				
Screening for clinical concerns	374 (97.7)	27 (77.1)	347 (99.7)	<0.01
Active clinical concerns	147 (38.4)	26 (74.3)	121 (34.8)	<0.01
Warning signs of deterioration	26 (6.8)	5 (14.3)	21 (6.0)	0.08
Escalation Strategies	35 (9.1)	6 (17.1)	29 (8.3)	0.12
Watcher activation(s)	66 (17.2)	3 (8.6)	63 (18.1)	0.24
Staffing resource concerns	4 (1.0)	2 (5.7)	2 (0.6)	0.04
Other	4 (1.0)	0 (0)	4 (1.1)	1
Additional Participant Involvement	30 (7.8)	9 (25.7)	21 (6.0)	<0.01
Other Nursing Staff	7 (1.8)	5 (14.3)	2 (0.6)	
Clinician	19 (5.0)	3 (8.6)	16 (4.6)	
Other	4 (1.0)	1 (2.9)	3 (0.9)	

Table 3 – Thematic Analysis of Deterioration Concerns for New Patients. We applied a grounded theory approach after screening observer field notes and the medical record for features related to clinical deterioration of new patients identified during critical care outreach team rounds. We present the key themes that emerged in our review of these cases. We provide the count of patients with relevant themes and examples cases that were emblematic of that theme. PICU = pediatric intensive care unit.

Thematic Element	Count	Example Case
New at-risk Patient	13	*Medically complex patient with recent orthopedic surgery and new drop in hemoglobin.*
Follow-up at-risk patient	8	*Infant recently transferred from the PICU for life-threatening electrolyte derangements who has mild tachycardia a few days after transfer back to the ward.*
early deterioration	7	*Patient with appendicitis and early signs of sepsis following surgery.*
patient flow	4	*Ward team discussed the need for PICU care pre and/or post-operatively for a patient with severe obstructive sleep apnea awaiting tonsillectomy and adenoidectomy.*
active deterioration	1	*Medically complex patient with COVID pneumonia admitted to the ward and weaning respiratory support with increasing work of breathing and new bloody secretions.*

before more serious adverse events occur. Indeed, observational and quasi-randomized studies in adults provide modest evidence that outreach systems can reduce arrest calls and potentially reduce mortality.[14,15,20,23,24] Our observational data highlight similar mechanisms by which CCOT can affect outcomes in pediatric patients. Most strikingly, 15% of new patients discussed during CCOT rounds went on to require ICU transfer within 48 hours. In-person rounds with dedicated ICU personnel created an accessible venue for ward clinicians to identify and discuss patients with new clinical changes or risk factors that did not yet meet thresholds for other components of our RRS. By facilitating early ICU involvement, the CCOT offers two benefits: bringing ICU skillset to children with recognized risk of deterioration and reinforcing existing safety systems for identifying at-risk children.

Beyond these benefits, qualitative feedback from 'end users' at our organization suggests that the CCOT may have a broader, positive impact on cross-disciplinary teamwork and safety culture. Indeed, within code reviews and other forums, the CCOT's care model is often highlighted for its ability to foster teamwork across ICU and ward clinicians, and to mitigate 'siloed' thinking that could exist across units (ICU, ward). It has also been cited as a means of promoting psychological safety among ward providers, who feel more empowered to activate the rapid response team due to the CCOT encouraging them to do so early and often. These system wide improvements in safety culture and opportunities for early mitigation provide a rational for our institution's significant financial investment in these safety operations.

Future research must evaluate whether these resource intensive systems improve healthcare delivery and patient outcomes without unnecessarily burdening resource constrained systems. The rarity of terminal events such as out-of-ICU cardiac arrest make them poor metrics for success in pediatrics.[11,25,26] While employing proximal metrics such as emergency transfers is one solution, shifting to process oriented assessment may be more appropriate given the CCOT's role in hospital safety operations. Critical care outreach should support high-reliability principles within the healthcare system – adding an intentional layer of redundancy that fosters resilience to changing contexts, sensitivity to operations and a deference to expertise.[27] From this perspective, the CCOT could be assessed by how effectively it brings critical care expertise to deteriorating patients and improves resiliency during times of high census or acuity – when more critically ill patients may need care outside of an ICU. Importantly, improved performance must be rooted in continued education that builds ward capacity to care for at-risk children outside of the ICU – avoiding the dreaded concern that increasing safety systems ultimately deskill the care teams they aim to help. Ultimately, a comprehensive assessment of critical care outreach will need to capture incremental improvements in patient safety that may be missed by traditional outcome measures.

Our study had several limitations. The single-center design, while allowing for detailed description of the context and development of a CCOT, limits generalizability to other settings. This is not unique to this study as critical care outreach assessments have been hampered by highly variable implementation across hospitals. Standardized design elements and outcome metrics are critical for future multicenter study. Additionally, providers were aware of observations and, in response, may have changed behavior – demonstrating more adherence to the CCOT protocol than occurs in routine practice. We used standardized observation tools and did not share the focus of our observations to mitigate this effect. Similarly, due to resource constraints, observations were limited to morning rounds and to content during rounds only. There is increasing evidence that differences in staffing and care between day and night may affect performance of these systems and future assessments will need to determine whether the CCOT can improve care across these contexts.[28–30] Additionally, the timeframe and limited scope of observations prevented us from better characterizing what patient factors triggered ward providers to identify them during CCOT rounds. Finally, we did not assess outcomes of practice changes related to the CCOT implementation because of dramatic changes in census and case mix index over the post-intervention period. Future work will address these challenges using process-oriented measures, more prevalent proximal outcomes, and longer post-intervention trends to meaningfully evaluate system level changes.

Conclusion

We successfully implemented a critical care outreach team within a free-standing children's hospital. The critical care outreach team

augmented existing rapid response system resources by providing additional layers of redundancy for identifying children at risk for deterioration and building continuity between the ward and ICU. Future work should investigate whether the CCOT improves operational safety processes and patient-centered outcomes.

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used OpenAI ChatGPT 4 to improve clarity and conciseness of the text. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

CRediT authorship contribution statement

Sanjiv Mehta: Writing – original draft, Visualization, Methodology, Data curation, Conceptualization, Writing – review & editing, Formal analysis, Investigation. **Meghan M. Galligan:** Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Kim Tran Lopez:** Investigation, Writing – review & editing. **Chip Chambers:** Investigation, Writing – review & editing. **Daniel Kabat:** Investigation, Software, Data curation, Writing – review & editing. **Kelly Papili:** Methodology, Investigation, Writing – review & editing, Project administration. **Hannah Stinson:** Conceptualization, Writing – review & editing, Visualization, Supervision. **Robert M. Sutton:** Conceptualization, Methodology, Formal analysis, Writing – review & editing, Visualization, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.resplu.2024.100626.

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