BRIEF REPORT

How do we detect and respond to clinical deterioration in hospitalized children? Results of the Pediatric Care BefOre Deterioration Events (CODE) survey

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Abstract

Systems to detect and respond to deteriorating hospitalized children are common despite little evidence supporting best practices. Our objective was to describe systems to detect/respond to deteriorating hospitalized children at Pediatric Resuscitation Quality Collaborative (pediRES-Q) institutions. We performed a cross-sectional survey of pediRES-Q leaders. Questionnaire design utilized expert validation and cognitive interviews. Thirty centers (88%) responded. Most (93%) used ≥1 system to detect deterioration: most commonly, early warning scores (83%), watcher lists (55%), and proactive surveillance teams (31%). Most (90%) had a team to respond to deteriorating patients and the majority of teams could be activated by clinician or family concerns. Most institutions (90%) collect relevant data, including number of rapid responses (88%), arrests outside intensive care units (100%), and serious safety events (88%). In conclusion, most pediRES-Q institutions utilize systems to detect/respond to deteriorating hospitalized children. Heterogeneity exists among programs. Rigorous evaluation is needed to identify best practices.

INTRODUCTION

Systems to detect and respond to deterioration in hospitalized children outside the intensive care unit (ICU) are common.[1] Rapid response teams (RRTs) and early warning scores (EWS) have been credited with decreasing cardiac arrests occurring outside ICUs.[2] However, evidence supporting best practices is limited.[3,4]

This study aimed to build on previous work by surveying North American pediatric resuscitation leaders regarding the use of systems to detect and respond to clinical deterioration.[1] It provides an update on the state of pediatric rapid response systems and highlights system components among hospitals engaged in resuscitation quality improvement (QI). We hypothesized there would be high variability in system components and data collection among institutions, demonstrating the need for standardized recommendations to improve outcomes for deteriorating children.

METHODS

Study design and setting

This cross-sectional survey assessed the use of systems to detect and respond to deterioration in children hospitalized outside the ICU. We utilized purposive sampling to recruit resuscitation leaders from North American sites in the Pediatric Resuscitation Quality Collaborative (pediRES-Q; ClinicalTrials.gov: NCT02708134), a resuscitation QI network.[5] This sampling strategy was selected to ensure respondent familiarity with institutional practices and to optimize the response rate by recruiting individuals engaged in voluntary resuscitation QI. The study was determined to be nonhuman subjects' research by the Cincinnati Children's Hospital Institutional Review Board (2020-0464).

Survey design

The questionnaire design, adapted from Lockwood and colleagues, is based on a published survey development process.[1,6] Our survey items aimed to address the following construct, informed by literature review: variability in the use, components of, and evaluation of systems to detect and respond to deteriorating children hospitalized outside the ICU. We conducted interviews with 10 subject matter experts to ensure construct validity. We performed cognitive interviews and pilot testing with eight clinicians who assess deteriorating children. The final 43-item instrument is included (Supporting Information: Appendix). Descriptions of systems included in the questionnaire are listed (Supporting Information: Table 1).

Data collection and analysis

Invitations to participate were emailed to pediRES-Q investigators. The survey was administered via Research Electronic Data Capture hosted at Cincinnati Children's Hospital, which is a secure, web-based software platform designed to support data capture for research studies that have been described previously.[7] No incentives were provided. Responses were collected between September 1, 2021 and March 1, 2022. Responses were summarized using descriptive statistics with counts and proportions. Characteristics of responding and nonresponding institutions were compared using Fisher's exact test.

RESULTS

Sample characteristics

The survey was completed by 30/34 centers (response rate 88%). Respondents included 29 physicians and 2 nurses; at one center, a physician and nurse completed the survey together. All participants held leadership positions within their institution's resuscitation system. Among the institutions, 70% (21/30) were freestanding children's hospitals, 63% (19/30) had >250 pediatric beds, and 97% (29/30) had academic affiliations. These hospital characteristics were not associated with survey response status when comparing responding and nonresponding institutions.

Detection systems

Most (93%; 27/29) institutions used ≥1 process to detect deteriorating hospitalized children (Table 1). The most common was pediatric EWS (83%; 24/29) followed by watcher lists (55%; 16/29) and proactive surveillance teams (31%; 9/29). While vital signs were included in the majority of EWS and watcher lists, there was variability in other parameters. Most EWS calculations included exam findings. Most watcher list criteria included active problems, clinician concern, high-risk therapies, and EWS. Of note, 94% of watcher list systems (15/16) included clinician concerns, compared with only 38% (9/24) of EWS.

Response systems

Of 30 sites, 90% (27) reported having a team (separate from "Code Blue" teams) that responds to deteriorating patients; of those, 96% (26/27) had an RRT and 33% (9/27) had a proactive surveillance team. Proactive surveillance teams were asked about in the questionnaire's detection and response sections due to the overlap in function of these teams.

After detecting deterioration, 20/27 centers (74%) had mandatory or recommended responses with recommended responses more common (recommended: 17/27; mandatory: 13/27; both: 10/27). Elevated EWS was the most common trigger for both mandatory and recommended responses. Of sites with mandatory responses, 85% (11/13) required RRT evaluation, 62% (8/13) required care team

TABLE 1 Systems to detect deteriorating pediatric patients outside the ICU.

Systems in use[a]	N (%)
Use of any system/process	27/29 (93)
EWS	24/29 (83)
List of patients at risk for deterioration (watchers)	16/29 (55)
Other prognostic or clinical prediction tool	5/29 (17)
Dedicated clinician or team whose role is proactive surveillance	9/29 (31)
Condition-specific triggers	17/29 (59)
Sepsis score	15/29 (52)
Asthma score	4/29 (14)
Bronchiolitis score	2/29 (7)
Nonspecific respiratory score	3/29 (10)
Other	1/29 (3)
Parameters included in deterioration systems	
EWS	
Vital signs	23/24 (96)
Physical exam findings	20/24 (83)
Medications	3/24 (13)
Test results	3/24 (13)
Active diagnoses or problems	6/24 (25)
Clinician concern	9/24 (38)
Family concern	9/24 (38)
High-risk therapies	6/24 (25)
Other	2/24 (8)
Watcher list	
Vital signs	9/16 (56)
Physical exam findings	7/16 (44)
Medications	3/16 (19)
Test results	2/16 (13)
Active diagnoses or problems	8/16 (530)
Clinician concern	15/16 (94)
Family concern	6/16 (38)
High-risk therapies	9/16 (56)
EWS or automated score	10/16 (63)
Other	1/16 (6)
Relevant data collection	
Any data collection	26/30 (87)
Process metrics	
Frequency that a prediction/detection tool is activated	13/26 (50)

TABLE 1 (Continued)

Systems in use[a]	N (%)
Accuracy of prediction/detection tool	10/26 (39)
Number of RRT activations	23/26 (88)
Provider satisfaction with the system	12/26 (46)
Family satisfaction with the system	3/26 (12)
Patient outcomes	
Codes (cardiac arrest or respiratory arrest) outside the ICU	26/26 (100)
Serious safety events	23/26 (89)
Need for urgent/emergent transfer to the ICU	17/26 (65)
Previously published metrics	
UNSAFE transfers (Brady)	9/26 (35)
Critical deterioration events (Bonafide)	6/26 (23)
Codes outside ICU	16/26 (62)

Abbreviations: EWS, early warning score; ICU, intensive care unit; RRT, rapid response team; UNSAFE, unrecognized situation awareness failures event.
[a]One missing.

huddles, and 54% (7/13) required increased vital signs or assessment frequency. Of sites with recommended responses, 77% (13/17) recommended RRT evaluation, 65% (11/17) recommended care team huddles, and 47% (8/17) recommended increased vital signs or assessment frequency.

Team composition and activation

RRT and proactive surveillance team composition are shown in Figure 1a. The most common members of RRTs were respiratory therapists (RTs) (92%; 24/26), ICU nurses (88%; 23/26), and ICU providers (69%; 18/26). By comparison, the most common members of proactive surveillance teams were ICU nurses (67%; 6/9), RTs (44%; 4/9), and non-ICU providers (22%; 2/9). Clinician concern was the activation trigger, most commonly included in both RRTs (92%, 24/26) and proactive surveillance teams (78%, 7/9). Family/caregiver concerns could also activate both team types in most institutions (Figure 1b).

Data collection

Of institutions with deterioration systems, 90% (26/29) collected related metrics (Table 1). The most common process metric was the number of RRT activations (88%; 23/26). The most commonly measured outcomes were arrests occurring outside the ICU (100%; 26/26) and serious safety events (88%; 23/26).

(a)

Team Member	Rapid Response Team*	Proactive Surveillance Team
Respiratory therapist	24/26 (92)	4/9 (44)
ICU Provider	18/26 (69)	1/9 (11)
ICU Attending	8/26 (31)	1/9 (11)
ICU Fellow	14/26 (54)	0/9 (0)
ICU Resident	4/26 (15)	0/9 (0)
Other physician	1/26 (4)	0/9 (0)
Other physician	0/26 (0)	0/9 (0)
ICU APP/NP	7/26 (27)	0/9 (0)
ICU PA	0/26 (0)	0/9 (0)
Non-ICU Provider	9/26 (35)	2/9 (22)
Attending	2/26 (8)	2/9 (22)
Fellow	0/26 (0)	1/9 (11)
Resident	7/26 (27)	0/9 (0)
Other physician	3/26 (12)	0/9 (0)
APP/NP	1/26 (4)	1/9 (11)
PA	0//26 (0)	0/9 (0)
Nurses		
ICU Nurse	23/26 (89)	6/9 (67)
Non-ICU nurse	5/26 (19)	1/9 (11)
Charge nurse	8/26 (31)	1/9 (11)
Pharmacist	3/26 (12)	0/9 (0)
Hospital-wide leader	3/26 (12)	1/9 (11)
Other	2/26 (8)	2/9 (22)

ICU = intensive care unit; APP = advanced practice provider; NP = nurse practitioner; PA =
Physician Assistant
*Rapid response team composition missing for 1 site.

(b)
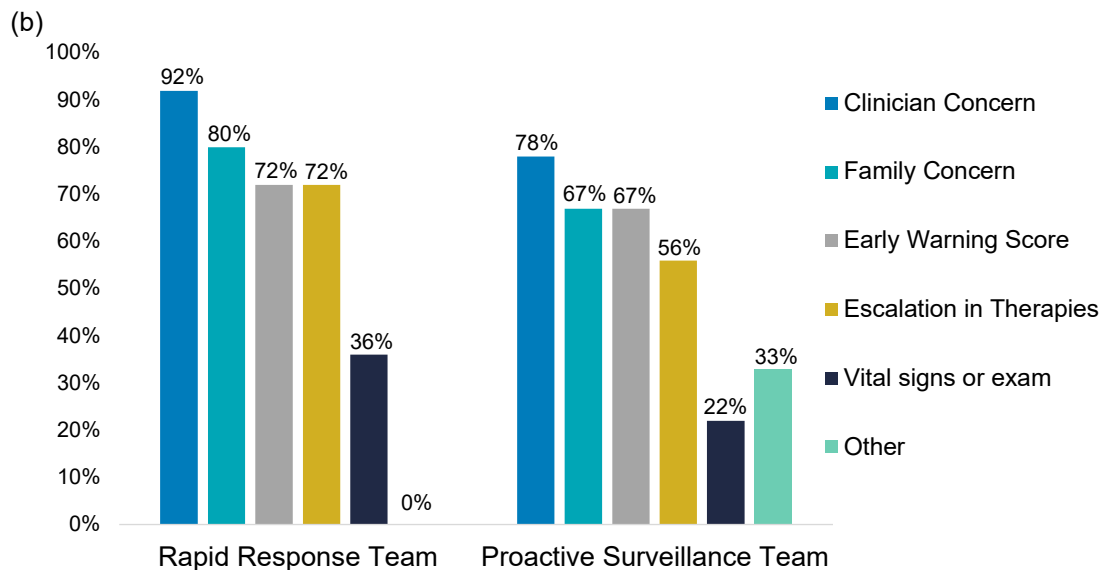
FIGURE 1 (a) Rapid response team and proactive surveillance team composition among respodent institutions and (b) rapid response team and proactive surveillance team activation triggers.

DISCUSSION

Pediatric resuscitation leaders at 30 North American pediRES-Q institutions reported widespread use of systems to detect and respond to deteriorating children hospitalized outside the ICU. While 93% of respondents reported using ≥1 process to detect deteriorating children, there was system variability. Our study details important aspects of deterioration systems, including system activation and evaluation. Notably, family and clinician concerns were commonly included activation criteria for RRTs and proactive surveillance teams. While 90% of institutions collected related data, there was no consistency on specific metrics.

The Care BefOre Deterioration Events survey results align with previously published data investigating rapid response systems in different hospital cohorts,[8,9] including Lockwood et al.'s survey of Pediatric Research in Inpatient Settings (PRIS) hospitals.[1] In our study, 83% of centers used EWS compared with 77% of PRIS respondents. Most sites in both studies had protocolized responses to deterioration and reported RTs and ICU nurses as the most frequently included members of RRTs. These similarities are unsurprising since both studies sampled from North American pediatric care systems. Notably, more institutions in our study used watcher lists (55% vs 31%) and proactive surveillance teams (31% vs. 18%). We hypothesize that this difference could be accounted for by the difference in sampled groups: pediRES-Q institutions may be more likely to have advanced deterioration systems.

For both RRTs and proactive surveillance teams, clinician concerns and family concerns were commonly included activation triggers. Qualitative work on bedside nurses' concern has noted that important indicators of deterioration, including change in pain, alteration in activity/interaction level, and provider instinct, may not appear in EWS.[10,11] Including clinician concern as an activation trigger provides an additional opportunity to respond early to patient deterioration. Research on family-activated rapid responses has focused on impact and feasibility. Brady et al implemented family activation of medical emergency team (MET) evaluation over a 6-year period in a children's hospital and found that only 2.9% of MET activations were triggered by family concern.[12] While family-activated MET evaluations were less likely to result in ICU transfer than clinician-activated MET evaluations, they did still sometimes detect important physiologic deterioration or communication failures. Advocates of family-activated systems emphasize the positive impact on safety culture and family-centered care. While additional research can clarify the best ways to incorporate family and clinician perspectives, systems designed to eliminate undetected patient deterioration must value stakeholder observations that may not be included in other commonly assessed parameters.

Respondent institutions overwhelmingly collected data related to their programs (90%). The most common were incidences of RRT activations, codes outside the ICU, and serious safety events. To optimize program evaluation, including feasibility and impact assessments, as well as multicenter benchmarking, effective, standardized metrics are crucial. Since pediatric arrests are increasingly rare outside of ICUs, more sensitive outcome indicators such as emergency transfers and critical deterioration events[13–15] may provide better program performance assessment.

In the absence of evidence-based practices for pediatric clinical deterioration systems, should pediatric centers establish or expand these programs? What's the optimal structure? Further investigation is needed to answer these questions. Economic evaluation is also needed to identify high-value components as centers allocate limited resources. In the interim, descriptive data provides an example of peer institutions' systems for those adapting deterioration systems to the local context.

Limitations

Our descriptive data is not linked with patient outcomes, limiting our ability to make inferences about the best pediatric deterioration systems. Our survey elicited brief responses, leaving the opportunity for qualitative in-depth work exploring these concepts. Conducting the study among North American pediRES-Q sites limits generalizability.

CONCLUSION

Most pediRES-Q hospitals reported using a system to detect and/or respond to deteriorating children hospitalized outside the ICU. While heterogeneity exists, there were some practices used at the majority of sites: EWS use, including family and clinician concern as activation triggers, and relevant data collection. Future investigations should focus on evidence to support best practices, including determining reliable measures for program evaluation.

CONFLICT OF INTEREST STATEMENT

Dr. Vinay Nadkarni serves as the President of the Society of Critical Care Medicine (SCCM). The views expressed in the manuscript are his and are not intended to represent the views of the SCCM. The remaining authors declare no conflict of interest

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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