Prevalence, Characteristics, and Opinions of Pediatric Rapid Response Teams in the United States

abstract

OBJECTIVE: Rapid response teams (RRTs) have been proposed as patient safety initiatives for hospitalized children. The aim of this study was to determine the prevalence, characteristics, and opinions of RRTs in hospitals with PICUs in the United States.

METHODS: This study was conducted as a cross-sectional survey of PICU physicians in adult and children's hospitals that care for children. One survey was sent to the PICU medical director in each hospital. The primary outcome was the presence of an RRT. Other outcomes included RRT characteristics and beliefs regarding their impact on patient safety.

RESULTS: The survey response rate was 64% (134 of 210). Of the responding institutions, 79% (103) had an RRT; most of these teams were implemented in the last 5 years. Family activation was present in 69%, and automatic triggers existed in 34% of cases. RRTs included a median of 3 members and were composed of physicians in 77%, nurses in 100%, and respiratory therapists in 89% of institutions. Respondents with RRTs were more likely to agree that RRTs improve patient safety than respondents without RRTs (76% vs 52%) and more likely to disagree that they are not worth the money invested (82% vs 63%).

CONCLUSIONS: Although the evidence and opinions on the benefit of RRTs are mixed, the majority of US hospitals with PICUs have implemented RRTs. These systems demonstrate variability in activation mechanisms and team composition. Hospitals may be empirically adopting these initiatives without knowledge of the specific characteristics that are optimal for patient outcomes.

INTRODUCTION

A rapid response team (RRT) or medical emergency team is an in-hospital team of multidisciplinary personnel that responds to emergency situations outside the ICU setting and evaluates clinically deteriorating patients, performs critical interventions, and sometimes transfers patients to a higher level of care. Such teams may replace or coexist with traditional “code blue” teams that are dedicated to cardiopulmonary resuscitation. RRTs have earned attention as health care delivery initiatives to improve clinical outcomes for hospitalized patients outside the ICU. In the adult literature, a trial that randomized public hospitals to either implementing RRTs or continuing usual care demonstrated no benefit in the composite outcome of mortality, cardiac arrest, or transfer to the ICU. Although we are unaware of any randomized studies in pediatric settings, single-center before-and-after studies of RRT implementation have found decreased rates of respiratory arrests outside the PICU and decreased cardiopulmonary arrest rates.
specifically demonstrated a mortality benefit, although a retrospective study revealed that a large children’s hospital without an RRT program also demonstrated a mortality benefit during the same study period. A meta-analysis of 5 single-center pediatric studies revealed a 38% reduction in cardiopulmonary arrest rates and a 21% reduction in hospital mortality after RRT implementation. Recently, a multicenter study of 4 pediatric hospitals found no change in cardiopulmonary arrest rates or mortality after RRT implementation but did find a reduction in the mortality rate after PICU readmission within 48 hours.

One of the challenges in evaluating the clinical impact of RRTs is the lack of standard recommendations for team composition and how the team should function. RRTs may vary in who can activate the team, activation triggers, and team composition; such variations might affect the institutional acceptability, sustainability, and utilization of such teams, and ultimately, patient clinical outcomes. We conducted a cross-sectional survey of PICU physicians to determine the prevalence, characteristics, and opinions regarding pediatric RRTs in institutions that care for children in the United States.

METHODS

Study Design

This study was conducted as a cross-sectional survey of pediatric critical care physicians in adult and children’s hospitals with PICUs in the United States. Given the absence of a central PICU registry, 2 sources of data were searched to obtain a directory: the Virtual Pediatric ICU Web site (www.picu.net) and the National Association of Children’s Hospitals and Related Institutions Web site (www.childrenshospitals.net). One survey was sent to each hospital. At each institution, we attempted to identify and direct the survey to the PICU medical director; if the medical director was unable to complete the form, he or she was encouraged to forward the survey to a critical care physician who had knowledge of the hospital’s pediatric RRT. PICU physicians were targeted because they often oversee RRTs and make decisions to transfer patients to higher levels of care.

The project was approved by the Duke University School of Medicine Institutional Review Board.

Survey

The survey instrument was designed by the primary investigator (Dr Chen) with input from a survey methodology expert (Dr Kemper) and pediatric critical care content experts (Dr S Odetola and Turner) (Appendix). Surveys were pilot tested among critical care physicians at the primary investigator’s institution and edited for clarity. Surveys were distributed online and by mail, with the option of responding via either route. Three waves of contact were pursued from April 2010 through June 2010.

Outcomes

The primary outcome of interest was the prevalence of RRTs in hospitals with PICUs. RRT characteristics included who can activate the team, triggers for activating the team, composition of the team, and whether administrative and clinical outcome data were collected, such as the number of activations, rates of cardiopulmonary arrests on the wards, and number of transfers to the PICU or other higher levels of care. Beliefs and the perceived value of RRTs were surveyed by using a Likert scale. Finally, hospital data were collected, including the number of PICU beds, the presence of a geographically separate pediatric cardiac ICU apart from the medical/surgical PICU, and the presence of residency and fellowship training programs.

Statistical Analysis

Descriptive statistics were used to summarize RRT prevalence, RRT characteristics, respondents’ opinions, and hospital data. To assess nonresponse bias, survey recipients were divided geographically into 4 regions according to the US Census Bureau and response rates were compared by using the \( \chi^2 \) test. For analyses involving the year of implementation, data were divided into early adopters of RRTs (before and including 2007) and late adopters of RRTs (2008 to the present). For analyses involving survey opinions, Likert scale data were divided into 3 categories: disagree (1–2), neutral (3), and agree (4–5). The associations between early and late adopters, family activation, the presence of automatic triggers, and survey opinions were analyzed by using the \( \chi^2 \) test. The relationships among hospital characteristics and opinion data between institutions with and without RRTs were analyzed by using \( \chi^2 \) tests (or Fisher’s exact test for expected cell counts <5) and Kruskal-Wallis tests for categorical and nonparametric continuous data, respectively. For all analyses, \( P < .05 \) was considered statistically significant. SPSS 16.0 (IBM Corporation, Armonk, NY) was used for data analysis.

RESULTS

Prevalence of RRTs

Surveys were sent to 210 hospitals with PICUs in the United States. The overall
response rate was 64%, with 134 eligible participants responding to the survey. Response rates were similar according to US census region (West: 52%; Midwest: 73%; Northeast: 61%; South: 61%; \( P = .24 \)). Four surveys with incomplete data were excluded from the analysis, resulting in a final sample size of 130. Of these surveys, 103 (79%) were completed by the PICU medical director, and the rest were completed by other pediatric critical care physicians at the hospital. Of the 130 respondents, 103 (79%) had an RRT (Fig 1). Ninety-five (92%) of these RRTs were implemented between 2005 and 2009, with 49 (48%) being implemented in 2008 and 2009 (Fig 2).

**Hospital Characteristics**

Characteristics of the PICUs at responding hospitals are depicted in Table 1. Compared with institutions without RRTs, institutions with RRTs had PICUs with more beds (median: 19 vs 8; \( P < .01 \)) and were more likely to have separate pediatric cardiac ICUs (95% vs 5%; \( P < .01 \)), fellowship training programs (94% vs 6%; \( P < .01 \)), and residency training programs (83% vs 17%; \( P = .03 \)).

**RRT Characteristics**

All RRTs were available 7 days a week, 24 hours a day. Eighty percent of institutions had a RRT that was separate from the code (cardiopulmonary resuscitation) team. Typical patient events that would trigger RRT activation included respiratory distress (95%), circulatory issues such as shock or arrhythmia (90%), neurologic issues such as seizure or mental status changes (92%), and general concern from the ward staff regarding clinical status (85%). RRTs could be activated by families in 69% of the responding hospitals. Automatic triggers, defined as activation of the RRT via predetermined changes in the patient’s vital signs or overall clinical status, were present in 34% of hospitals. Early and late adopters of RRTs did not differ in the availability of family activation (72% vs 63%; \( P = .35 \)) or in the presence of automatic triggers for activation (32% vs 38%; \( P = .57 \)).

RRTs included a median of 3 individual members (range: 2–8). RRTs were composed of physicians (critical care attending physicians, critical care fellows, hospitalists, and/or residents) in 77% of responding institutions. Of these teams, 47% included attending physicians, 37% included fellows, and 55% included residents. Nurses (PICU, transport, and/or ward) were present in 100% of teams and respiratory therapists in 89% (Fig 3). The leader of the RRT was either a physician (63%), a nurse (29%), a nurse practitioner (3%), or a combination

![FIGURE 1](image1.png) Prevalence of RRTs among respondents. Percentages represent the proportion of the total sample.

![FIGURE 2](image2.png) Year of implementation among institutions with RRTs.

<table>
<thead>
<tr>
<th>TABLE 1</th>
<th>Characteristics of PICUs in the Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characteristic</td>
<td>Value</td>
</tr>
<tr>
<td>Sample size</td>
<td>130</td>
</tr>
<tr>
<td>Census region, n (%)</td>
<td></td>
</tr>
<tr>
<td>West</td>
<td>23 (18)</td>
</tr>
<tr>
<td>Midwest</td>
<td>37 (28)</td>
</tr>
<tr>
<td>Northeast</td>
<td>26 (20)</td>
</tr>
<tr>
<td>South</td>
<td>44 (34)</td>
</tr>
<tr>
<td>No. of PICU beds, median (IQR)</td>
<td>16 (11–24)</td>
</tr>
<tr>
<td>Presence of a separate pediatric cardiac ICU, n (%)</td>
<td>43 (33)</td>
</tr>
<tr>
<td>Presence of a fellowship training program, n (%)</td>
<td>52 (40)</td>
</tr>
<tr>
<td>Presence of a residency training program, n (%)</td>
<td>106 (82)</td>
</tr>
</tbody>
</table>

IQR, interquartile range.
of these individuals (5%). Most responding institutions tracked the number of RRT activations (96%) as well as clinical outcomes such as mortality, codes, and emergent tracheal intubations associated with RRTs (84%).

Beliefs and Perceived Value of RRTs

Opinions were surveyed regarding the benefits and perceived value of RRTs (Table 2). Respondents from institutions with RRTs were more likely to agree that RRTs improve patient safety than respondents from institutions without RRTs (76% vs 52%; \( P = .02 \)), more likely to disagree that RRTs are not worth the money invested (82% vs 63%; \( P = .03 \)), and more likely to disagree that RRTs are not worth the staff invested (86% vs 67%; \( P = .03 \)).

Early adopters of RRTs were more likely than late adopters to believe that RRTs reduce the number of codes on the wards (96% vs 80%; \( P = .02 \)). On the other questions, there was no association with the year of RRT implementation and survey opinions.

Among hospitals with RRTs, 81% answered that their ward teams felt comfortable activating an RRT, and 21% of respondents thought that their institutional RRT was underutilized. Agreement that an RRT was underutilized was similar in early versus late adopters of RRTs (14% vs 29%; \( P = .08 \)), institutions with family activation versus those without family activation (16% vs 31%; \( P = .08 \)), and institutions with automatic triggers versus those without automatic triggers (21% vs 21%; \( P = .94 \)).

DISCUSSION

In this study, we surveyed US adult and children’s hospitals with PICUs and found that the majority have pediatric RRTs. Most of these systems have been implemented in the last 5 years, and their availability nearly doubled between 2008 and 2009, perhaps due to the publication of pediatric studies favoring their adoption.3–8 In 2005, VandenBerg et al15 conducted a survey of urgent response mechanisms in medium-to-large (≥2 pediatric wards, ≥50 acute inpatient beds) North American hospitals with PICUs. Only 16% had a pediatric RRT. Our study built on this important work by surveying hospitals of all sizes, lending enhanced generalizability to the study findings.

In recent years, the definition of rapid response systems has been formalized, literature has been published on the subject, and novel ideas have been put forth such as family activation, automatic triggers for activation, and nursing-led teams. Accordingly, we found that pediatric RRTs demonstrate variability in their fundamental characteristics. According to the Medical Emergency Team Consensus Conference, rapid response systems should include 4 components: (1) an afferent limb that detects a patient condition or staff concern and triggers a response; (2) an efferent limb that assesses patients; (3) a process improvement limb that continuously re-evaluates the system; and (4) an administrative limb that implements and sustains the system.1
In the afferent limb of the system, VandenBerg et al\(^9\) reported that 21% of institutions with RRTs had automatic criteria for activation in 2005. We found only a slight increase in our study. A case for automatic triggers was made in a large, randomized controlled trial of RRT implementation in adults.\(^2\) In this study, there was a failure to activate an RRT in 51% of patients who demonstrated calling criteria before an unplanned ICU admission, and in 50% of patients who demonstrated calling criteria before an unexpected hospital death. Automatic age-specific vital sign triggers were used in 4 published studies of pediatric RRTs.\(^3,5,6,8\) In 1 study, the incidence of children who fulfilled specific trigger criteria 6 hours before cardiac arrest decreased after RRT implementation.\(^8\) However, pediatric alert criteria in the literature may be variable, unvalidated, and often have low positive predictive value.\(^19\) More research is necessary to define acceptable pediatric criteria for automatically triggering RRT activation. Potential candidate measures include the Pediatric Early Warning Score\(^27,28\) and the Melbourne Activation Criteria,\(^19\) which are aggregate scores of respiratory, cardiovascular, and neurologic compromise.

Another point of debate is permitting families of children to activate the RRT system. There is a hypothetical concern that adding family activation would increase the number of nonemergent, unnecessary calls. However, 1 study showed that implementing family activation only resulted in 2 family activations over 1 year but increased the number of RRT calls from nursing staff by lowering barriers to activation and emphasizing family-centered care.\(^20\) Family activation may thus foster a hospital culture that recognizes family members as crucial members of the medical care team. Although family activation is a relatively new idea, it was available in the majority of institutions and may soon be standard. Family activation and automatic triggers were not associated with the year of RRT implementation. Such advances in RRT methods may be grafted onto older RRTs or implemented directly into the development of newer RRTs.

In the efferent limb of the system, VandenBerg et al\(^9\) found varying composition of pediatric RRTs in 2005. Some “teams” only had 1 member, and 35% of teams did not include a registered nurse (26% at night) and 69% of teams did not include a respiratory therapist (67% at night). Our study suggests that since then, RRTs have become more structured, with the majority incorporating multiple members such as physicians, nurses, and respiratory therapists. Studies of pediatric RRTs have mainly been conducted in large academic institutions, permitting the availability of pediatric critical care attending physicians and/or fellows on the team.\(^3,5,6,8\) An interesting question is the optimal composition of RRTs in institutions with limited critical care personnel. In 1 study, a statistically nonsignificant decrease in cardiopulmonary arrest rates was observed after implementing an RRT composed of a nurse and a respiratory therapist with critical care physician consultation.\(^7\) The incorporation of other hospital staff on RRTs is important to investigate at hospitals with limited critical care capacity. Hospitalist physicians, who may have the skills and expertise necessary to identify and perform the early steps of resuscitation before PICU intervention, may be considered for such a role.\(^21\) They may have knowledge of the patient’s physiologic status before the need for RRT activation and are often the first responders for clinically deteriorating patients on hospital wards.

The patient’s own ward team was formally part of the team in only one-fifth of cases. Including the patient’s ward team on the RRT may improve house staff education and encourage a stronger relationship between the ward and PICU staff.\(^22,23\) Some respondents indicated that their RRT was underused; including the ward team in the RRT may address this deficiency and foster a sense of teamwork among the caregivers on the ward.

With regard to the process improvement and administration limbs, most institutions tracked the number of RRT activations and effect on clinical outcomes. As with all quality improvement initiatives, RRTs may need time to mature to reach peak efficacy or may deteriorate in the absence of adequate feedback, administration, leadership, and re-education.\(^1\) Standard guidelines for monitoring and reporting RRT data have been proposed in the literature.\(^24\)

Because of the uncertainty regarding the benefit of RRTs, we evaluated the degree to which respondents believed that RRTs were essential for patient safety and worth the investment. Most respondents from institutions without RRTs did not believe this to be true. Barriers to implementation thus may include both a lack of agreement that RRTs are beneficial as well as more limited resources and personnel to devote to quality improvement initiatives. A potential issue is that no cost-effectiveness analyses of RRTs have been performed. A recent
review suggests that optimizing composition of the team, limiting diversion from other patient-safety initiatives, expanding the role of the code team to encompass RRT responsibilities, and focusing implementation on areas with severely ill patients are potential ways to make RRTs more cost-effective.26

This is the first comprehensive study specifically focusing on the prevalence, characteristics, and opinions of pediatric RRTs in the United States. We pursued multiple methods of contact and were able to obtain data from the majority of institutions that care for children. Our response rate of 64% was similar to the median rate of 63.3% reported in a recent analysis of survey studies in critical care journals.26

Our study has some notable limitations. We targeted only hospitals with PICUs, but hospitals without critical care capability may have versions of RRTs that intervene without transferring to a higher level of care. We surveyed PICU physicians because they often supervise RRTs; however, selecting only PICU physicians may have produced more favorable opinions. It is noteworthy that uncertainty remains regarding the clinical benefit of RRTs despite this potential bias. Other limitations include issues common to survey studies. Self-reported practice and beliefs may differ from actual behavior and attitudes. Nonresponse bias, in which results may differ between nonrespondents and respondents, may affect the data. However, our response rates were similar across census regions, lessening the impact of nonresponse bias due to geography.

**CONCLUSIONS**

Although the evidence on the benefit of RRTs is mixed and opinions vary regarding their importance as patient safety initiatives, the majority of US hospitals with PICUs have implemented RRTs. Hospitals may be empirically adopting these initiatives without awareness of the structure, composition, and attributes that are optimal for patient outcomes. This study lays the foundation for future research into specific characteristics of RRTs as currently implemented and their impact on patient flow dynamics, PICU volume, caregiver work load, and resource utilization.

**ACKNOWLEDGMENT**

We thank Samantha Tate for her technical assistance with this project.

**REFERENCES**


### APPENDIX

**RAPID RESPONSE TEAM SURVEY IDENTIFIER:**

1. Do you provide clinical care in a pediatric ICU (PICU)?
   1 Yes 2 No → PLEASE STOP AND RETURN THE SURVEY.

A *rapid response team* (RRT; sometimes called a *medical emergency* or *outreach team*) quickly responds to patients on the general wards at an *early stage of instability*. This team is typically *activated* for specific patient conditions or staff concerns and may coexist with traditional code teams.

2. Please indicate your *agreement* with the following statements about RRTs.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>RRTs decrease mortality</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>RRTs decrease the number of codes on the wards</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>RRTs are unnecessary when there are code teams</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>RRTs are not worth the money invested</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>RRTs are not worth the staff invested</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>RRTs are essential for patient safety</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

3. Are you the *Medical Director* of your primary PICU practice setting?
   1 Yes 2 No

4. Do you train *fellows* in your unit?
   1 Yes 2 No

5. Do you train *residents* in your unit?
   1 Yes 2 No

6. Is your hospital affiliated with a medical school?
   1 Yes 2 No

7. How many PICU critical care *medical/surgical* beds do you have? ___________
8. How many PICU critical care cardiac beds do you have? If your unit is a combined medicine/cardiac unit, or if you have no cardiac unit, please enter 0. __________

9. Is there a pediatric RRT in your hospital?
   1 Yes → What year was it implemented? __________
   2 No → Is one in development? 1 Yes 2 No
If you currently do not have a RRT, PLEASE STOP AND RETURN THE SURVEY.

10. Is the RRT available at night?
    1 Yes 2 No

11. Is the RRT available on weekends?
    1 Yes 2 No

12. Is the code team separate from the RRT?
    1 Yes 2 No

13. Who can activate the RRT? Circle all that apply.

1. Physician
2. Nurse
3. Respiratory therapist
4. Family
5. Patient
6. Other (describe): __________

14. What are the typical triggers for activating the RRT? Circle all that apply.

1. Any patient that staff or family is worried about
2. Respiratory distress (apnea, tachypnea, hypoxemia)
3. Circulatory issues (shock, arrhythmia)
4. Temperature (fever, hypothermia)
5. Neurologic issues (seizure, mental status changes, uncontrolled pain/agitation)
6. Other (describe): __________

15. Are there automatic triggers for calling the RRT at your hospital?
    1 Yes 2 No

16. Who composes the RRT? Circle all that apply.

<table>
<thead>
<tr>
<th>Critical care training?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Attending physician</td>
</tr>
<tr>
<td>2. Nurse practitioner</td>
</tr>
<tr>
<td>3. Nurse</td>
</tr>
<tr>
<td>4. Fellow</td>
</tr>
<tr>
<td>5. Resident</td>
</tr>
<tr>
<td>6. ICU charge nurse</td>
</tr>
<tr>
<td>7. Respiratory therapist</td>
</tr>
<tr>
<td>8. Patient’s ward team</td>
</tr>
<tr>
<td>9. Other (describe): __</td>
</tr>
</tbody>
</table>

17. Who is the RRT leader? Circle.

1. Physician
2. Nurse
3. Nurse practitioner
4. Other (describe): __________

18. Do RRT members have other clinical responsibilities while they are on the team (eg, ICU, emergency department)?
    1 Yes 2 No

19. Do you track the number of RRT activations?
    1 Yes 2 No

20. Do you track the effect of your RRT on mortality, codes or unplanned intubations on the wards?
    1 Yes 2 No

21. Please indicate your agreement with the following statements about RRTs.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ward team feels comfortable activating an RRT</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Our RRT is underutilized</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>