Rapid response systems for paediatrics: Suggestions for optimal organization and training

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Abstract

Resuscitation and cardiac arrest events in the paediatric population are rare occurrences. Improving outcomes from such events continues to be a difficult challenge. Rapid response systems and teams have been integrated into many hospitals in an effort to facilitate early identification and management of patients at risk for clinical deterioration. Optimizing education in the form of team training is a major component of successful team performance. Simulation-based team training, is a key educational supplement for existing standardized resuscitation courses. This position statement describes the evidence supporting rapid response systems and teams as well as simulation-based team training and provides recommendations for implementation in hospital care for paediatric patients.

Keywords: Education; Paediatric; Rapid response teams; Rapid response systems; Resuscitation; Simulation; Team training

BACKGROUND

Resuscitations and cardiac arrest events in the paediatric population are rare occurrences. Survival outcomes both for in- and out-of-hospital cardiac arrests remain poor (1). Recent resuscitation guidelines have been developed through comprehensive review of the evidence guiding resuscitative care (1,2). Unfortunately, guidelines are inconsistently adhered to by health care teams in times of crisis (3). Completing standardized life support training, such as the Basic Life Support (BLS) course and the Pediatric Advanced Life Support (PALS) course, is often required for paediatric health care providers caring for critically ill patients. Yet the educational literature suggests poor retention of essential resuscitation knowledge, skills and behaviours within three to 12 months of taking such courses (3). This challenge has forced hospitals caring for critically ill children to re-examine how resuscitative care is delivered beyond the emergency room and intensive care units.

In an effort to improve hospital-wide outcomes for critically ill patients, many adult and paediatric hospitals have implemented rapid response systems (RRSs), which may include rapid response teams (RRTs) or medical emergency teams and care processes (4–17). Teams comprise a variety of health care providers with advanced skills in airway management, venous access and medication administration (4). The RRS is intended to identify critically ill patients and mobilize a clinical response to prevent or reverse patient deterioration. Although many hospitals in Canada have integrated RRTs into their system of care, there are no national standards to guide the organization and implementation of paediatric RRTs. Nor are training requirements for paediatric RRT members standardized, which could lead to wide variability in education and practice patterns among RRTs with different institutions (5).

Simulation-based education provides an effective, safe and risk-free environment for training resuscitation teams (18–31). Simulations involve the use of ’high-fidelity, static mannequins, and/or plastic models … in which the learner physically interacts to mimic an aspect of clinical care’ (18,19). In the simulated environment, paediatric providers can practice clinical skills and decision-making as well as hone behavioural skills needed for efficient and effective team function. Team training focuses on critical group skills such as leadership, resource allocation, communication and situational awareness (30,31).
Some paediatric hospitals have established a simulation-based curriculum for trainees and, in some cases, for hospital code teams (32–34). In Canada, the content and quantity of hospital-based simulation training cover a wide spectrum, and little effort has been made to establish guidelines for training paediatric RRTs.

This position statement examines the principles underlying RRS organization and RRT configuration, reviews evidence for their effectiveness, looks at the literature supporting simulation-based team training, and provides recommendations for RRS/RRT implementation in hospitals caring for paediatric patients.

RAPID RESPONSE SYSTEMS AND RAPID RESPONSE TEAMS

Traditionally, hospital ward teams have been responsible for the care of admitted patients. Support was not regularly available until a patient’s condition deteriorated, a ‘code’ was called and a ‘code team’ arrived to initiate resuscitation. Typically, adverse events leading to poor patient outcomes are preceded by abnormal physiological signs (6–8). The health care literature identifies three main systemic issues contributing to adverse events: failure to plan, failure to communicate and failure to recognize a patient’s deteriorating condition (i.e., failure to rescue) (9).

Often, the RRS-related elements needed to recognize and respond to illness already exist in some form but are suboptimal. For example, infrequent or inadequate vital signs monitoring may contribute to delays in calling for help. Alternatively, early warning systems or calling criteria may be improperly implemented, resulting in inadequate responses to calls for help. Finally, the education of ward staff in preventing patient deterioration may not sufficiently provide the skills and behaviours necessary for effective team function (3).

RRSs have developed in parallel with an increasing interest in improving hospital care quality and outcomes (11). The Institute for Healthcare Improvement’s 100,000 Lives Campaign has recommended that hospitals implement an RRS as one of six strategies to reduce preventable in-hospital deaths (12). An RRS includes efforts to improve detection of and response to patient deterioration, staff education—resulting in error reduction and improved patient outcomes—and staff and equipment support for integrated, team-based crisis response (5–12). The RRS has four main components: an event detection and response-triggering arm, a planned response arm, a quality monitoring arm and an administrative support arm (3,5–12). Event detection is often facilitated by an early warning system score—a tool designed for hospital teams to help recognize early signs of clinical deterioration (35). Many different early warning systems scores have been described, with varying degrees of predictive value (35–38). Effective implementation requires staff education, vital signs monitoring, recognition of deterioration using early warning systems or calling criteria, a system for calling for help and an integrated response in the form of an RRT. In addition to improving safety, quality and care for patients, RRTs benefit staff by developing service and educational partnerships among hospital units and enhancing communication and clinical skills. The ultimate result is a reduction in adverse events and improved clinical practice (9).

A typical RRT is a multidisciplinary team of medical, nursing and respiratory therapy staff. They are charged with the prompt evaluation, triage and treatment of ward patients showing signs of clinical deterioration (10). RRT members can order critical laboratory tests, imaging studies and medications, as well as transfer patients to higher levels of monitoring and care.

ARE RAPID RESPONSE TEAMS EFFECTIVE?

Studies evaluating the effect of RRT implementation in paediatrics have demonstrated improved clinical outcomes. While the quality and design of these studies vary, their findings collectively provide a compelling argument for RRT implementation in hospitals caring for paediatric patients (Table 1) (13–17,39–41).

The results from several studies of RRTs were analyzed in one systematic review and meta-analysis, which found that RRT implementation was associated with a 37.7% reduction in rates of cardiopulmonary arrest outside the intensive care unit and a 21.4% reduction in hospital mortality rates (11). Furthermore, a cost-benefit analysis of an RRT in one children’s hospital suggested that operational costs could be recouped by reducing the number of clinical deterioration events, even modestly (41).

IMPLEMENTING RAPID RESPONSE SYSTEMS AND/OR RAPID RESPONSE TEAMS

Effective implementation involves a series of steps with ongoing support from institutional leaders. Secure support ensures that financial and human resources are committed and ongoing. Engaging relevant stakeholders on a dedicated committee provides structured oversight for RRS development, implementation and evaluation. The steps to implementation include: establishing a program timeline, identifying team members and defining their roles and responsibilities, developing call criteria and activation processes, developing physician order sets and call records, garnering health care provider support, pilot testing system function, record keeping and data collection and, lastly, implementing an educational program. Training ensures that all RRT staff have the necessary knowledge, skills and team-based behaviours required to deliver quality care to acutely ill patients. Learning programs may include...
practicing clinical assessment skills, reviewing evidence-based interventions and protocols, and simulation-based team training to enhance communication, leadership and situational awareness. Effective teamwork is paramount when managing acutely ill children, with RRT members working together to perform efficient and potentially life-saving tasks (30–32).

**Team training**

Preventable medical errors can be caused by process failures on the part of individuals, teams or systems (42). Optimizing care of critically ill paediatric patients depends, first and foremost, on the timely, efficient and coordinated functioning of the resuscitation team (30–32). Crisis resource management, including team training, is based on guiding principles that improve team function during resuscitation. Effective teamwork has been shown to improve patient outcomes in various clinical contexts (20–24).

**Elements of team training**

Many different models for interprofessional teamwork-related resuscitative care have been described in the literature (30–32,43,44). No single model has emerged as an established standard in the international resuscitation community, but common elements are apparent. Key factors include (but are not limited to):

- **Leadership**—An established team leader directs the process of care, prioritizes team activities, assigns roles, motivates team members, synthesizes information and coordinates tasks to ensure delivery of efficient, effective care (30,31).
- **Situational awareness** (or mutual performance monitoring)—Accurately perceiving and understanding the clinical picture helps a team to anticipate, prepare and predict aspects of future care (45). For example, a team managing a patient with status epilepticus should be aware of potential disease progression, such as airway compromise or persistent seizures, and plan management accordingly. The team’s ability to share insight and understanding and adapt care will directly impact therapy and patient response. A high degree of situational awareness helps prevent fixation errors (where team members inadvertently focus on a specific aspect of patient care or a particular diagnosis at the expense of tasks or diagnoses more relevant to positive outcome). Teams can avoid fixation errors by actively sharing mental models or thought processes at critical points (46,47).

### Table 1. Benefits of RRS and RRT implementation in paediatrics

<table>
<thead>
<tr>
<th>Author, country</th>
<th>Year of study</th>
<th>Study design</th>
<th>Number/type of hospital</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharek et al. (13), United States</td>
<td>2007</td>
<td>Time series</td>
<td>1/academic</td>
<td>RRT implementation associated with reducing hospital-wide mortality rate and code rate outside the paediatric ICU setting. Also, the mean monthly mortality rate decreased by 18% and the mean monthly code rate per 1000 admissions decreased by 71.7%</td>
</tr>
<tr>
<td>Brill et al. (14), United States</td>
<td>2007</td>
<td>Before/after</td>
<td>1/academic</td>
<td>RRT implementation associated with reducing risk of respiratory and cardiopulmonary arrests outside critical care areas in a large, tertiary care children’s hospital</td>
</tr>
<tr>
<td>Zenker et al. (15), United States</td>
<td>2007</td>
<td>Before/after</td>
<td>1/academic</td>
<td>36% decreased incidence of both cardiac and respiratory arrests after RRT implementation</td>
</tr>
<tr>
<td>Hunt et al. (16), United States</td>
<td>2008</td>
<td>Before/after</td>
<td>1/academic</td>
<td>73% decreased incidence of respiratory arrests after RRT implementation</td>
</tr>
<tr>
<td>Tibballs and Kinney (17), Australia</td>
<td>2009</td>
<td>Before/after</td>
<td>1/not reported</td>
<td>RRT implementation associated with reducing total hospital deaths and increasing survival after cardiac arrests on the wards</td>
</tr>
<tr>
<td>Kotsakis et al. (39), Canada</td>
<td>2011</td>
<td>Large multi-centre</td>
<td>4/academic centres in Ontario</td>
<td>RRS implementation associated with decreasing rate of PICU mortality after readmission</td>
</tr>
<tr>
<td>Bonafide et al. (40), United States</td>
<td>2014</td>
<td>Interrupted time series</td>
<td>1/academic</td>
<td>RRS implementation associated with a significant downward change in the pre-intervention trajectory of critical deterioration and a 62% net decrease relative to the pre-intervention trend</td>
</tr>
</tbody>
</table>

ICU: Intensive care unit; PICU: Paediatric intensive care unit; RRS: Rapid response system; RRT: Rapid response team.
• Resource allocation—Human and material resources should be efficiently and effectively allocated but also adaptable, such that the team can shift care as the patient’s condition changes. Tasks should be assigned to qualified team members to ensure they are performed accurately and appropriately (30,31).

• Communication—An efficient exchange of information, including the ‘closed loop’ (where a directive is given, verbally acknowledged, then verbally confirmed once performed) is essential. Information delivery that is timely, appropriate in tone and content, and directive or assertive in nature can positively influence team dynamics during resuscitative care. Multidirectional information-sharing and inquiry should involve corrective mechanisms and actions when needed (30,31).

The role of simulation-based team training
Most hospitals caring for paediatric patients require their nursing, respiratory therapy and physician staff to be trained in standardized resuscitation courses such as BLS and PALS. While these courses are considered the ‘gold standard’ in resuscitation education, many providers struggle to retain essential knowledge and skills beyond three to 12 months of course completion (3). One critical question to be asked is: “What is the best way for RRT members to learn and maintain the team-based skill-sets necessary to optimize patient care and outcomes?” A growing body of literature supports the use of simulation-based team training (SBTT) to improve resuscitation performance, in both simulated and real clinical environments (20–31,44,46,48). Models include high realism simulation (i.e., capable of recreating a range of physiological findings and responses in a realistic environment) and low realism simulation (i.e., static manikins with or without a realistic environment). One recent systematic review and meta-analysis of simulation-based training for resuscitation, team training and/or communication skills demonstrated strong benefits for all types of learning (18). A comparable study of the paediatric literature found similar benefits for care providers (19). The potential for this method of educating RRTs is immense and still largely untapped in Canada. Although high-fidelity simulations seem to improve skill acquisition at course conclusion (compared with low-fidelity training), the benefits for training with low-fidelity manikins remain considerable, particularly in low-resource settings (49).

Concurrent with ongoing research in this field has been the establishment of several standardized team training courses (e.g., TeamSTEPPS, MedTeams) in North America (43,50,51). Training teams in the simulated environment has very real advantages, including: a safe, risk-free learning context (i.e., no potential patient harm); an on-demand learning experience in both rare and common clinical conditions; and team engagement in the learning process until competence is demonstrated. The thoughtful integration of effective instructional design features, such as distributed learning (i.e., where learning sessions are spaced out over time), feedback and multiple learning strategies, can further augment the impact of SBTT (52).

Several paediatric studies support the value of SBTT for improving attitudes, care processes and patient outcomes in acute care contexts. Thomas et al. described improved teamwork behaviours and adherence to neonatal resuscitation program (NRP) protocols after team training exercises (53,54). Teamwork concepts were subsequently integrated into a new version of NRP, resulting in trainees demonstrating more teamwork behaviours (e.g., information-sharing, inquiry, assertion, vigilance and workload management) compared with participants enrolled in the traditional NRP course (44). While this study focused on the neonatal context, it sheds light on the potential value of SBTT for other courses, such as BLS and PALS. Since 2005, elements of team training have been incorporated into the PALS curriculum in the forms of video-based discussion and postsimulation debriefing (55,56).

Other paediatric studies have assessed performance of multidisciplinary teams in simulated resuscitation scenarios. They demonstrated that SBTT improves skill levels (57), global clinical competency and teamwork behaviours in residents (58). Paediatric trauma team training using high-fidelity simulation improved multiple aspects of trauma care (59). One SBTT program incorporating TeamSTEPPS concepts for paediatric intensive care providers proved highly effective for increasing teamwork skills in the context of postcardiac surgery cardiac arrest (60). In one study conducted at a Canadian paediatric hospital, residents not only acquired team leadership skills following SBTT but were able to demonstrate skill retention at six-month follow-up (32). Studies have also shown links between SBTT and improved patient care processes and outcomes. An SBTT program consisting of weekly in situ simulation scenarios for RRT members led to quicker recognition of deteriorating patients, more rapid escalation to intensive care and reduced hospital mortality (48). Another hospital study demonstrated improved cardiac arrest survival rates after a longitudinal mock code program was implemented (61).

These studies collectively support the use of SBTT as an effective method for improving team performance during resuscitation. Access to SBTT for paediatric providers in Canada could be facilitated through courses offered by simulation programs at tertiary care centres, educational outreach to rural hospitals by simulation programs, and local or rural/remote hospitals developing their own SBTT programs (62,63). More research needs to be done to identify the ideal method of training teams with diverse membership (e.g., including residents and fellows) and to solidify linkage between enhanced team performance and improved patient outcomes.

RECOMMENDATIONS
For rapid response systems (RRSs):
Hospitals caring for paediatric in-patients should develop and implement a RRS. Implementation should include:
Standards for vital signs monitoring
- Calling criteria or early warning scores
- A planned response arm
- A quality monitoring process and administrative arm
- Education on the early detection and management of deteriorating patients for front-line health care providers.

For rapid response teams (RRTs):
- Hospitals caring for paediatric in-patients should implement and train RRTs with expertise in paediatrics. The composition, structure and functions of the team should be adapted based on resource availability and tailored to facility needs.
- Special attention should be paid to the following details of implementation:
  - Composition (skills and disciplines) and member availability
  - Calling criteria
  - Awareness of and interface with hospital staff
  - Methods of activation
- Education should include simulation-based team training where resources are available. Partnering with other institutions on educational programs can help secure institutional commitment and support.

Acknowledgements
This position statement was reviewed by the Community Paediatrics and Adolescent Health Committees of the Canadian Paediatric Society. It was also reviewed by representatives from the Canadian Association of Pediatric Health Centres (CAPHC).

References


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