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Rapid response systems 20 years later: new approaches, old challenges

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In 1990, Schein and colleagues changed the paradigm of in-hospital cardiopulmonary arrest. Their report, "Clinical Antecedents to In-Hospital Cardiopulmonary Arrest," provided evidence from adults suggesting that many arrests could have been prevented if existing signs of deterioration were identified, interpreted, communicated, and responded to appropriately.¹ Five years later, Liverpool Hospital published the first report of a rapid response system.² This marked the start of a patient safety movement that spread quickly to children's hospitals.³

Rapid response systems aim to improve the detection and management of deterioration in hospitalized patients. They combine tools to help clinicians identify deterioration with medical emergency teams that can be summoned to the bedsides of ill patients. Rapid response system implementation was associated with reductions in cardiopulmonary arrests (relative risk 0.62, 95% confidence interval 0.46–0.84) and mortality (relative risk 0.79, 95% confidence interval 0.63–0.98) in a recent meta-analysis,⁴ and reversed a trend of increasing critical deterioration events (a more proximate outcome) in a quasi-experimental study.⁵ Due in part to mounting evidence, common sense appeal, and their inclusion in major initiatives like the Institute for Healthcare Improvement's 5 Million Lives Campaign, rapid response systems are now nearly universally present in hospitals worldwide.

Unfortunately, rapid response systems have not fully solved the problem they targeted 20 years ago, and, despite progress, the challenges in pediatrics remain complex. Children still deteriorate on hospital wards, and 40% or more of these events may be preventable.⁶ There is an opportunity to renew the enthusiasm that surrounded the first generation of rapid

response system work, which focused primarily on the medical emergency team response, to pursue the more difficult work of optimizing the identification of deteriorating children. Below we propose a set of recommendations for a research agenda aimed at addressing this challenge.

Research agenda

The identification arm of rapid response systems includes physiologic monitoring, individual triggers for activating the response arm (e.g. call the medical emergency team if the respiratory rate exceeds 60), and early warning scores that combine vital signs and clinical observations.

Determining how to configure physiologic monitor alarms so they are effective tools that convey actionable information should be a research priority of those who strive to improve the identification of deteriorating children. While bedside monitors have potential to save lives, outside of the ICU as few as 1 in 100 physiologic monitor alarms are clinically actionable.⁷ High rates of nonactionable alarms are associated with slower response times, consistent with alarm fatigue.⁷ In the rare instances when alarms truly represent impending cardiopulmonary arrest, delayed responses can have devastating patient outcomes.⁸ This research priority should include developing guidelines describing how to best use continuous monitoring to optimize timely identification of deterioration while minimizing nonactionable alarms.

Implementing early warning tools that combine clinical variables into scores has been associated with reductions in mortality in adults.⁹ However, with physiologic parameters now being measured by monitors thousands of times each day but rarely stored, analyzed, or understood, there is great opportunity to prioritize improving early warning systems for children in two ways. First, large datasets can be used to develop profiles of wellness and deterioration by age, disease, and other characteristics. Patients' trajectories can then be mapped to these profiles in order to detect deterioration, which may only be evident as deviation from an expected trajectory of improvement. Second, individual patients' data can be analyzed in real time using streaming analytics with machine learning approaches. Instead of using population-based thresholds to define deterioration, personalized thresholds have the potential to improve the performance of scoring systems. Rather than more before and after studies, more rigorous designs including multicenter cluster-randomized trials should be used to determine if these models offer meaningful improvements in effectiveness.

To improve outcomes, a better performing index of deterioration must also be fully integrated into workflows and perform well on measures of usability. Its real world performance, like any clinical decision support tool, is a function of how it is displayed and integrated into clinical work. The 5 "rights" of clinical decision support are relevant here: ensuring that the right information is presented to the right people, in the right intervention format, through the right channels, at the right time in workflow.¹⁰ We suggest prioritizing research focused on better understanding who is best positioned to see and act on these data, where to deliver the decision support (e.g. the electronic health record, a mobile phone), how

to package and display relevant data and trends so they are concise and actionable, and how to target specific points in workflows when clinicians are well-poised to take action.

While making improvements in how we make decisions based on clinical data has great potential to help, this work should proceed in parallel with efforts to better incorporate and value the knowledge and expertise of patients and families. Parents of hospitalized children are uniquely poised to detect subtle changes in behavior that may indicate deviations from expected improvement. An opportunity exists to develop and evaluate interventions to meaningfully partner with parents during hospitalization using traditional communication approaches as well as technology-based approaches to gather their ongoing perspectives on the patient's condition. At most hospitals, the current extent of family involvement in activating a response to deterioration is a poster on the wall explaining how they can call a medical emergency team. This is a modest first step. The hospital remains a disorienting and intimidating place with complex and implicit sociocultural barriers to escalation. There is the potential for parents to blame themselves for not calling if they had concerns and their child deteriorated, as well as the potential for shame and backlash from staff if the parents called and the team determined that their child was fine. Deep and broad partnerships with patients and families should be used to collaboratively develop tools and systems that welcome and value their input, while evaluating the impact of these tools on patient outcomes. If shown to contribute meaningfully to detecting deterioration, these data should be presented to providers with the same importance as vital signs.

Related opportunities also exist to better employ the ability of the hospital ward-based teams to identify deterioration and provide timely therapies or facilitate more seamless escalation to medical emergency teams. Proactive identification strategies through huddles, roving critical care outreach teams, and safety rounds are increasing, but little high-quality evidence exists. As hospital leaders make choices about where to devote finite resources, it is critical to prioritize research to better understand the comparative value of these different strategies.

Conclusions

The past two decades of rapid response system implementation and spread represent a triumph of the healthcare system's ability to broadly deploy a patient safety intervention, reaching hospitalized children as well as adults. The first generation of pediatric rapid response systems improved care and saved lives while also providing scaffolding upon which hospital leaders can examine how concepts like culture, empowerment, and teamwork play out on hospital wards at all hours. The second generation of pediatric rapid response systems should continue to build on these achievements while further optimizing use of the data, tools, and people available at the bedside to take the next leap forward. Achieving the goal of zero preventable patient deaths demands it.

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