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Quality improvement utilizing in-situ simulation for a dual-hospital pediatric code response team

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ABSTRACT

Objective: Given the rarity of in-hospital pediatric emergency events, identification of gaps and inefficiencies in the code response can be difficult. In-situ, simulation-based medical education programs can identify unrecognized systems-based challenges. We hypothesized that developing an in-situ, simulation-based pediatric emergency response program would identify latent inefficiencies in a complex, dual-hospital pediatric code response system and allow rapid intervention testing to improve performance before implementation at an institutional level.

Methods: Pediatric leadership from two hospitals with a shared pediatric code response team employed the Institute for Healthcare Improvement's (IHI) Breakthrough Model for Collaborative Improvement to design a program consisting of Plan-Do-Study-Act cycles occurring in a simulated environment. The objectives of the program were to 1) identify inefficiencies in our pediatric code response; 2) correlate to current workflow; 3) employ an iterative process to test quality improvement interventions in a safe environment; and 4) measure performance before actual implementation at the institutional level.

Results: Twelve dual-hospital, in-situ, simulated, pediatric emergencies occurred over one year. The initial simulated event allowed identification of inefficiencies including delayed provider response, delayed initiation of cardiopulmonary resuscitation (CPR), and delayed vascular access. These gaps were linked to process issues including unreliable code pager activation, slow elevator response, and lack of responder familiarity with layout and contents of code cart. From first to last simulation with multiple simulated process improvements, code response time for secondary providers coming from the second hospital decreased from 29 to 7 min, time to CPR initiation decreased from 90 to 15 s, and vascular access obtainment decreased from 15 to 3 min. Some of these simulated process improvements were adopted into the institutional response while others continue to be trended over time for evidence that observed changes represent a true new state of control.

Conclusions: Utilizing the IHI's Breakthrough Model, we developed a simulation-based program to 1) successfully identify gaps and inefficiencies in a complex, dual-hospital, pediatric code response system and 2) provide an environment in which to safely test quality improvement interventions before institutional dissemination.

1. Introduction

Pediatric cardio-pulmonary arrest events are rare but carry significant impact for patients and anxiety for providers [1,2]. It is standard of care for any hospital caring for pediatric patients to have in place a formal emergency response system. The need for such as system is particularly crucial in a subspecialty hospital caring for a fragile sub-population of pediatric patients being treated for airway disorders such as Massachusetts Eye and Ear Infirmary (MEEI). MEEI is connected by a covered bridge to Massachusetts General Hospital *for* Children (MGH*f*C), a tertiary care children's hospital offering a broad range of pediatric services.

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MEEI's pediatric emergency response includes a full complement of responders to adequately handle the initial management of pediatric emergencies. Given the strong relationship between the two hospitals, the MEEI emergency response team is augmented by an additional layer of responders from MGH*f*C. Given the rarity of pediatric emergency events at MEEI, the efficiency of this dual-hospital pediatric emergency response system has not been adequately evaluated.

Simulation successfully trains personnel to respond to emergencies in environments where emergencies occur rarely but where the stakes are very high, e.g. the commercial aviation industry and space programs [3]. Anesthesiology was the first of many medical disciplines to integrate this training model into medical education, typically at an off-site location [4]. Advances in simulation technology now enable educators to conduct in-situ, simulated emergencies to practice within the actual work environment, enable multidisciplinary participation and more fully engage clinicians physically, conceptually and emotionally [5,6].

MGH*f*C established an in-situ, multidisciplinary, simulation-based education program in its pediatric intensive care unit (PICU) in 2009. This program has sought to identify and address responders' gaps in knowledge, skills and attitudes with the unforeseen benefit of also identifying systems-based challenges previously unrecognized given the rarity of pediatric emergency events. Simulation to prospectively identify and address real patient safety threats has been previously described by Herzer and colleagues, and utilized for quality improvement purposes in obstetrics and pediatrics [7–9]. In situ simulation has also been used to evaluate new clinical spaces or processes of care and to orient code response teams to a new hospital facility [10–12].

Given the complexity of the dual-hospital emergency response team at MEEI and the rarity of actual events to help evaluate the system, leadership from both facilities committed to the development of an in-situ, dual-hospital, simulation-based pediatric program to identify gaps and improve efficiencies in the code response employing a series of Plan-Do-Study-Act (PDSA) cycles and following key process and outcomes measures.

2. Materials and methods

After studying several published methodologies for instituting continuous quality improvement, the combined pediatric leadership from MEEI and MGH*f*C structured their program according to the Institute of Healthcare Improvement (IHI)'s Breakthrough Series (BTS), a collaborative improvement model developed as a tool to help organizations improve performance in less than one year by adapting and disseminating existing knowledge to other, similar sites to achieve shared goals [13]. The model consists of seven steps.

1) Form a team

A collaborative team with representatives from MEEI and MGH*f*C was formed. This team included leaders at three different levels as advised in the BTS model: 1) systems leaders with sufficient power and influence to affect change; 2) technical leaders with knowledge of the actual process of care; and 3) day-to-day leadership to move the process forward at the ground level [6].

2) Set aims

The core leadership group solidified their aims by asking, “What are we trying to accomplish?” The answer to this question was simple: to use simulation to safely identify gaps in the pediatric code response at MEEI and improve efficiencies employing an iterative process of quality improvement.

3) Establish Measures

The team asked itself, “How will we know that a change is an improvement?” While improved patient outcomes are the ultimate goal, the rarity of pediatric code events made this unfeasible as a measure. Although simulation-based training has been shown to improve simulation-based performance and to increase trainees' confidence in participation in real critical events, few studies have been able to demonstrate whether this translates into improved patient outcomes and safety [14–16]. Despite this limitation, the group settled on a number of key process and outcome measures. Based on analysis of an initial simulated event, the group identified three specific measures: 1) code response time for secondary MGH providers; 2) time to initiation of CPR when indicated; 3) and time to attainment of vascular access. Additional measures were added over time after analyzing subsequent simulated emergency events.

4) Select Changes

The technical leadership team constructed a process map to understand the steps involved in a pediatric emergency response at MEEI (Fig. 1). Challenges identified during the debriefing of each simulated event were linked to the process map to help develop appropriate quality improvement interventions.

5) Test Changes

Twelve PDSA cycles employing a series of simulated pediatric code events across MEEI were conducted to test specific changes to the pediatric emergency response and to help unearth other systems-based challenges impeding ideal emergency response. For example:

2.1. Plan

The leadership group planned specific changes/interventions to address gaps and inefficiencies based on analysis of each simulated events and with aid from the MEEI Pediatric Emergency Response Process Map. Some of the initial interventions included 1) orientation of all MGH*f*C pediatric providers to MEEI building layout; 2) distribution of MEEI elevator passes to members of the MGH*f*C emergency response team for rapid elevator retrieval; and 3) initiation of a new requirement that all MEEI pediatric providers be PALS certified. These changes and interventions were then tested during subsequent simulated events.

2.2. Do

Each simulated pediatric emergency occurred amidst the regular work flow of MEEI and MGH*f*C. All potential participants were oriented to the program in advance, including the goals and objectives of the program, rules of engagement and orientation to the interactive mannequin (see Appendix A). Code responders included nurses, physicians, pharmacists, respiratory therapists, operations assistants, social workers and security. Participants were asked to respond to pediatric emergency drills unless this would require them to abandon a real emergency. They were instructed to act as they would in real life, such as performing needed procedures, drawing up medications and accessing the code cart. They were directed to retrieve and use all needed supplies and equipment from the real hospital supply. Facilitators stayed out of sight during the event. Following each 20 min case, a trained physician facilitator led an interactive, 40 min debriefing focusing on self and team reflection, analysis and synthesis of information. The literature reports on a wide range of time allotments for simulation-based