

# Operating Room Codes Redefined: A Highly Reliable Model Integrating the Core Hospital Code Team

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## ABSTRACT

**Introduction:** Typically, multidisciplinary teams manage cardiac arrests occurring outside of the operating room (OR). This approach results in reduced morbidity. However, arrests that occur in the OR are usually managed by OR personnel alone, missing the benefits of out-of-OR hospital code teams. At our institution, there were multiple pathways to activate codes, each having different respondents, depending on time and day of the week. This improvement initiative aimed to create a reliable intraoperative emergency response system with standardized respondents and predefined roles. **Methods:** A multidisciplinary improvement team led this project at an academic pediatric hospital in California. After simulations performed in the OR (in situ), the team identified a valuable key driver—a consistent activation process that initiated standard respondents, 24 hours a day, 7 days a week. By utilizing core hospital code members routinely available outside of the OR during days, nights, and weekends, respondents were identified to augment OR personnel. Code roles were preassigned. After education, we conducted in situ simulations that included the perioperative and out-of-OR code team members. We administered a knowledge assessment to perioperative staff. **Results:** The knowledge assessment for perioperative staff (n = 52) had an average score of 96%. Review of subsequent OR codes reflects an improved initiation process and management. **Conclusions:** The process for activating the emergency response system and roles for intraoperative code respondents were standardized to ensure a predictable code response, regardless of time or day of the week. Ongoing simulations with perioperative personnel continue to optimize the process. (*Pediatr Qual Saf* 2019;3:e172; doi: 10.1097/pq9.000000000000172; Published online April 12, 2019.)

## INTRODUCTION

An intraoperative cardiac arrest, also known in some settings as a “code blue,” is defined as an event during the care of an anesthesia care team that requires cardiopulmonary resuscitation with closed

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or open chest compressions.<sup>1</sup> Intraoperative arrests are a low volume, high-risk event with an approximate incidence of 7 in 10,000 noncardiac adult surgeries.<sup>2</sup> The pediatric perioperative population is at a higher risk than adults, with an incidence of 22 arrests in 10,000 noncardiac surgeries and an incidence of 127 arrests in 10,000 pediatric cardiac patients.<sup>1,3</sup>

Compared with intraoperative codes, the incidence of in-hospital pediatric cardiac arrests occur at a rate of approximately 8 in 10,000 patients.<sup>4</sup> Despite a higher incidence of pediatric intraoperative cardiac arrests, the likelihood of any one anesthesiologist experiencing a code is rare compared with the in-hospital code team that is composed of a smaller group of providers that routinely respond to rapid response and code events throughout the hospital. Multidisciplinary code teams, in particular, those including intensive care specialists, have been associated with reduced adverse events, mortality, and mean duration of hospital stay.<sup>5</sup> Despite this, intraoperative codes are traditionally managed by available and often variable operating room (OR) personnel, missing the benefit of the out-of-OR hospital code team which has more experience with team management of cardiac arrests. Typical respondents to out-of-OR codes include anesthesiologists, intensive care physicians and nurses, pharmacists, and respiratory therapists.

Significant efforts have been directed toward improving the management of perioperative arrests using high-fidelity simulation, crisis resource skill training, and cognitive aid checklists.<sup>6</sup> Although establishing consistent team roles, clear, closed-loop communication, and simulations has been shown to improve outcomes, standardized methods for initiating intraoperative code responses have not been reported.<sup>7</sup> Most ORs utilize paging systems to notify available perioperative providers, resulting in inefficient and often chaotic responses.<sup>8</sup> To help ameliorate this chaos, perioperative providers undergo continuing education, including the American Heart Association Advanced Life Support certifications, to help prepare code respondents to control the intraoperative crises during an intraoperative cardiac arrest.

At our institution, the intraoperative emergency response system included multiple different methods to activate codes depending on time and day of the week. The number and type of responders also varied. Because the official hospital policy was not being reliably followed, the chief nursing officer and vice president of medical affairs chartered a quality improvement project. The goal of this quality improvement initiative was to optimize patient safety by standardizing the code response system. The aims were to simplify the emergency response activation, standardize respondents, and predefine associated roles to optimize communication, preparedness, and timeliness during OR code blues.

## METHODS

### Context

This quality improvement project was performed at Lucile Packard Children's Hospital Stanford, a freestanding, 365 bed academic, pediatric hospital in Northern California. The hospital has 16 ORs and 12 non-OR settings, including ambulatory procedure rooms and interventional suites. The intervention included both the OR and non-OR settings. The educational phase of the study occurred from April 2018 to June 2018. The institution serves a racially diverse population and provides perioperative services to approximately 13,500 perioperative patients each year. The anesthesia and surgical providers include academic faculty, fellows, residents, nurse practitioners, nurses, surgical technicians, and physician assistants. As a quaternary care trauma center with neonatal, pediatric, and cardiovascular intensive care units, the surgical population ranges from complex neonates to ambulatory procedures on healthy children. All nurses and anesthesiologists are required to have advanced cardiac life support or pediatric advanced life support certification.

### Approach

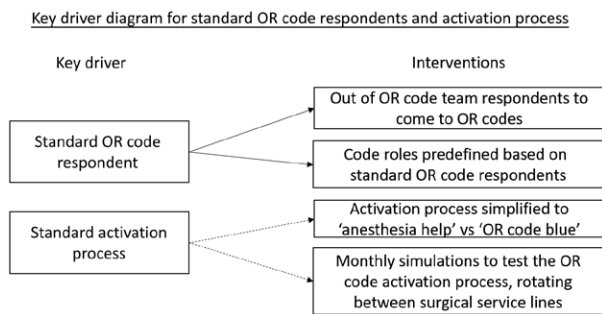
**Preintervention.** The chief nursing officer and vice president of medical affairs chartered this project. A multidisciplinary quality improvement team of physicians, nurses, pharmacists, quality managers, and hospital code response

team leaders led this initiative. Our initiative began with a stakeholder engagement phase that occurred over 4 weeks and ultimately led to a team that reviewed the background and current state of the variable ways in which code blue events could be initiated. We developed an A3 project plan as part of the quality improvement methodology. We developed the A3 through historical analyses of intraoperative arrests and perioperative staff interviews. Unstructured interviews of nurses, anesthesiologists, and surgeons were conducted by members of the quality improvement team to elucidate the current state to drive a needs assessment. Although a standard method for activating an intraoperative emergency response existed in policy, multiple homegrown pathways were identified, confusing practical application and potentially leading to suboptimal patient care. Based on staff interviews, a qualitative assessment determined that these homegrown pathways could lead to deficits in optimal communication, preparedness, and efficient responses to code blues. Different types of emergency responses included: anesthesia stat, anesthesia help, staff emergency, in-OR code, OR code blue, extracorporeal membrane oxygenation (ECMO) code, and a standard code blue (Table 1). Staff recognized the inconsistencies in code initiations, but supported the development of different pathways due to the variability of code respondents depending on the time of day. Another revelation was that anesthesiologists often assumed multiple roles, sometimes hindering the quality performance of competing assignments. Although cognizant of this practice habit, some reported difficulty in identifying other respondents with the requisite skill sets, particularly during nights and weekends due to a relative lack of redundant staffing during nights and weekends. OR nurses shared similar concerns regarding the ability to distribute competing nursing code roles on nights and weekends. Based on the current state analysis, a key driver diagram was developed to guide the interventions (Fig. 1).

**Table 1. Various Emergency Responses Identified Before Implementation of New Intraoperative Activation System**

Emergency Response	Action
Anesthesia stat	Phone call to reach an available anesthesia attending, emergently
Anesthesia help	Phone call to reach an available anesthesia attending, urgently
Staff emergency	Wall "staff emergency button" pushed to notify local "personnel of opportunity" to respond
In-OR code	Wall "code blue button" pushed to notify OR personnel including PACU staff and pharmacists
OR code blue	Wall "code blue button" and phone call to the page operator to declare OR code and request page to be sent to PACU, pharmacy, and PICU teams
ECMO code	Wall "code blue button" and phone call to the page operator to declare ECMO code and request page to be sent to ECMO team
Standard code blue	Wall "code blue button" and phone call to page operator to request overhead announcement and "blast page" for hospital wide members of code team to arrive

ECMO, extracorporeal membrane oxygenation; PACU, post anesthesia care unit; PICU, Pediatric Intensive Care Unit.



**Fig. 1.** Key driver diagram.

**Table 2. Perioperative Code Team Respondents**

OR Respondent	Out-of-OR Respondent
Anesthesiology team (including resident or fellow and attending. Also including anesthesia technicians)	PICU intensivist
Surgical team (including resident or fellow, and attending)	PICU fellow
OR nurse	PICU RN (transport or float RN)
OR surgical scrub technician	Nurse supervisor
OR pharmacist	Main pharmacist

PICU, Pediatric Intensive Care Unit; RN, Registered Nurse.

**Intervention.** After several meetings and simulations performed in the OR (in situ simulations), the improvement team recognized a valuable key driver—a consistent activation process that initiated a standardized responding team, 24 hours a day, 7 days a week. The ability to activate a standard team provided efficient use of perioperative resources and eliminated the confusion identified by perioperative staff during the current state analysis. By utilizing core hospital code members routinely available outside of the OR during days, nights and weekends, standard respondents were identified (Table 2). Because anesthesiologists, surgeons, OR nurses, and surgical scrub technicians were consistently available, only a truncated group of out-of-OR code members were needed for intraoperative codes to provide consistent backup to OR members, particularly on nights and weekends (Table 2). Once we identified the respondents, code roles were pre-assigned (Table 3). Some roles, such as the anesthesiologist, were given multiple roles because there are consistently multiple anesthesiologists available, such as an attending and trainee. Also, given the dynamic, evolving needs of a code, an anesthesiologist may be reassigned by the code leader, such as switching from central line placement to medication administration after the central line is completed.

We simplified the emergency response activation process to a dichotomous system—OR code versus anesthesia help to reduce variability in respondents depending on the time of day. Activation of an OR code involved 2 steps: (1) calling the emergency response operator, who sent a page to the specialized out-of-OR

code members and the perioperative code members and (2) sounding a unique, local, perioperative alarm by pushing a button located in the OR in which the arrest was occurring. Anesthesia help referred to any urgent, noncode scenario that required additional support, such as an unexpected difficult airway. Activation of the anesthesia help code involved 2 steps: (1) calling the anesthesia emergency phone that was carried by an available anesthesiologist who was not providing direct patient care and (2) sounding a unique, local, perioperative alarm located in the OR in which the help was needed. The development of the new code response system took approximately 8 weeks.

**Postintervention.** Following interdepartmental electronic correspondence, several perioperative leadership meetings, and perioperative team education, we initiated the enhanced pediatric emergency response system. Stakeholder engagement and agreement was increased through active championing by frontline employees who are members of the perioperative quality improvement team and surgical, anesthesia, and perioperative nurse leaders. We displayed cognitive aids in each OR above the OR code and anesthesia help buttons to increase the visibility of the new process. The initial educational phase occurred over 2 months and also consisted of several components including 2 weeks dedicated to comprehensive training of OR staff.

After education, we conducted 4 daytime announced and 1 daytime unannounced in situ simulations that included the perioperative and out-of-OR code team members. Four attending anesthesiologists, 2 surgeons, and 6 nurses, including the OR nurse manager and assistant manager participated in these simulations. The purpose of these simulations was to educate the staff about the new process, ensure that activation of the code response team was reliable, and test system reliability and assignment of standard code roles. By conducting in situ simulations, we were able to observe possible barriers to implementation of the activation system that we could not easily identify in a sim-laboratory or discussion setting. Code team performance was not tested. Ongoing continuing education was scheduled to occur once monthly, corresponding to a 1-hour delayed OR start. Approximately, 7 perioperative members, including a surgical attending and resident, anesthesia attending and resident, 2 OR nurses and 1 scrub technician, and 5 out of the OR respondents were involved in the ongoing monthly simulations. The surgeons with the delayed OR start participated as the surgical representatives in the simulated code. The monthly simulations rotated between surgical service lines. We developed and administered a tool to assess knowledge retention of the process and associated roles by the perioperative staff to ensure adequate educational efforts. We measured our immediate results by a knowledge assessment which demonstrated high competency among perioperative staff.

Table 3. Team Roles and Responsibilities

Member	Role	Responsibility
Perioperative staff Anesthesiologist or PICU intensivist	Initiate the OR code Team lead	Activate "OR code blue" vs "Anesthesia help" Manage code by assigning tasks, assessing progress with the help of OR cognitive code aids. Intensivist is available to lead team if anesthesiologist(s) have competing roles Establish intravenous access at direction of team lead
Anesthesiologists and OR/PICU nursing	Peripheral IVs, central, and arterial lines	
Anesthesiologist Nurse supervisor	Airway Event manager	Maintains a patent airway, including oxygenation and ventilation Distribute code role arm bands and ensure all roles assigned; crowd control
Anesthesiologist and main/OR pharmacist Anesthesiologist and OR/PICU nurses Nurse, surgeon, and scrub and anesthesia technicians PICU fellow	Medication administration Blood verification Chest compression	Administer medication at the direction of the team lead Verification of blood products before administration Provide continuous, high-quality chest compressions
Surgeon	CPR coach	Assists with CPR management: track timing of compressions, ensure high-quality CPR
OR/PICU nurses OR nurse OR nurse, anesthesia technician OR and main pharmacist	Surgical interventions	Controls surgical site as needed, develop surgical plan for interventions, surgical airway, IO, central lines
	Blood/laboratory runner Code recorder	Transport blood and laboratories to destination Document all code activity
	Code cart and supply runner Medication preparation	Brings code cart into OR, retrieve, and maintain supplies Prepare infusions and code medications

CPR, cardiopulmonary resuscitation; IO, Intraosseous; IV, Intravenous; PICU, Pediatric Intensive Care Unit.

## RESULTS

After a needs assessment, the team identified several problems that included the lack of a standardized activation method for an intraoperative emergency response, the assumption of multiple roles by anesthesiologists during the nights and weekends, and the challenge of assigning all appropriate nursing roles during nights and weekends (Table 4). After education and simulation sessions were conducted, we administered the knowledge assessment tool to perioperative staff (n = 52/54). Test takers were OR nurses. We targeted nurses because they are the main care providers that activate the code or anesthesia help pathways. The average score was 96%, and 100% of participants answered that they felt comfortable performing their designated role during an intraoperative code. Anecdotal reports of subsequent intraoperative codes indicate that the process is now reliable with less variability in code initiation and respondents. Ongoing monthly simulations (6) with perioperative staff have helped retain familiarity and understanding with the emergency response system. Approximately, 7 perioperative members, including a surgical attending and resident, anesthesia attending and resident, 2 OR nurses and 1 scrub technician were involved in the ongoing monthly simulations.

## DISCUSSION

Quality improvement methodology including utilization of an A3 project plan and key driver diagram was utilized to assess and redesign the perioperative emergency response systems (Fig. 1).<sup>9</sup> The process for activating the emergency response system and roles for intraoperative code respondents were standardized to ensure a predictable code response, regardless of time or day of the week. This project was initiated by the chief nursing officer and vice president of medical affairs in response to

Table 4. Preintervention Problem Analysis

Preintervention Problem Analysis	
Opportunities	Implications
Lack of standard activation method of emergency response	Confusion around how to activate an emergency response for a given scenario
Anesthesiologists assumed multiple code roles during nights and weekends	Suboptimal performance of individual code roles
OR nurses reported challenges with assigning nursing code roles during nights and weekends	Inadequate nursing resources led to an inability to optimally perform individual code roles
Lack of redundant staffing during nights and weekends	Assumption of multiple roles by a single provider

an identified need to optimize responses to OR codes. Ongoing simulations with perioperative personnel continue to optimize the process. Review of subsequent OR codes reflects an improved initiation process and management. There were no unintended consequences reported by perioperative providers. However, they may arise, including unavailable PICU providers and sterility concerns with multiple respondents entering the OR. Overlapping or duplicate roles need to be carefully managed by the code leader as they could lead to confusion. Also, the lack of familiarity of the perioperative environment from non-OR respondents may require ongoing consideration.

Despite the historical tradition of intraoperative codes being managed by OR care teams, given increasing case complexities and pressure for efficient staff models, a multidisciplinary approach to intraoperative codes that include out-of-OR respondents should be considered. Most intraoperative arrests are managed inefficiently.<sup>8</sup> During the day, unnecessary personnel respond to OR codes, hindering performance.<sup>8</sup> The resulting imbalance of personnel in the OR with the code can result in limited resources for patients in the other ORs. Contrary to

the abundance of help available during the day, intraoperative codes that occur on nights and weekends often face the opposite problem of limited OR staff availability, resulting in unfilled code roles.

Outcomes following cardiopulmonary arrests are significantly different depending on the time of day and whether the code occurred during the weekend.<sup>10–13</sup> The use of standard resuscitation teams may optimize outcomes in patients with cardiac arrest.<sup>14</sup> Given the variability of OR code responders during typical intraoperative arrests, a focused group of OR code providers supplemented with a subset of out-of-OR code respondents offers a reliable and standardized team with predefined roles even during nights and weekends.<sup>15</sup> The reliability requires a consistent activation that is virtually always responded to by the predetermined team. Despite the potential to increase in the total number of respondents to an intraoperative code, having a dedicated group of respondents that routinely respond to code events throughout the hospital provided experience and role clarity. The results of our intervention were an appropriate increase in the number of available respondents on nights and weekends and a net decrease in the number of respondents during the day.

There were several limitations to this project. Due to the infrequency of intraoperative arrests, this project was unable to show a decrease in morbidity, although the methods used to design the proposed OR code team have been well studied and shown to be effective. The objective measures of this study were limited to a knowledge assessment by the OR nurses which showed a high competency level for code roles and the emergency response activation. Nurses were targeted for the assessment, as they are the primary activators of the emergency response system. We provided the additional members of the code response team with knowledge assessments and feedback during simulation debriefing. Although simulations *were not conducted* during nights and weekends, they did include perioperative staff that *work* during nights and weekends. Also, our hospital's centralized paging system may not be generalizable to other institutions that may rely on different activation response systems. However, the structure and formation of a standardized intraoperative code response team can still be applied, as evidence from our monthly ongoing simulations and our in situ simulations, which demonstrated a consistent activation of the emergency response system with appropriate respondent roles.

Furthermore, our institution includes a pediatric intensive care unit with night and weekend coverage. These in-house staff made it possible to create a standardized intraoperative code response team, which may be difficult to replicate in some hospitals without these resources.

Also, the relatively rare incidence of intraoperative codes at our institution minimizes disruption to the out-of-OR respondents.

This improvement project describes a standardized method of activating the intraoperative emergency response with predetermined roles. Ongoing perioperative simulations provide opportunities for continued optimization. Future efforts will measure differences in morbidity and examine outcomes on nights and weekends compared with daytime arrests.

## DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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