SPECIAL ARTICLE

Using Simulation to Develop Care Models for Rapid Response and Code Teams at a Satellite Facility

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ABSTRACT

BACKGROUND: Our institution recently completed an expansion of an acute care inpatient unit within a satellite hospital that does not include an on-site ICU or PICU. Because of expected increases in volume and acuity, new care models for Rapid Response Teams (RRTs) and Code Blue Teams were necessary.

OBJECTIVES: Using simulation-based training, our objectives were to define the optimal roles and responsibilities for team members (including ICU physicians via telemedicine), refine the staffing of RRTs and code Teams, and identify latent safety threats (LSTs) before opening the expanded inpatient unit.

METHODS: The laboratory-based intervention consisted of 8 scenarios anticipated to occur at the new campus, with each simulation followed by an iterative debriefing process and a 30-minute safety talk delivered within 4-hour interprofessional sessions. In situ sessions were delivered after construction and before patients were admitted.

RESULTS: A total of 175 clinicians completed a 4-hour course in 17 sessions. Over 60 clinicians participated during 2 in situ sessions before the opening of the unit. Eleven team-level knowledge deficits, 19 LSTs, and 25 system-level issues were identified, which directly informed changes and refinements in care models at the bedside and via telemedicine consultation.

CONCLUSIONS: Simulation-based training can assist in developing staffing models, refining the RRT and code processes, and identify LSTs in a new pediatric acute care unit. This training model could be used as a template for other facilities looking to expand pediatric acute care at outlying smaller, more resource-limited facilities to evaluate new teams and environments before patient exposure.

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As many children's medical centers expand into surrounding communities, there are ongoing challenges of how to maintain the quality of inpatient acute care across multiple inpatient sites. Smaller satellite facilities often have few or no in-house critical care providers, may have staff that are less experienced in providing critical care services, and may have fewer available ancillary staff. New telemedicine and communication models of care can be used to maximize quality of care at satellite or community facilities. Researchers in multiple studies have shown successful implementation of telemedicine models for resuscitations, although most frequently in the context of Code Blue resuscitations as opposed to worsening acuity on the floor as in our setting.[1–3] A multidisciplinary group of leaders was tasked with developing the new care model for an expanded, satellite, 42-bed inpatient unit at our institution. They decided to implement telemedicine to allow critical care support and embed that resource into the development of a Rapid Response Team (RRT) and Code Team.

In studies, researchers have shown that when a new unit is being opened, whether it be an emergency department (ED), ICU, or adult acute care unit, simulation can improve outcomes, identify latent safety threats (LSTs), refine scope of practice, and improve team dynamics.[4–8] Our institution used simulation-based training in the laboratory and in situ settings before the opening of a satellite ED, specifically to help design, implement, and assess the safety of new health care teams within a new facility.[5] However, there are no previous studies in which the authors specifically discuss the use of simulation-based training and telemedicine models in preparation of opening a new pediatric acute care unit, particularly the care of the deteriorating child in non-Code Blue situations.

Our institution's satellite campus is an example of a community satellite hospital using simulation to prepare both new campus staff and the main campus PICU telehealth responders for RRT and Code Blue situations in the new inpatient expansion. Our objectives were to define optimal staff roles for the RRT and Code Teams at the satellite inpatient unit, refine scope of practice, learn how to best use telemedicine for critical care support, and identify potential threats to patient safety (defined as LSTs) before the facility opens by using simulation and through an iterative process with each subsequent debriefing.

METHODS

This was a prospective investigation leveraging high-fidelity simulation, postsimulation debriefings, and telemedicine technology within cohorts of institutional leaders and bedside providers to determine the best practice for a pediatric inpatient unit before it opened.

Setting and Subjects

The simulation and debriefing sessions took place in 2 locations. The first was a 400 sq ft simulation laboratory on the main (academic) campus, which included 2 patient rooms, 1 control room, and 1 debriefing room. One of the patient rooms and the debriefing room were outfitted with telemedicine equipment to allow for the testing of that system and the communication between providers over video. The equipment available during the simulations mirrored what would be expected on the inpatient unit. The second setting was the actual inpatient unit at the satellite campus after construction was complete but before patients were admitted (preopening). All patient rooms were outfitted with telemedicine equipment and connected to the telemedicine command center in the PICU at the main campus. This allowed for the testing of that system and the communication between providers over video. Providers were required to use only equipment and resources from the unit.

Subjects were hospital employees who were hired to work at the satellite campus. All professions (physicians, nurses, advanced practice nurses, respiratory therapists, and pharmacists) who would provide bedside care in the new unit were enrolled, and training was considered mandatory. In anticipation of higher acuity, hospital leadership planned for and hired critical care-trained nurses to work in the satellite inpatient unit. Additionally, without on-site critical care physicians, the team leadership and airway management roles during RRTs and Code Blue events would have to be different. Table 1 shows providers at RRTs and Code Blue Teams at the main, academic campus compared to what was initially proposed for the new satellite campus before training. The PICU fellow is the main physician responsible for responding to RRTs and Code Blue events at both the main (in person) and satellite (via telemedicine) campuses. At times, that role is filled by an ICU attending. Thus, both attending physicians and fellows were involved and provided telemedicine consultation in the simulation-based training sessions.

Study Interventions

Leadership from hospital medicine, patient services (nursing), respiratory therapy, surgery, and the Center for Simulation and Research met to determine educational and system training needs. In addition to those high-level discussions, a cohort of both physician and nursing managers (leadership assessment) and bedside providers (learners' assessment) were queried by using the center's online intake needs assessment survey (SurveyMonkey.com). The results of these discussions and surveys were triangulated in this needs assessment to help drive course content, learning objectives, and scenario selection as part of the standard intake process at the Center for Simulation. Eight clinical scenarios likely to be encountered on the new inpatient unit were chosen, developed, and then piloted in the laboratory (phase I) for simulation training. The chosen scenarios were sepsis, status epilepticus, anaphylaxis, bronchiolitis (respiratory failure), supraventricular tachycardia, cardiopulmonary arrest, hemorrhagic shock, and peripherally inserted central catheter complication. The scenarios were developed using an event-based approach, with critical trigger points and expected responses aligned with the learning objectives for each scenario and the overall course. For feasibility, 2 4-hour laboratory courses (each involving 4 scenarios) were developed and piloted in the laboratory (phase II). Both courses were required for all new, full-time satellite nurses, whereas existing physicians, nurses, advanced

TABLE 1 Comparison of Providers at RRTs and Code Blue Teams at Main, Academic Campus Versus Proposed Teams for New Satellite Campus Before Training

Role	Main RRT	Satellite RRT	Main Code	Satellite Code
Physician lead	PICU fellow or attending	Hospital medicine attending	PICU fellow or attending	Hospital medicine attending
Nurse lead	Critical care RN 1	Floor manager RN	CC RN 1	Floor manager RN
Code cart RN 1	—	—	Cardiac ICU RN	ED RN 1
Code cart RN 2	—	—	CC RN 2	CC RN 1
Pharmacist	—	—	Doctor of pharmacy (day shift only)	Doctor of pharmacy (day shift only)
Medicine administration nurse	—	—	ED RN	Floor RN 1
ED paramedic	—	—	All shifts	When available
RT	RT 1	RT 1	RT 1 and 2	RT 1 and 2
Bedside assessment, order entry	—	—	Resident 1	Advanced practice nurse
Airway physician	—	—	Resident 2	ED or anesthesia attending
Intraosseous placement or defibrillator	—	—	Resident 3	APRN or floor manager RN
Chest compressions	—	—	Resident 4, 5, and 6	Floor RN 2, 3 and 4, paramedic
Manager of patient services	All shifts	All shifts	All shifts	All shifts
Chaplain	All shifts	When available	All shifts	When available

APRN, advance practice nurse; CC, critical care; RN, registered nurse; RT, respiratory therapist; —, not applicable.

practice nurses, respiratory therapists and pharmacists who would work in some capacity in the new facility were required to attend 1 course. The courses were designed to be interprofessional and included providers with differing of skill and experience levels. Each scenario was designed to simulate the new unit environment, including the participation of a critical care physician via telemedicine.

After each scenario, all providers (both participants and observers) were led through a debriefing by a group of trained facilitators. Training consisted of a standing 6-hour facilitator course offered at the Center for Simulation and Research, followed by ongoing mentoring by a center staff member until the facilitator and the staff member felt competency in debriefing was achieved. At minimum, the facilitation group included a physician, a nurse or respiratory therapist, and a staff member from the simulation center. A standardized debriefing format was used to ensure inclusion of learning objectives, learner identified topics, and facilitator identified topics in the discussion. Additionally, a standardized tool for recording outcomes was used to ensure consistency in reporting of outcomes.[6]

Each laboratory course consisted of a 30-minute presentation that included the relationship between teamwork and communication and how these affect patient safety, the RRT and code algorithms, responders to RRTs and codes, and the roles of the responders. The safety and communication portion included the topics of the effects of authority gradient, hierarchies, task fixation, mental modeling, the step back, clarifying questions, and closed loop communication. Because the successful avoidance or implementation of these are integral to the culture at Cincinnati Children's Hospital Medical Center, they are believed to be an important piece of the curriculum and were encouraged to be exercised during the simulations.[6] The didactic portion had a twofold pertinence to the study. It educated staff of the various responders to and roles within an RRT and code. Second, it provided permission and promoted confidence to professionally communicate feedback to team members and facilitators regarding observations noted and suggested improvements to these processes. The format of these laboratory courses was consistent with all of the simulation laboratory courses provided by the simulation center.

The simulation courses were implemented in the laboratory setting (phase III) until the actual care environment was constructed and outfitted with medical equipment. Once this space was available, a series of in situ sessions (phase IV) were performed to continue the team training and better evaluate the clinical environment before patients were admitted.

Outcomes and Measures of Outcome

Outcomes of interest were team structure issues, systems issues, LSTs, and team-level knowledge deficits. Facilitators recorded outcomes within these 4 categories on the standardized tool after each debriefing session. Recordings were based on direct observations during the simulations and debriefing discussions. Additionally, potential solutions, lessons learned, and mitigation strategies brought up during debriefings were recorded by facilitators. The debriefing data were reviewed by the simulation center, telemedicine, and facility expansion teams after each session to ensure completeness and accuracy. At interim points within the training (after phase II, after phase III, and after phase IV), formal reports were given to facility leadership to improve design and resource allocation of the new unit, improve new team communication, refine and revise team structure, and, ultimately, build effective models of care for the RRT and Code Blue Teams. The lessons learned from each session were also applied to and discussed within the following session using an iterative methodology.

Statistical Analysis

The outcomes were categorized (as noted above) as a qualitative synthesis of findings. No formal statistical analysis was indicated.

RESULTS

A total of 175 clinicians attended 17 simulation courses offered in the laboratory setting over a 6-month period. Each simulation involved a minimum of 4 nurses (including a critical care nurse), a hospital medicine physician, a telemedicine consultant (PICU physician), 2 respiratory therapists, an advance practice nurse, and a pharmacist, if available. Participant breakdown was 72 nurses, 39 advance practice nurses, 33 physicians, 28 respiratory therapists, and 3 pharmacists.

In the month before the opening of the unit, 2 in situ courses were offered at the satellite campus. During in situs, different providers rotated through these roles to increase exposure to the training, whereas providers not participating in the simulation watched from the debriefing room. Everyone participated in large group debriefings after each simulation. Over 60 providers participated at one point during the in situ sessions.

Team-Level Knowledge Deficits

Eleven knowledge deficits (Table 2) were identified, which centered around 4 areas: equipment, resources, procedural care, and medications, paralleling the outcome areas within LSTs. For example, during an early scenario session, the team did not know how to correctly operate the defibrillator for cardioversion versus defibrillation. The confusion centered on use of the sync button, which is indicated for cardioversion. This knowledge deficit was seen in multiple simulations and was addressed in debriefing sessions. Also, in later training, the model was adjusted so the responsibility of placing defibrillator pads should fall to the ED paramedic because he or she had a high level of expertise with this machine.

LSTs

Nineteen LSTs were identified across the 4 phases of training (Table 3), including multiple threats revolving around the implementation of telemedicine consultation with the ICU. A patient and family privacy concern of being constantly "live" and monitored via telemedicine was identified, which prompted the satellite unit to incorporate clarification of telemedicine use to families at time of admission.

Additionally, optimal placement of equipment and responders in the patient room in relation to the telemedicine screen was determined. For example, it was found that the defibrillator should be placed at the foot of the bed, facing the telehealth camera, allowing the ICU physician the ability to view the rhythm and assist in evaluating and managing the rhythm. The hospitalist, or team leader needs to stand toward the side of the bed rather than the foot of the bed, which is the norm for Code Blue events at the main hospital. This allows the crash cart and responders to easily enter the room and the ICU physician to optimally visualize the patient and interact with the hospitalist. Further trials led to the appreciation that the hospitalist should turn toward the camera to maximize communication. Another issue identified for the ICU physician and other personnel was noise, which both delayed answering of the telehealth calls and negatively affected the interpretation each other's tone of voice and level of concern.

Multiple sharp-end, patient-level care and communication processes were identified as either lacking or not well defined during the simulations (Table 3). Included were concerns about how to escalate care before an RRT or Code Blue is called. Bedside providers, specifically nurses, identified the lack of clear chain of command and asked for the development of well-defined procedures on who to contact for concerns, in what order to contact them, and how to contact them. Because these bedside providers were used to working with residents at the main academic campus, they identified that those first call providers are not available in the new setting.

Systems, Team Structure, and Role Changes Based on Training

In addition to these team-level knowledge deficits and LSTs, 25 system-level issues were identified specifically surrounding the RRT and Code Blue process (Table 4). Several changes were made because of feedback from the sessions (Table 5). One example was the decision that the hospitalist led all RRTs and Code Blue events with the ICU physician in support, compared to the model at the base campus in which the ICU physician is the team leader. In

TABLE 2 Team-Level Knowledge Deficits Identified

Area	Deficit	Discussion	Phase of Training
Equipment	Use of defibrillator	How to turn on to monitor (not automated external defibrillator) mode; use of sync button for cardioversion; defined need for additional defibrillator training for staff before the opening	I/II, III
	Code carts	Staff consistently gave feedback that at the main campus they "move away" when the code team arrives, so if they are going to be part of codes at satellite campus, they need to be knowledgeable about the code cart (contents, location, use of equipment, etc); specific needs such as where the backboard is located, side wing usage, and how to use bristojets (especially how to mix dextrose)	I/II, III
	HFNC	What the indications for HFNC are, how to use and set up the machine, and how to interpret the patient as a "responder" to high flow; this is important because there is no HFNC on the floors at the main campus	I/II, III
Resources	Scope of practice	Responsibility for placement of IO catheter	III
	Bedside code sheets	Staff not familiar with code sheets because they do not routinely use them	I/II
	Orders during resuscitation	How are orders entered into the electronic medical record? Who puts them in?	III
Procedural care	IO	Technique, equipment needed, sizing, and location for placement of IO catheter (including how to flush after placement)	I/II, III
	Cardiopulmonary resuscitation (here pertaining to chest compressions)	Providers felt that basically all staff need training in cardiopulmonary resuscitation (here pertaining to chest compressions) above what is learned in and maintained from basic life support and pediatric advanced life support	I/II
	Push-pull method for fluid boluses	How to set up and use for expedient administration; for continued training, the registered nurse educator has skill days planned to educate the registered nurses to ensure competency	III
Medications	Epinephrine delivery in anaphylaxis	Subcutaneous versus intramuscular versus IO or intravenous; dosing for each route	III
	Confusion surrounding rapid sequence intubation and narcotic "kits" or pouches	Where will they be stored? Who will get them and bring to the bedside? What medications will be available in them? What medications will not?	III, IV

HFNC, high flow nasal cannula; IO, intraosseous.

addition, all communication to and from the ICU physician should run through the hospitalist. Identifying who was in charge was a key change concept because it was challenging for team members to know who to defer to when both the in-person hospitalist and telemedicine ICU physician gave orders. A second example involved medication delivery in emergent situations. Feedback indicated that the pharmacist and/or the on-site critical care nurses should be responsible for the code cart and drawing up medicines because they are the most familiar and efficient with the resuscitation medications. Having a defined role within the team in which a pharmacist or bedside nurse would remain logged into the Pyxis system was also found to be helpful. Having set positions for each role aided in easy role identification and better communication with the hospitalist and ICU physician.

Systems changes made from session feedback included pre-telemedicine huddle and RRT process modifications, clarification of code criteria, and clarification of rapid sequence intubation process. For RRTs, the concept of the pre-telemedicine huddle originated from pre-RRT hallway huddles at the main campus, which allow for the floor and RRT teams to discuss the case before entering the room, allowing optimal communication and clarification of indication for the RRT. Before calling the RRT at the satellite campus, the hospitalist, patient-flow personnel, and charge nurse now communicate via phone bridge with the base campus critical care physician. In addition, critical care nurses, the manager of patient services (the administrative nurse in charge of bed flow), and, when available, the vascular access team were added as first responders for all RRTs and codes. The last additional change was adding a shared RRT note for the manager of patient services and the hospitalist to complete documentation of parameters for either immediate or subsequent transfer after re-evaluation to the ICU at the base campus.

Likewise, the Code Blue process was revised multiple times throughout simulation training. As an example, airway

TABLE 3 LSTs Identified

Area	Threat	Discussion	Phase of Training
Equipment	Telemedicine setup	Possible privacy concerns regarding the display (or lack thereof) of the camera view on the patient side were identified. Having an inset that shows what the ICU can see is crucial for the providers in the room in regards to positioning, etc, but it also helps ease privacy concerns for those in the room	III
	Telemedicine audio	It is difficult for the providers to hear the ICU (telemedicine) physician's "tone" when they call in, which delayed communication in a few simulations. Can the volume, tone, or signal be modified?	III
	Telemedicine setup	Defibrillator should be placed in view of monitor for ICU physician to help identify and manage rhythms	III, IV
	Code button sound/signal	Left on, this prevented ICU physician from hearing communication in the room	IV
	Video laryngoscope would not plug into the wall outlet at the bedside	This has a 2-pronged plug which will not go into wall outlets because these "safety" outlets require the 3 pronged plug. Thus, the video laryngoscope needs to be plugged into the power supply strip on the intravenous pole and then that strip needs to be plugged into the wall outlet	IV
	Climber crib makes it difficult for the telemedicine (ICU) physician to see the patient	Need to turn the bed and lower all railings	IV
Resources	Coverage for patients when RRT and/or Code Blue is called	How will the development and implementation of the RRT and Code Blue roles impact patient care in other rooms and hospital locations?	I/II
	Documentation during emergencies or codes	Routinely was not done during simulations. We are working with the electronic medical record build team to develop 8 scenarios in playground that can be used in this training. This will help with abstraction of patient information, but will we expect providers to document in the electronic medical record during patient care? Currently, at the main campus, the code team is on paper; will that be the same at the satellite campus?	I/II
	Need a process for subspecialty escalation	How to contact oncology physician and/or team in an emergency, how to contact cardiology to read an electrocardiogram emergently, etc.	I/II
	Need a process of escalation before an RRT or Code Blue is called	Specifically, will bedside nurses have a hierarchy to follow? For example, will the advanced practice nurse be called first and then the physician, if needed?	I/II
	Need process for getting emergent blood products	It was noted that there would be a blood bank at the satellite campus, which is different because currently there is only 6 Us of O-negative blood on campus	I/II
	Need to develop process around managing the parents during emergencies	It will be the manager of patient services' responsibility, but early in a code, it may need to be the charge nurse (chaplain only available on weekdays, no child life available); security should also respond. Should social work respond to codes to help with this?	I/II; IV
	Need to develop process around activation of transport	Currently, the process is to call Statline at the main campus and speak with the transport person in charge of the units; will it be similar?	I/II
Procedural care	Need for the *Pediatric Emergency Dosing Code Book* to be placed on code carts	Bedside code sheets only have limited and specific code medications listed; during non-code emergencies, a resource for other medications is needed	IV

TABLE 3 Continued

Area	Threat	Discussion	Phase of Training
	Need a process (and policy) developed around the scope of practice for IO catheters	It seems clinical managers are being identified as providers who can place IOs; currently, there is a policy (CPC-I-231) allowing trauma core nurses, satellite ED nurses and transport nurses to place IOs, which needs to be expanded to include some satellite floor providers	I/II
	Need to clarify the rapid sequence intubation process	Will this be done the anesthesia way, the ICU way, or the ED way? The respiratory therapists are already knowledgeable and comfortable with the ED checklist/process. All of the teams asked for consistency independent of who the airway physician is and independent of time of day. What drugs are going to be available?	III
Medications	Need anaphylaxis kit on code carts	Thought of having EpiPen and EpiPen Jr to use for all kids >10 kg to reduce potential errors with drawing up 1:1000 epinephrine	I/II, VI
	Need a process around anaphylaxis medications	We can look to hematology and oncology for their current process because they have epinephrine, solumedrol, Benadryl, and prednisone in a prepackaged kit	I/II
	Plan for getting medications from pharmacy in an urgent or emergent situation	Will there be a pharmacist present at any level of escalation? How will medications that are not in the code cart or the floor Pyxis get to a resuscitation? Will orders be entered into the electronic medical record by physician, advanced practice nurse, or nursing?	I/II

IO, intraosseous.

management was identified as a potential high-risk, low-frequency procedure on the unit. Within an on-site ICU, physician identification of airway providers and processes was needed. Because respiratory therapists and ED attending physicians were in house and both disciplines were familiar with the ED's rapid sequence intubation protocol, this process was selected for the new unit. This process included the use of video laryngoscopy to maintain situation awareness and assist in laryngoscopy and tube placement. Having a specific location for the airway doctor to stand and a position for the video laryngoscope aided the ICU physician in providing assistance. As another example, code criteria beyond true cardiopulmonary arrest were clarified (Table 5). These clinical deterioration scenarios included respiratory failure (as defined by the use of positive-pressure ventilation), circulatory failure (as defined as requiring infusion of >60 mL per kilogram in less than an hour or the use of inotropes), intraosseous line placement, and/or a seizure that lasted at least 10 minutes, thus requiring a second dose of a benzodiazepine.

Equipment and Resource Changes Based on Training

Key equipment and resource gaps (Table 5) were found throughout the course of the training, including knowledge and skills surrounding the code carts. Because the hospitalists and majority of nurses do not participate in codes at the base hospital, orientation to the code cart and revision of the code record sheet was needed. To support best practice guidelines for cardiopulmonary arrest, American Heart Association algorithms (Pediatric Advanced Life Support and Adult Cardiac Life Support) were added to every crash cart. Additionally, other cognitive aids for more common, yet high risk, illnesses (eg, anaphylaxis, status epilepticus) were added to the code cart.

DISCUSSION

As children's hospitals expand to include many community settings, models to ensure quality and safe care for all children across sites and resources are needed. In previous studies, researchers have discussed the use of simulation in pediatric EDs, neonatal care in delivery rooms, and PICUs to orient teams to new facilities or improve quality and safety.[4–7] However, this is the first project to use simulation as part of preparation for the opening of a pediatric acute care unit.

In training 175 providers in the laboratory setting and 60-plus providers in situ setting by using an iterative learning process, we found that simulation can be used to orient new pediatric hospital medicine teams to rapid response and Code Blue situations, to identify LSTs and team-level knowledge deficits within this environment, and to improve telemedicine-assisted code and rapid response models. Best practices gained in the satellite setting through this iterative process of simulation-based training and immediate debriefing include (1) the development of clear role definitions and scope of practice that best use team member skill sets, (2) the establishment of clear (and often lower) thresholds for which the Code Blue Team should be activated, and (3) the identification of key skill and knowledge gaps that require training to mitigate future errors in care.

Like researchers in previous studies, we demonstrate the utility of simulation-based training before and while opening a new

TABLE 4 Systems Issue Identified Specific to MRT and Code Blue Process

Area	Issues Identified in Simulation and Debriefing	Discussion	Phase of Training
Roles and responsibilities	Who does airway?	There is going to be an airway physician proceduralist, but can this person precept an HM physician, APRN, or resident through procedure?	III
	Who is team leading?	Can the HM physician defer to the ICU physician? If so, what role will the HM physician then fill? What action can the HM physician take if the ICU physician takes over or team members defer to the ICU rather than the HM physician? The airway doc (ED, ICU, or anesthesia) will also have experience running codes, so it is vital that there is communication at the team level about who is leading the resuscitation	III, IV
	"Runners" need to be identified	The charge nurse should ideally designate this because it cannot always be the patient care assistant because sometimes things need to be retrieved from Pyxis	III, IV
	Another person needed at the Pyxis	Someone logged in and ready to get supplies (medications, equipment) out and deliver it to the bedside team	III
	Documentation of care	Need a defined person to document care during Code Blue events and RRTs, especially with regards to timing of medications and other interventions.	III
	Defibrillator setup	Who will be responsible for defibrillator setup if a code is not called, and thus a paramedic is not there (eg, a patient in supraventricular tachycardia who needs cardioversion)?	III
	Clarify the role and responsibilities of the (1) charge nurse and (2) critical care nurses at the satellite campus	Discussed the charge nurse being placed next to the team leader with the following responsibilities: documenting, helping the physician team leader maintain situation awareness, identifying and assigning missing roles and responsibilities (eg, runners)	I/II, IV
	Who should be doing bedside assessments and reassessments during emergencies?	Possible role for APRN?	IV
	What is the role of the ED paramedic?	They have expertise in cardiopulmonary resuscitation (here pertaining to chest compressions) and the use of a defibrillator, which most other disciplines do not, so it's recommended that they run the defibrillator and "coach" providers doing cardiopulmonary resuscitation (here pertaining to chest compressions)	IV
	What is the role of the ED nurse?	Ideally, the ED nurse should go to the bedside (not to the code cart) and deliver medications and fluids.	IV
	The majority of the staff do not know each other, including what their discipline and role is	Identified need to use stickers (like at the main campus ICU and ED) to allow better role definition when personal protective equipment is in place	IV
Communication	Surgical patients	If RRT or Code Blue is called on surgical patient, how will surgical APRN be contacted?	III
	Clarification of "calling a code" criteria	At minimum, a code will be called for cardiopulmonary arrest or near arrest state; respiratory failure (defined as any use of positive pressure), any planned intubation, circulatory failure (defined as >60 mL/kg nasal saline given in short time period [<60 min]), and any use of inotropes, chronotropes, or vasopressors. The team further questioned whether a code should be called for any use of a crash cart? Any intraosseous placement? Seizure activity: any, >1 min, or >5 min? With no resolution despite first antiepileptic drug?	I/II, III

TABLE 4 Continued

Area	Issues Identified in Simulation and Debriefing	Discussion	Phase of Training
	Activating RRT	What phone no. is to be called for RRT and does the activation of an RRT at the satellite campus get relayed to the ICU at the main campus?	I/II
	Communicating with transport services	Can the calling of a Code Blue be immediately sent to transport to make them aware of the potential need for moving the patient to the main campus? Does every code patient (if they survive) need to be moved to the main campus?	I/II
	Need to develop process of communication to support services during emergencies (specifically, radiology, laboratory, blood bank, and pharmacy)	Which provider will handle these phone calls?	I/II
	Positioning of the team leader	In relation to equipment (ie, telemedicine screen) and team (ie, nurses at code cart), the physician team leader needs to stand where he or she can see the patient, monitor, telemedicine screen, and code cart	IV
	Staff assist versus RRT	Assist button is in the room (next to Code Blue button) and when pushed, it will alert the unit coordinator but does not go to pagers; an RRT has to be called by phone because there is no RRT button	IV
	Need to develop telemedicine consultation process	Including the expected response time for the ICU physician, the scripting of the initial conversation (ie, who at the satellite campus is going to share the team's mental model with the ICU physician), what responsibilities and authority the ICU physician has, and who they will be talking to at the satellite campus (eg, 1 person, entire team)	I/II
Resources	Pharmacy consultation	During evening or night and weekend shifts when a pharmacist is unable to attend a code or RRT, is it possible for the team to include the pharmacist via speaker phone?	III
	Code sheet	Providers need training on this. Can the font be larger? Can the form be simplified?	III
	Algorithms	Need for pediatric advanced life support and advanced cardiac life support as well as other best practice algorithms (eg, seizure, anaphylaxis), to be placed on the code cart	III, IV
Equipment	Is there a need for an "RRT kit"?	Suggested supplies include normal saline, stopcocks, intravenous fluid tubing; use of a rolling Pyxis or kits; portable suction; respiratory bag	III
	Video laryngoscope	Recommended for providers to allow visualization by team leader and ICU physician during intubation attempts; this was purchased and thus training and implementation strategies need to be put in place	III
	Airway Box	Need to develop an "airway box" because there is not a critical airway team or cart at the satellite campus	IV

APRN, advanced practice nurse; HM, hospital medicine.

care environment with our intervention.[5,8] One theme that evolved was the use of this strategy to refine provider responsibilities and best use team skills to maximize team effectiveness before patient exposure.[5] Participants suggested assigning critical care nurses to crash cart medication preparation and ED nurses to the administration of the medications because they believed these strategies would reduce medication errors and decrease time to medication delivery. Participants requested a defined team leader and a defined leadership hierarchy between the in-person team leader and the telemedicine ICU physician, which resulted in reduced team conflicts and team-level confusion as we progressed through the training. Also, having a specific location for the team leader to stand subjectively improved telemedicine-based communication with the ICU physician, reduced time to intervention and redundancies in communication, and improved the feelings of teamwork in the

TABLE 5 System Changes Made Through Iterative Simulation With Debriefing Training Process

Topic	Knowledge or Resource Gaps	Lessons Learned	System Changes
Crash cart	Location in the room	Providers need further training with the code cart because, again, ICU nurses often play this role at base facility	Additional crash cart and code sheet orientation added in subsequent sessions
	Midlevel providers are inexperienced with the drawing and administration of medications Not all providers are familiar with code sheet	Code sheet is not easy to use for providers	Critical care nurse responsible for crash cart medications ED nurses responsible for administration pediatric advanced life support, advanced cardiac life support, and other best practice guidelines added to the cart on the new unit Code sheet font was enlarged and sheet was simplified
Defibrillator	How to turn it on How to select synchronized mode	Need further training for providers before the opening because, typically, ICU staff at the base facility code team handle this role	Additional defibrillator orientation and practice in subsequent sessions. ICU physician should be able to view
Access	Who can place and IO?	Need to make sure IO equipment is available on new unit	Additional IO and epinephrine practice in subsequent sessions
	What IO equipment is needed and how to we flush them?	Providers need further IO practice	Pharmacist on call or available
	Epinephrine administration in anaphylaxis	Providers need further training in epinephrine administration	
	Dosage and Pyxis knowledge is limited among providers	Additional pharmacy support needed	
Airway	Hard to mitigate intubation failures with telemedicine	Need airway training for HM providers	Airway training required for HM providers
	Which RSI protocol (ED, ICU, or anesthesia) is best for our setting?	Need to have video laryngoscopy equipment so the ICU physician can help HM providers	Purchase of video laryngoscope to allow for visualization by ICU physician and HM team leader
		Need further discussions with ED, anesthesia, and others about RSI protocol	RSI protocol adopted from the ED
Code Blue classification	Code Blue versus RRT in a setting without direct ICU support	Code Blue needs more strict criteria than typically because of lack of direct critical care support	Cardiopulmonary arrest >60 mL/kg normal saline bolus Use of inotropes Use of positive-pressure ventilation Seizure >10 min (requires second dose of benzodiazepine) IO placement

HM, hospital medicine; IO, intraosseous; RSI, rapid sequence intubation.

room. As in a previous study, the use of simulation before initiation of patient care promoted improved team dynamics for their new health care teams.[9]

Similar to previous studies, identifying limited access to critical care, airway support, and vascular access support is key in identifying safety threats and redefining code classification in the new facility.[4] Our iterative debriefing process and reporting structure led bedside providers, unit managers, and hospital leaders to define a specific set of criteria (Table 5) for calling a Code Blue event. These criteria lowered the threshold compared with the main, academic campus, which all team members felt was appropriate given their projected resources and experience in critical situations.

Identifying key knowledge and skills gaps has been associated in previous studies with improved team member satisfaction, error reduction, and situational and environmental awareness.[4,6,9] Our findings were similar in that providers identified their need for orientation to and/or practice with specific equipment (eg, defibrillator), procedural care (eg, intraosseous line placement), and cognitive aids (eg, Pediatric Advanced Life Support guidelines) (Table 5).

When trying to generalize our findings and implement our iterative simulation-based process in a community setting, 1 limitation is the major commitment a hospital or institution must make strategically and financially. However, when opening a new facility, we found in this project and in a previous one[5] that institutional leadership often is more willing to provide the funding and resources for this type of training. Our main campus location has had a simulation laboratory since 2001 and has used in situ simulation since 2007. The main area of involvement initially was the ED. However, starting in 2007, all of the high-risk units (operating suites, PICU, NICU, cardiac ICU, transport medicine, and extracorporeal membrane oxygenation [ECMO] team) were trained in the laboratory setting with a similar method initially and then in situ simulations were employed throughout the hospital.[4,6,10,11] Currently, there are ongoing laboratory-based courses for the ED, NICU, cardiac ICU, and ECMO providers and in situ programs in the ED, NICU, PICU, cardiac ICU, ECMO (including extracorporeal cardiopulmonary resuscitation), and operating suites. For noncritical care units, there are standing mock code (eg, clinics, inpatient units, and nonpatient care areas) and code team training programs that occur monthly. Additionally, in 2008, when this satellite hospital opened its ED and short-stay unit, the same simulation-based methodology was used,[5] and, since then, the ED has maintained a laboratory-based and in situ simulation program. It is based on these programs and the published literature that hospital leadership requested the use of simulation before and after the opening of this satellite inpatient unit.

Our study has several other limitations. First, we are limited by the lack of quantitative data to further validate the qualitative iterative process used by the team to prepare providers and systems for the new facility. Future studies could collect pre-, post-, and ongoing survey-based data surrounding provider preparedness for critical illness events in a satellite setting. Blinded review of video recordings from simulations with application of validated teamwork scales could better assess for improvements in team leadership, teamwork, and communication. Second, it was unclear in this project the amount of ongoing practice that will be needed to sustain knowledge and skills gained by the providers during these sessions. The majority of providers only participated once, although some were involved in both laboratory and in situ sessions. Future studies could apply pre-, post-, and ongoing knowledge and skill assessment tools. Third, correlation of simulation-based training with improvements in patient-level outcomes and safety on the new unit was not assessed. There is likely a need for ongoing fine tuning of rapid response and code processes in situ, as has been recommended by researchers in previous studies.[6] Currently, a monthly 4-hour patient safety course is provided on the satellite campus, as well as 4 in situ simulations per month. The foci of these sessions have been expanded to include the assessment and management of tracheostomy patients because 10 of the 42 beds have been dedicated to transitional care patients. Future studies investigating the use of ongoing in situ mock codes for these patients or the incorporation of just-in-time training surrounding tracheostomy emergencies are other areas of possible future study for the satellite facility.[12–14]

CONCLUSIONS

Simulation-based training can assist in developing staffing models, refine the RRT and code processes, and identify LSTs in a new pediatric acute care unit (Supplemental Figs 1–4). This training model could be used as a template for other facilities looking to expand pediatric acute care at outlying smaller, more resource-limited facilities to evaluate new teams and environments before patient exposure.

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