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Use of simulation to develop a COVID-19 resuscitation process in a pediatric emergency department

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The coronavirus disease 2019 (COVID-19) pandemic has created many challenges for health care providers. At the forefront is the need to balance optimal patient care with the safety of those providing that care. This is especially true during resuscitations where life-saving procedures cause widespread aerosolization of the virus. Efforts to mitigate this exposure to front-line providers are therefore paramount. We share how we used simulation to prepare our pediatric emergency department for COVID-19 resuscitations.

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INTRODUCTION

The American Heart Association's (AHA) Coronavirus Disease 2019 (COVID-19) guidelines emphasize the need to balance timely, high-quality resuscitation with health care provider safety.¹ Safely and rapidly implementing these guidelines may be challenging as the inherent stress that accompanies new algorithms may be compounded by fears of disease transmission and impede understanding and effective execution of new processes.

Simulation may help teams with systems integration.²⁻⁵ Through collaboration and bidirectional feedback, simulation creates a safe analytic lens into spaces and processes so that flow may be optimized and risk minimized. And by encouraging deliberate practice with facilitated feedback prior to actual patient care, simulation educates participants, decreases cognitive load,⁶ and mitigates errors by increasing individual and team comfort and confidence with high stakes events such as COVID-19 resuscitations.

We used simulation to iteratively develop a COVID-19 resuscitation process for our pediatric emergency department (PED), a 47 bed, Level I Pediatric Trauma center with approximately 60,000 annual

PED visits and housed in a free-standing, suburban children's hospital. Our simulations allowed us to collaborate, leverage different perspectives and devise an easily understood, unified resuscitation process that helps protect our team.

DISCUSSION

Simulation to define the current state

Our first step was to assess our current PED space, teams, flow, and processes. We consulted subject matter experts and devised a COVID-19 pediatric resuscitation simulation scenario. Our subject matter experts and administrative leadership joined our simulation as silent observers. Our standard resuscitation team (Table 1) was hands-on and managed patient arrival by Emergency Medical Services (EMS), patient resuscitation, and disposition.

We then debriefed and solicited feedback taking into account all perspectives about PED flow, patient care, personnel safety, and opportunities to minimize contamination risks.

We discovered that our current resuscitation space and path for EMS into that space was not optimal for COVID-19 resuscitations. EMS' aerosol generating procedures (AGP) would contaminate personnel, equipment, and supplies along the path into our resuscitation rooms. Additionally, these rooms contain copious equipment and supplies that need to be terminally cleaned or discarded after resuscitative AGPs leading to prolonged room turnover time. Also, these rooms are positive pressure. This is not optimal as naturally ventilated or negative pressure rooms are preferred for COVID-19 AGPs.^{7,8}

Our simulation also showed that we had to reduce exposure risk, decrease our resuscitation team size, and monitor the number of staff within the resuscitation room. Individual team members had to take

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Table 1.
Pre-COVID-19 resuscitation staffing model

Location	Team member	Role
At the patient stretcher	Team lead physician	Runs the resuscitation
	Airway provider	Manages airway
	Resident or physician assistant	Conducts primary and secondary survey
	Respiratory therapist	Assists with airway procedures/management
	Bedside nurse	Obtains access, labs, performs procedures
	Medication nurse	Draws up medications, fluids
Next to the team around the patient stretcher or at the periphery of the room	Technician	Places patient on monitor, assists with procedures
	Documenting nurse	Documents resuscitation in medical record
	2nd resident or physician assistant	Computer order entry during resuscitation
	Back up respiratory therapist	Assists primary respiratory therapist as needed
	Back up technician	Assists primary technician as needed
At doorway or immediately outside the room	Flow supervisor	Assesses needs—asks more staff to enter resuscitation room as needed

on more tasks than usual and we had to be creative within our space. And we needed to do this as quickly as possible prior to our anticipated peak of COVID-19 patients.

We summarized and sorted our simulation findings and feedback according to methods, equipment, supplies, and associates. Our key stakeholders assigned criticality to each item and together we developed potential mitigation options. Based on this, we conducted further simulations to leverage work as imagined with work as done⁹ to ensure that our mitigation strategies translated to the frontline.

SIMULATION TO DEVELOP A NEW PROCESS

We had to limit contamination from AGPs along EMS' path into and within our PED. None of our existing negative pressure rooms are near our ambulance entrance. Our decontamination space was ideal as it is next to the ambulance entrance, is physically closed off from the rest of the PED, and has minimal equipment. Since it contained several positive pressure rooms, our facilities team changed airflow into and within one area so that it had negative pressure airflow. We ran simulations trialing different algorithms of bringing in equipment and supplies versus strategically stocking the room. We decided to stock the room with vital airway and vascular access supplies placed in labeled, encased plastic basins presorted according to

patient weight following Broselow tape recommendations (Fig. 1 and 2). We chose this method as it was the easiest and quickest to reliably clean postresuscitation and still allowed for the use of appropriate weight-based pediatric equipment.

We also used simulation to determine our optimal number of staff around the head of the bed, within the room and outside of the room (Table 2).

We began with normal staffing, then subsequently removed 1 person at a time. We analyzed team comfort level and performance with each composition of team members. We monitored our teams' ability to maintain room negative pressure, adherence to AHA COVID-19 guidelines, personnel safety, communication within and outside of the room, and success with the simulated resuscitation.

After achieving consistency in performance and participant feedback, we finalized room layout, equipment and supplies, and staffing models. In total, we conducted 7.5 hours of systems integration simulations over 2 weeks utilizing input from 30 different interprofessional participants.

SIMULATION TO EDUCATE TEAMS

We created an educational PowerPoint for the PED team that compared AHA COVID-19 and non-COVID-19 resuscitation



Fig 1. Cabinet with basins containing supplies presorted according to patient weight.

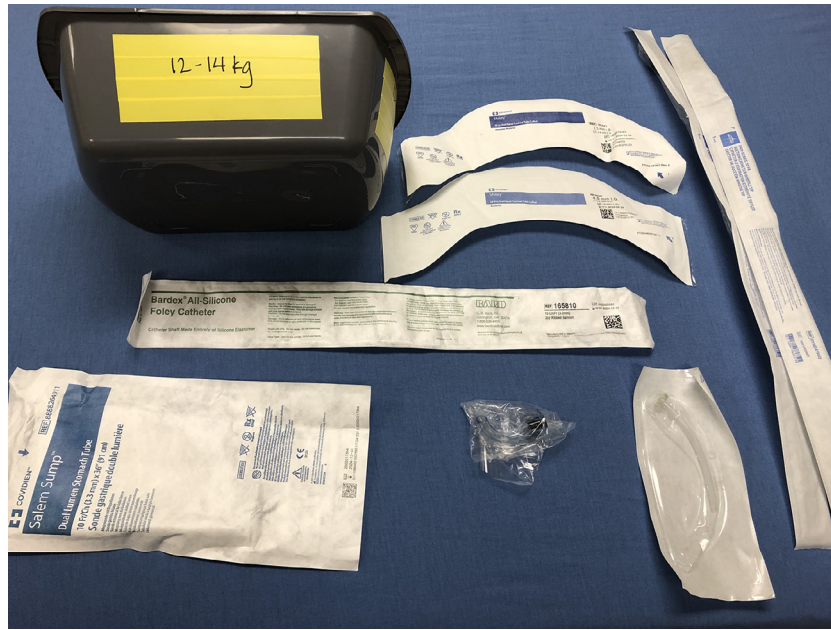


Fig 2. Each basin contains the following appropriate weight-based supplies: 1 oral airway, 1 nasopharyngeal airway, 2 suction catheters, 2 endotracheal tubes, 1 nasogastric tube, and 1 Foley catheter.

recommendations and detailed who, what, why, where, when, and how of our new space. We distributed diagrams of staff placement and team member checklists. We oriented staff to the room, equipment, and supplies within the room, location of checklists, and new processes. We also reviewed challenges of team communication while fully donned in PPE and emphasized the need for continual precise loop closure both within and outside of the resuscitation room to foster situational awareness and a shared mental model. We then ran simulations focusing on the physical space, staffing and flow within that space, personnel safety, patient safety, the value of clear closed loop communication,¹⁰ and AHA COVID-19 resuscitation guidelines. These immersive simulations gave participants the opportunity for deliberate practice with facilitated feedback and reflection on performance. As a result, simulations or elements within the simulations were repeated as needed to ensure proper performance. In total, we conducted 14 hours of training simulations for 66 PED staff. The feedback is universal increased comfort with our new space, increased understanding of needed infection prevention and control

measures surrounding COVID-19 resuscitations, improved understanding of AHA COVID-19 recommendations, and increased confidence in resuscitating a COVID-19 pediatric patient.

CONCLUSIONS

We utilized simulation as a vehicle to help us better understand COVID-19 resuscitation-related infection prevention and control issues within our PED. Simulation allowed us to understand barriers within our current space and helped us develop and refine a new process that would allow us to effectively resuscitate pediatric COVID-19 patients while minimizing personnel risks. And we used simulation to educate staff about our new space, processes, and workflows. Buy in from leadership stakeholders was key as they invested in our process, supported our journey and ensured that we were aligned with our organization's goals. Interprofessional input, willingness of staff to participate and learn new processes, timely and effective bidirectional feedback and loop closure of issues brought up during the simulations

Table 2.
COVID-19 resuscitation staffing model

Location	Team member	Role
At the head of the stretcher	Airway provider	Manages airway. May also function as team lead if PED physician. Conducts primary survey.
	Respiratory therapist	Places patient on monitor, assists with airway procedures/management and assists with bedside nurse procedures as needed.
	Bedside nurse	Obtains access, labs, performs procedures. Together with airway provider completes secondary survey as needed.
Standing 6 feet away in room in full PPE—eligible to be utilized at the bedside only if needed	Team lead	Physician leading the resuscitation if the airway provider is not functioning as team lead.
	Medication nurse Technician	Draws up medications, fluids and hands them over to bedside nurse. Ensures that the room stays shut. Calls out any equipment, supplies that need to be brought into the room.
	Documenting nurse	Documents resuscitation in medical record
Outside of the resuscitation room	Resident or physician assistant	Computer order entry during resuscitation
	Back up respiratory therapist	Runner for the hands-on respiratory therapist as needed
	Back up technician	Runner for equipment/supplies as needed
	Flow supervisor	Runner for medications as needed and ensures that room stays shut during resuscitation

PED, pediatric emergency department; PPE, personal protective equipment.

also led to our success. Further analysis is needed to ensure that these efforts translate to actual patient care within our PED.

We encourage the use of simulation to augment infection prevention and control initiatives. We hope that our journey may help inspire other teams to maximize the potential of simulation during the COVID-19 pandemic.

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