A National US Survey of Pediatric Emergency Department Coronavirus Pandemic Preparedness

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Objective: We aim to describe the current coronavirus disease 2019 (COVID-19) preparedness efforts among a diverse set of pediatric emergency departments (PEDs) within the United States.

Methods: We conducted a prospective multicenter survey of PED medical director(s) from selected children's hospitals recruited through a long established national research network. The questionnaire was developed by physicians with expertise in pediatric emergency medicine, disaster readiness, human factors, and survey development. Thirty-five children's hospitals were identified for recruitment through an established national research network.

Results: We report on survey responses from 25 (71%) of 35 PEDs, of which 64% were located within academic children's hospitals. All PEDs witnessed decreases in non–COVID-19 patients, 60% had COVID-19–dedicated units, and 32% changed their unit pediatric patient age to include adult patients. All PEDs implemented changes to their staffing model, with the most common change impacting their physician staffing (80%) and triaging model (76%). All PEDs conducted training for appropriate donning and doffing of personal protective equipment (PPE), and 62% reported shortages in PPE. The majority implemented changes in the airway management protocols (84%) and cardiac arrest management in COVID patients (76%). The most common training modalities were video/teleconference (84%) and simulation-based training (72%). The most common learning objectives were team dynamics (60%), and PPE and individual procedural skills (56%).

Conclusions: This national survey provides insight into PED preparedness efforts, training innovations, and practice changes implemented during the start of COVID-19 pandemic. Pediatric emergency departments implemented broad strategies including modifications to staffing, workflow, and clinical practice while using video/teleconference and simulation as preferred training modalities. Further research is needed to advance the level of preparedness and support deep learning about which preparedness actions were effective for future pandemics.

Key Words: COVID-19, preparedness, innovations, simulation

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The coronavirus disease 2019 (COVID-19) pandemic continues to threaten and strain health care systems and their supply chains with high volumes of critically ill patients.[1,2] As of this writing, the United States alone has had 6 million confirmed cases and approximately 160,000 deaths. However, the prevalence of this disease has not been evenly distributed, and COVID-19 "hot spots" have appeared at different times in cities throughout the United States.[3] With students of all ages returning to the classroom in the fall, there is the potential for a large national surge of pediatric patients seeking care in emergency departments.

Health care systems have prepared for the potential surge of acute care patients, yet little is known about how these facilities have formally trained their staff.[4,5] Although most identified cases are adults, approximately 1% to 2% of cases have occurred in children 18 years or younger.[6] Many pediatric hospitals have stopped all elective procedures to protect patients and staff and minimize infection risks.[7] After the 2009 H1N1 outbreak, the National Academy of Medicine developed guidance for establishing crisis standards of care for use in disaster situations.[8] Key features of this report highlight the importance of proactive preparedness to maximize resource utilization and optimize patient care while minimizing harm to the society. Tiered, proactive strategies consist of preparation, conservation, substitution, adaptation, reuse, and reallocation of critical resources.[8] Studies of health care systems in other countries have highlighted the obstacles and deficiencies in providing adequate staff and facility preparedness.[9,10]

The goal of this study was to evaluate the spectrum of preparedness for the COVID-19 pandemic by pediatric emergency departments (PEDs) within selected children's hospitals in the United States. In this evaluation, we examine the (1) departmental preparedness efforts for COVID-19, (2) training modalities for COVID-19 care and changes in current policies/procedure/guidelines, and (3) the role of simulation-based COVID-19 training.

METHODS

Study Design

We conducted a cross-sectional multicenter national survey of PED medical director(s) across a selected set of children's hospitals in the United States. An established team of researchers in pediatric critical care medicine and pediatric emergency medicine and experts in medical simulation, quality, and safety in health care designed and analyzed the survey.

Pediatric Emergency Departments

Thirty-five children's hospitals were identified for recruitment through an established national research network "Improving Pediatric Acute Care Through Simulation" (ImPACTS).[11] The ImPACTS was founded in 2013 to improve the quality of care delivered to acutely ill and injured children and has conducted multiple projects measuring the readiness of emergency departments through surveys, simulation, and quality improvement. All children's hospitals had active simulation programs at the time of the survey. The survey was conducted between May and June 2020. An anonymous Qualtrics survey (www.qualtrics.com) was

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distributed via e-mail to all 35 children's hospital lead investigators across the ImPACTS network. Each network site lead was instructed to e-mail the link to their PED medical directors and copy the study coordinator. Three e-mail reminders were sent by the study coordinator to the medical directors 1 week apart for 3 weeks.

Survey Development

The questionnaire was developed and reviewed by physicians with expertise in pediatric emergency medicine, disaster readiness, and survey development. To help ensure construct validity, we conducted a literature review to identify important characteristics in pediatric outbreaks preparedness within the ED setting. To help ensure content and face validity, a draft of the survey was presented for preliminary review to a focus group of 3 PED directors who made comments regarding readability and suggested edits to clarify some of the ambiguous questions. It was then piloted for length and comprehensibility at the same 3 PEDs that were not included in the study. The survey was iteratively revised in 3 cycles based on the feedback and pilot data.

Thirty-nine questions were included in the survey of physicians in multiple parts. The questions focused on 6 themes: (1) PED and medical director demographics, (2) pediatric patient flow during the pandemic, (3) changes to the staffing models related to the pandemic, (4) the use of personal protective equipment (PPE), (5) changes in clinical practice and innovations, and (6) the current modalities of training including simulation. An open comment section was available at the end of the survey. The study was considered exempt by the institutional review board.

Statistical Analysis

We compared the response's frequencies and percentages by testing differences using the Fisher exact test. All statistical analyses were performed using SAS Version 9.4.

RESULTS

A total of 35 PEDs within the network were identified. Responses from 25 PEDs (71%) were received.

Theme 1. PEDs and Medical Director Characteristics

Sixty-four percent of PEDs were located within academic children's hospitals, whereas 32% were in children's hospitals within combined children/adult hospitals. All PEDs (100%) had cared for pediatric patients with COVID-19 at the time of the survey. The ED populations varied from <20,000 to >100,000 annually, and hospital size from <100 to >400 beds.

Theme 2. Changes in Patients Flow Across PEDs

All PEDs (100%) witnessed decreases in non–COVID-19 patients. Sixty percent had COVID-19–dedicated units, and 32% changed their unit pediatric patient age to include adult patients (>18 years of age; Table 1).

Theme 3. Changes in the Staffing Model

All PEDs (100%) implemented changes to their staffing model, with the most common change impacting their physician staffing (80%) and triaging model (76%), defined as the process of assessment of a patient on arrival to the ED to determine the priority for medical care based on the clinical urgency. The majority (92%) prohibited medical students from any direct patient care, whereas 52% and 16% limited but did not prohibit residents and fellows from direct patient care, respectively Table 1.

TABLE 1. Changes in Patient Flow and Staffing Model

	n (%)
Changes in Patients Flow Across PEDs	
Presence of COVID dedicated unit(s)?	
Yes	15 (60.00)
No	10 (40.00)
Change in the age range of patients seen at your PED to include adult patients	
Yes	8 (32.00)
No	17 (68.00)
Changes in the staffing model	
Implementation of changes to the health care provider staffing model	
Change in length of shift	9 (36.00)
Change in providers assignment for COVID-19 patients (dedicated teams)	7 (28.00)
Change in triaging model	19 (76.00)
Change in room assignment	17 (68.00)
Introduced remote patient monitoring	7 (28.00)
Change in physician staffing	20 (80.00)
Other	5 (20.00)
Limiting the exposure of medical trainees for patients with known or suspected COVID-19	
Fellows prohibited from direct patient care	—
Fellows limited but not prohibited from direct patient care	4 (16.00)
Advanced practice providers students prohibited from direct patient care	4 (16.00)
Advanced practice providers students limited but not prohibited from direct patient care	1 (4.00)
Residents prohibited from direct patient care	1 (4.00)
Residents limited but not prohibited from direct patient care	13 (52.00)
Medical students prohibited from direct patient care	23 (92.00)
Medical students limited but not prohibited from direct patient care	—
No changes	—

Theme 4. Use of Enhanced PPE

All PEDs (100%) conducted training for appropriate donning and doffing of PPE. The 2 most common formats were hands-on training (76%) and video-based content (84%). All PEDs had procedures to enhance PPE practice safety and audit competencies among providers. Efforts for optimization of the doffing areas varied, but 56% had dedicated staff to observe the doffing process and had dedicated doffing zones. Sixty percent of PEDs reported shortages in PPE (Table 2).

Theme 5. Practice Changes/Innovations

The most common concerns related to the current COVID-19 practice were changes in protocols and guidelines (72%) and a shortage in equipment and supplies (36%). The majority implemented changes in the airway management protocols (84%) and cardiac arrest management in COVID patients (76%). The most common innovations in airway management were decreasing team members in the room during resuscitation (96%) and using video laryngoscopy only for intubation (72%). The most common innovations in cardiac arrest management were decreasing team members in the room during resuscitation (88%) and caring for

TABLE 2. The Use of PPEs

	n (%)
Current issues/limitations in regard to the utilization of PPE	
Lack of access to PPE	—
Shortage in PPE	15 (60.00)
Inability to reuse PPE	1 (4.00)
Other issues	10 (40.00)
Conducting training to appropriately don and doff PPE for PED staff?	
Yes	25 (100.00)
No	—
Unsure	—
Format of the PPE training?	
Hands on training	19 (76.00)
Video-based content	21 (84.00)
Didactic/small group training	9 (36.00)
E-mail material	17 (68.00)
Other	4 (16.00)
Procedures to enhance safety in PPE	
Buddy system	8 (32.00)
Increased staff	3 (12.00)
Dedicated staff (spotter)	11 (44.0)
Distribution of printed safety	16 (64.00)
Other	6 (24.00)
Auditing PPE competencies?	
Assess the performance of doffing team	11 (44.00)
Written examination	—
Simulation assessment	6 (24.00)
Provide structured feedback around key competency areas	7 (28.00)
Regularly assess competencies with spot checks and/or video	8 (32.00)
None	7 (28.00)
Other	—
Optimization of doffing areas	
Dedicated doffing area to avoid team members from bumping into one another or equipment	14 (56.00)
Zoning to distinguish clean area from potentially contaminated areas to reduce the likelihood that team members cross over between these areas spreading contamination	11 (44.0)
We use the same space for donning and doffing of PPE	12 (48.00)
Dedicated staff to observe the doffing process (doffing spotters)	14 (56.00)
Other	8 (32.00)

patients with suspected or confirmed COVID in negative pressure rooms only (48%). Only 56% of PEDs implemented training for surge capacity management. The most common methods for keeping PED providers updated and best-prepared regarding COVID-19 preparedness activities were mass e-mail messaging (96%) and virtual meetings (84%; Table 3).

Theme 6. Training Modalities of COVID-19

The most common training modalities were video/teleconference (84%) and simulation-based training (72%). The most common learning objectives were team dynamics (60%), and PPE and

TABLE 3. Practice Changes/Innovations

	n (%)
Concerns related to the current COVID-19 clinical practice	
Lack of clinical guidelines/protocols	6 (24.00)
Change in guidelines/protocols	18 (72.00)
Lack of PPE training	3 (12.00)
Physician staff shortage	2 (8.00)
RN staff shortage	3 (12.00)
Other staff shortage	2 (8.00)
Shortage in equipment/supplies	9 (36.00)
Patient surge and crowding	5 (20.00)
Other	9 (36.00)
No concern	1 (4.00)
Implementation of training in airway management	
Yes	21 (84.00)
No	4 (16.00)
Unsure	—
Practice innovations in airway management	
Caring for patients with suspected or confirmed COVID in negative pressure room	11 (44.00)
Using video laryngoscopy only for intubation	18 (72.00)
Decreasing clinical care team number	24 (96.00)
Incorporating new methods of communication between team members	17 (68.00)
Implementing airway management checklists	14 (56.00)
Using telemedicine/video technology	10 (40.00)
Other	5 (20.00)
Intubation of suspected or confirmed COVID patients	
An anesthesiologist who responds as part of the airway team	7 (28.00)
An anesthesiologist or other dedicated airway provider who is called if intubation is required	7 (28.00)
An attending physician unless the patient is suspected of having a difficult airway	11 (44.0)
An attending physician or emergency senior resident/fellow	8 (32.00)
An attending physician or emergency junior resident	—
Other	3 (12.00)
Any appropriately trained member of the team	2 (8.00)
Implementation of training for cardiac arrest management	
Yes	19 (76.00)
No	6 (24.00)
Unsure	—
Practice innovations for cardiac arrest management	
Caring for patients with suspected or confirmed COVID in negative pressure rooms only	12 (48.00)
Changing CPR practice	8 (32.00)
Decreasing clinical care team numbers	22 (88.00)
Incorporating new methods of communication between team members	12 (48.00)
Using telemedicine/video technology	7 (28.00)
Other	5 (20.00)
Implementation of training for surge capacity management	
Yes	14 (56.00)
No	11 (44.00)
Unsure	—

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TABLE 3. *(Continued)*

	n (%)
Methods to update all providers updated regarding COVID preparedness activities	
Mass e-mail	24 (96.00)
Regular in-person huddle/meetings	12 (48.00)
Virtual conferences/meetings	21 (84.00)
Simulation-based	10 (40.00)
Other	3 (12.00)

CPR indicates cardiopulmonary resuscitation; RN, registered nurse.

individual procedural skills trainings (56%). The majority of simulation occurred in the in situ setting in patient care areas (64%). High-fidelity and low-fidelity simulators were used in 36% and 40% of PEDs, respectively. The most helpful simulation training was team training and team dynamics (44%). The least helpful simulation trainings were individual procedural skills (24%). The most common facilitators to conducting simulation were the established simulation team within the department/hospital (56%). The most common challenges to conducting simulation were securing adequate PPE (44%) and lack of time for preparation (28%; Table 4).

DISCUSSION

This report provides an early view of the initial policy changes, management, and training of hospital personnel in pediatric emergency medical facilities in the United States in response to the COVID-19 pandemic. The majority of facilities used personnel changes that incorporated changes in physician staffing, triaging, and room assignments. All facilities reported PPE training for donning and doffing, with the biggest issue regarding PPE being availability. The majority of programs provided staff with updated airway training and cardiac arrest management training. Video/teleconference and simulation-based training were the top modalities used to train staff. The primary focus of this simulation-based training was PPE donning/doffing, procedural skill performance, and team dynamics.

Despite that previous studies have highlighted health care system obstacles that impact preparedness during the current pandemic,[9,10,12,13] there are limited data specific to PED preparedness. One recently published survey of 65 PEDs in North America identified staffing, operations, and clinical care changes due to COVID-19.[14] They reported that a majority of PEDs had COVID-19–dedicated units to protect staff and patients from virus exposure, 46% of PEDs had PPE shortages, and academic teaching programs limited medical students and resident direct patient care of persons under investigation for COVID-19. These findings are all consistent with our survey findings of PEDs within the ImPACTS research network. Overall, surveyed PEDs reported implementing numerous practice innovations to reduce the risk of health care worker transmission. This risk reduction is of utmost importance, as health care provider exposure to COVID is a serious threat. In a study of European pediatric EDs, 25% of centers reported COVID-positive ED staff, with even higher contagion rates in inpatient centers (69%).[15] In addition, in pediatrics, staff may be at increased risk because of children often being asymptomatic carriers.[16]

In addition to assessing changes in the clinical environment and staffing in response to COVID-19, our survey evaluated changes to staff training. These staff training changes incorporated technology and simulation-based strategies. The majority of the simulation-based training objectives included the use of PPE,

TABLE 4. Training Modalities of COVID-19

	n (%)
Modalities currently used for training staff	
Video/teleconference	21 (84.00)
Didactic	10 (40.00)
Online modules	13 (52.00)
Simulation-based training	18 (72.00)
Virtual reality	—
Other	—
Importance of simulation-based training for the preparation of ED staff for COVID-19 patient management	
Extremely important	7 (28.00)
Important	8 (32.00)
Neutral	3 (12.00)
Unimportant	—
Not at all important	—
Objectives of the simulation-based training	
PPE (donning and doffing)	14 (56.00)
Individual procedural skills (ie, intubation)	14 (56.00)
Team training (ie, CPR)	12 (48.00)
Team dynamics (ie, communication)	15 (60.00)
Mass casualty and surge capacity management	5 (20.00)
Diagnostic testing	2 (8.00)
Facility utilization and contingency planning (use of negative pressure rooms)	10 (40.00)
Tent deployment	3 (12.00)
Other	1 (4.00)
Location of the training	
Simulation center	5 (20.00)
In situ	16 (64.00)
Classroom setting	1 (4.00)
Other format (boot camp)	3 (12.00)
Simulation equipment	
High-fidelity (full-body mannequin) simulator	9 (36.00)
Low-fidelity (full-body mannequin) simulator	10 (40.00)
Task trainers (intubation heads, central line trainers, etc)	5 (20.00)
Standardized patients (actors)	3 (12.00)
Virtual reality	—
Other	1 (4.00)
Participating members	
Physicians	18 (72.00)
Nurses	16 (64.00)
Respiratory therapists	14 (56.00)
Technicians	14 (56.00)
Residents/fellows	14 (56.00)
Students	—
Other staff	6 (24.00)
Most helpful simulation training	
PPE (donning and doffing)	7 (27.00)
Individual procedural skills (ie, intubation)	9 (36.00)
Team training (ie, CPR)	11 (44.00)
Team dynamics (ie, communication)	11 (44.00)
Other	3 (12.00)
Leas helpful simulation training	
PPE (donning and doffing)	4 (16.00)

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TABLE 4. *(Continued)*

	n (%)
Individual procedural skills (ie, intubation)	6 (24.00)
Team training (ie, CPR)	2 (8.00)
Team dynamics (ie, communication)	3 (12.00)
Other	6 (24.00)
Facilitators of the simulation-based training	
Presence of a simulation center	11 (44.00)
Presence of a simulation team in your department/hospital	14 (56.00)
Buy-in/support from hospital administration team	11 (44.00)
Involvement in other simulation collaborative and simulation leadership	11 (44.00)
Other	2 (8.00)
Challenges to executing simulation-based training	
Buy-in/support from hospital administration team	2 (8.00)
Financial resources	3 (12.00)
Securing adequate supplies (PPE)	11 (44.00)
Staff buy-in and participation	2 (8.00)
Lack of a trained simulation team	1 (4.00)
Lack of simulation logistics/supplies	2 (8.00)
Lack of time for preparation	7 (28.00)
Lack of desire for this form of training	—
Other	7 (28.00)
Development of novel or unique training equipment or training aides	
Yes (ie, intubating fume hood) please share	9 (36.00)
No	9 (36.00)

CPR indicates cardiopulmonary resuscitation.

individual procedural skills (ie, intubation), and team dynamics (communication). Of note, greater than 60% of these simulation-based trainings were conducted in situ, particularly in the airway and cardiac arrest management. This could be attributed to the fact that cardiac arrest and airway management are among the highest risk procedures that put staff at a high exposure risk to infection.[13] This training, in situ, is important to help seasoned staff overcome the "muscle memory" of executing resuscitations in a standardized way for years. The in situ interprofessional environment can quickly and effectively "disrupt" the standard operating procedure in a way that is most effective in highlighting significant changes to the protocol in preparation for modifications to practice in the actual clinical environment. The use of in situ simulation as a tool to evaluate new processes of care, measure system preparedness, and identify targeted areas for improvement has been reported in diverse clinical settings.[17–19]

Interestingly, the most common challenge to conducting simulation was securing adequate PPEs, which correlated with the reported shortage in PPEs in 60% of surveyed PEDs. Although this may pose a risk of health care providers while providing clinical care and negatively impact the realism of the simulation-based training, staff in health care facilities can probably mitigate that by wearing parts of their PPEs or finding acceptable alternatives to PPEs during simulation-based training.

Our findings highlight the importance of supporting a learning organization model based on rapid cycle experimentation and innovation and by the sharing of experiences between PEDs to avoid "reinventing the wheel," particularly during these challenging times. Future investigations should aim to identify data-supported best practices of pandemic-specific protocol changes.

This study has several limitations. The survey was only disseminated to PEDs that are in the ImPACTS research collaborative in the United States. The PEDs included in the research collaborative are pediatric academic medical centers with active simulation programs and do not reflect the preparedness of general EDs where the majority of ill and injured children initially present. It was conducted during a short period of 2 months at the start of the pandemic and may not reflect the subsequent changes throughout the whole pandemic to date. All these factors limit its generalizability. Future studies should evaluate the effectiveness of these various staffing, training, and management interventions to identify best practices in preparation for future pandemics.

CONCLUSIONS

This national survey provides insight into PED preparedness efforts, training innovations, and practice changes implemented during the start of COVID-19 pandemic to optimize staff safety and patient care. Our findings highlight the importance of sharing experiences between PEDs, particularly during these challenging times. Future research is needed to better understand the effectiveness of these preparedness efforts and support deep learning about which preparedness actions are effective for ongoing and future pandemics.

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