Curr Treat Options Peds (2017) 3:246–253
DOI 10.1007/s40746-017-0090-z

Disaster Medicine (M Anderson and M Dingeldein, Section Editors)

Pediatric Preparedness: Children's Hospitals Preparation for Disasters

Deanna Dahl Grove, MD

Address
University Hospitals Rainbow Babies and Children's Hospital, Case Western Reserve University, School of Medicine, 11100 Euclid Ave, Cleveland, OH, 44106, USA
Email: dld7@case.edu

Published online: 17 July 2017

This article is part of the Topical Collection on *Disaster Medicine*

Keywords Children's hospitals · Disaster preparedness · Surge capacity · Crisis standards of care · Pediatrics

Opinion statement

Children's hospitals and pediatric disaster preparedness seem to be an obvious partnership. Children's hospitals care for children and families, and their staff are experts in their fields. Individual children's hospitals and their staff, lending their expertise to healthcare coalitions across the nation will improve the preparedness for children and families. But children's hospitals need to take a more coordinated approach to disaster preparedness, by participating in their own preparedness, participating in their own drills, communicating and coordinating with external entities, and sharing their lessons learned through education. In addition, children's hospitals can promote readiness among hospitals that refer pediatric patients, through the Emergency Medical Services for Children (EMSC) National Pediatric Readiness Project. This can enhance the care of children in hospitals that do not care for children often and reenforce transfer agreements between entities. Thus, these hospitals would be better prepared to care for children on a daily basis and even better prepared should a disaster strike and would have a solid relationship with an expert partner, their children's hospital. Children's hospitals can also partner with their state EMSC representative and AAP disaster chapter contact to promote the welfare of children and families in a coordinated effort for disaster preparedness on a regional level. The Children's Hospital Association can be a source of coordinated efforts for its members and promote disaster preparedness efforts among members and outreach to health care coalitions. Progress has been made in the area of pediatric disaster preparedness, but there is much work to be done and children's hospitals have an important role to play in promoting preparedness on a local, regional and national level, through education, networking, and participation in healthcare coalitions.

Introduction

Disasters are increasingly in the public domain, due to our global society and social media. The images of children and families in distress remind people of the human toll that disasters take on individuals and communities. The awareness of disaster preparedness has been at the forefront in the USA since September 11, 2001. Subsequent disasters, including hurricanes Katrina and Sandy, remind people of the necessity to prepare for any type of disaster, with particular focus on children. Hospitals are a key component in any disaster to provide care to ill and injured people. Recommendations to incorporation children in to all aspects of disaster preparedness were given in the National Commission on Children in Disasters 2010 [1], including increased health system capacity and health professional education among many items identified. Resources have been developed to assist hospitals with disaster preparedness, and funding from the Assistant Secretary Preparedness and Response (ASPR) through the Hospital Preparedness Program (HPP) [2], but funding has shrunk and preparedness for children at these hospitals continues to be overlooked [3]. New Center for Medicare and Medicaid Services (CMS) emergency preparedness guidelines require that emergency plans and drills include special populations, of which pediatrics is one group [4].

Children make up almost 25% of the population in the USA [5]. Resources and toolkits have been developed to assist hospitals to prepare to care for children in disasters [6]. Speciality hospitals, such as children's hospitals, can have a key role in disaster preparedness. A study found that nearly 64% of the pediatric populations is located within 50 miles of a pediatric hospital, although there are some areas where a pediatric hospital are not easily accessed [7]. The role of children's hospitals in the healthcare system is to provide the specialized care to the pediatric population addressing the particular needs that children may have during illness or injury. Children are uniquely effected in disasters and require specialized care to ensure that they can recover and resume their lives within their families. Children's hospitals and their staff can be a source of wisdom and expertise when disasters strikes and have been active in the recent years contributing to pediatric preparedness.

Survey of children's hospitals

A survey conducted by the Disaster Response Task Force, appointed by the Children's Hospital Association (CHA) assessed the baseline preparedness of member hospitals and identified means to support hospitals through a framework. Sixty-four members (36%) responded representing a wide variety of institutions, free standing, urban, and rural hospitals in many geographic areas. Seventy percent reported having a standing committee dedicated to disaster preparedness, and 58% had an operating budget, with dedicated funds $2000–500,000 annually. Respondents (84%) had written plans for participation in local or state drills and 33% in national drills. Respondents participated in table top (89%) or live drills (86%), with some children's hospitals coordinating with regional partners, such as adult hospitals or daycares and schools. Memorandum of understanding (MOU) with regional adult hospital for patient transfers and/or supplies was reported by 81% of respondents, and 37% had an MOU with another children's hospital. Respondents reported that they felt more prepared for local or regional events than for national or international events. Opinions expressed by the respondents regarding future efforts included education and networking, development of best practices for drills, training and

interdisciplinary response teams, and potential national MOU between children's hospitals [8••].

Networking

Networking an important component for sharing of information and resources was identified as an element from the Disaster Response Network CHA survey. A coordinated effort of children's hospitals with the Center for Disease Control and Prevention (CDC) and American Academy of Pediatrics (AAP) occurred during the Ebola crisis of 2014–2015. The Pediatric response network consisted of 21 states (1–7 hospitals per area) and territories that participated in a virtual forum to exchange critical information with regard to Ebola within the pediatric population. In addition, the Pediatric response network fostered sharing of resources and improved the readiness of children's hospitals [9•]. Participants expressed that the network could serve as a forum to continue to share innovations and improvement of best practices in a broad area of pediatrics, but especially for disaster preparedness.

Another lesson from the Ebola crisis came from the UK. The authors described a system to care for pediatric patients with suspected Ebola during the crisis. Their process can serve to guide future planning for healthcare workers, hospitals, general public to create contingency plans for highly infectious outbreaks [10].

Disasters and drills

Reflection on events of a disaster has value to other hospitals, one children's hospital that had victims from the Boston marathon bombing in 2013 (total of 7 hospitals) was part of a qualitative after action leadership review. Themes identified during the review included: communication, use of social media, management of volunteers, and use of the EMR. During the event communication was a bottleneck, when cell towers were taken off line. Social media was helpful to circumvent communication, in particular "Twitter", to relay information to platform users. Another important lesson identified by leaders was to control of the number of volunteers arriving to help; leaders identified that having a plan away from patient care areas to coordinate these eager individuals was important so that there was not interference with ongoing clinical care. The EMR was another crunch point for efficiency, as healthcare members attempted to enter orders and document patient care. In addition, patient tracking was challenging, since there was not a common information system between institutions and prehospital agencies in the area [11]. The lessons learned from this incident can inform healthcare coalitions that include children's hospital on how they may improve their own processes before a live event occurs.

The Ebola crisis of 2014–2015 created an another opportunity for a children's hospital's at the center of the crisis, to use simulation and multiple Plan-Do-Study-Act (PDSA) cycles to evaluate safety threats and practice the process of personal protective equipment (PPE) doning and doffing for staff. This use of simulation assisted to identify threats and corrective actions in addition to create recommendations for use of simulation in disaster preparedness. The deliberate practice of using simulation assisted with preparation for an event

with a patient suspected of having Ebola and can inform preparation for future exposure to other highly infectious agents [12].

Another hospital shared an experience with a drill designed to test a pediatric intensive care unit (PICU) surge and appropriate medical management of patients in an Electronic Medical Record (EMR). The surge plan included the use of a general inpatient bed ward near the PICU for lower acuity patients. They were able to demonstrate that appropriate medical care could occur with use of their EMR in the PICU. During the drill, excessive staff were artificially available, to maintain "regular" patient care and there was heavy reliance upon trainees. In addition other lessons included that all hospital staff were not familiar with the surge plan and communication between units was not optimal [13].

Drills that involve regional coalitions are another means to evaluate pediatric readiness and are vital to support preparedness across and within multiple community partners to care for children. One children's hospital in the Midwest surveyed community hospitals use of live pediatric actors for drills (<16 years old) and found that many do not use live child actors. The range was 10–32% of hospitals that used live pediatric actors [14]. Live pediatric actors add a realistic component with unexpected challenges and spontaneity to a drill and assist to incorporate contingencies into mitigation for future exercises.

Another children's hospital, as a member of a coalition, created a drill that involved pediatric victims for a mass causality incident (MCI) event that involved multiple regional hospital partners. The study did a qualitative and quantitative evaluation of the drill to create improvement opportunities for emergency response and hospital preparedness for pediatric patients. Recommendations from this study included all hospitals conduct regular drills with pediatric victims, regular assessment of equipment for pediatric patients, clarification of roles during disasters and communication of roles, and ongoing education and training for all participants [15]. This type of drill with a regional coalition challenges many aspects of the disaster readiness spectrum and identifies elements and processes for improvement to ensure the preparation to care for children, beyond the speciality hospital.

Education

Education is vital to improve the care provided in a disaster. A children's hospital created a workshop with regional partners to improve triage of pediatric patients in a disaster. The workshop revolved around MCI triage, creating a scenario that curtailed access to the centrally located children's hospital. The primary aim was to implement an educational intervention on pediatric triage conducted by local pediatric experts who were members of the healthcare coalition, and the secondary aim was to assess MCI triage of providers after a just-in-time training (JIT). Components of the workshop consisted of keynote speaker with experience in Katrina, JIT on JumpSTART/SALT triage, and discussion about the Pediatric Assessment Triangle, length-based resuscitation tape use and safe transport of pediatric patients. A practical workshop followed the trainings where participants assigned triage colors to simulated patients. Conclusions of the workshop were that participants with less acute care experience and less exposure to pediatric patients did not perform MCI triage as well as more experienced individuals. In addition, simulated pediatric patients were

often over-triaged. Requests for subsequent similar workshops have followed the initial workshop [16].

Creating capacity

Creating capacity to care for pediatric patients during a disaster is an important element for hospitals and regional coalitions to coordinate before an event. The number of overall pediatric beds is smaller than general hospital beds in the USA and during a large scale event involving children, pediatric beds would likely need to be used for higher acuity pediatric patients and the ability to create space in nonpediatric beds would become vital. Reverse triage is a means of creating bed space and has been used for adult patients, but the not pediatric patients. Identifying appropriate patients for reverse triage and testing whether the process would create the necessary additional beds spaces is an important tool. A panel of experts was convened to create a classification system for pediatric reverse triage and early discharge [17]. The study then tested the classification system at one children's hospital. The classification did create needed surge space in the simulated scenario, but relied upon psychiatric unit early discharges to create space and identified that the role of pediatricians in the community would be key to follow up early discharged patients [18].

Pediatric beds, especially pediatric critical care beds, may be another scarce resource during disasters, especially if a surge of critically ill or injured children were to occur. The process of allocation and determination of how to use this scarce resource needs refinement. A workshop attended by individuals interested in critical care and disaster preparedness evaluated critical care bed allocation and pediatric triage in disaster/pandemic settings among attendees. The survey sought to determine if there could be consensus on triage and whether other factors such as age and preexisting conditions should be considered. The participants felt that all pediatric ages (neonate to adolescent) should be included and priority of those with the best neuro-developmental outcome. There was not a consensus on use of a subjective or objective score to triage critical care patients during a pediatric surge event [19•]. Since this survey, a critical care triage tool for pediatrics during crisis standards of care has been developed [20••]. Use of this tool during a simulated pandemic event suggested that survival was better with application of the score, than a first come first serve application [21].

Staff

Another important component of children's hospital preparation is the staff, determining whether they will be willing to come to work, anticipating potential barriers to working during and caring for staff members following a disaster. Child care could be a major barrier for staff attendance during a disaster. A study involving staff at a children's hospital assessed whether attendance at work would change for certain types of disasters. The authors identified that child care would affect ability to work during a pandemic event more than an earthquake, but the reasons for this difference were not elucidated. Furthermore, staff would rely upon hospital supported childcare and many individuals did not have an emergency childcare plan. The authors concluded that emergency childcare should be a component of any hospital disaster plan [22•].

Psychological support following a major incident is another component of disaster preparedness and vital to the recovery to normal operations and staff retention. A study following an incident at a European children's hospital identified staff that developed post traumatic stress disorder (PTSD). The study identified that staff members level of direct incident involvement, prior psychiatric conditions and phobias following the incident were more likely to have PTSD [23]. Ensuring that staff can be relied upon to respond in a disaster by having individuals and families create a disaster plan, anticipating the needs of personnel, and creating a supportive environment for recovery can encourage hospitals to return to normal operations as soon as feasible and foster resilience.

Conclusions

Children's hospitals and their expert staff are a key component in overall disaster preparedness. These speciality hospitals are experts in the care of ill and injured children and have leading pediatric specialists that are experts in their fields on their staff. Children's hospitals and their staff members can play a role in healthcare coalitions as the experts on pediatric issues, providing education, guidelines, leadership, and advocacy to improve the care of children, especially in disaster preparedness. Recent work in the areas of education, capacity building, critical care triage tool, and reverse triage has highlighted some of the areas that individuals and institutions have contributed to the knowledge of children in disasters. Networking during the Ebola crisis has created a framework for children's hospitals to work together to promote communication regarding best practices in disaster preparedness among themselves, which could eventually be shared with other entities. Continuing to foster this network, with regular discussions for disaster preparedness among children' s hospital administration and staff will promote disaster preparedness and likely continue to be a forum for sharing ideas and fostering new approaches to this important work. Sharing experiences or lessons learned will improve children's hospitals disaster preparedness and let these special hospitals be an expert resource to other healthcare institutions. There remains much work to be done among children's hospitals own preparedness and their role in healthcare coalitions to promote broader disaster preparedness for children.

Children's hospitals, in the survey done in 2011, desired to have more involved in regional drills by being a member of a healthcare coalition; this will let them lend their expertise in the care of children while cementing their relationship with a coalition. This partnership would further increase the demand for pediatric education among coalition members and assist with the coordination of more regional drills, improving all coalition members care of children, and may result in creating a best practices approach for pediatric drills, or at least incorporating children into drills. A recent survey has been conducted to ascertain among pediatric emergency departments that conduct disaster drills the best practices for drills that incorporate children (personal communication), and this may assist children's hospitals and other hospitals on creating pediatric drills. Children's hospitals as a member of a coalition can also foster interdisciplinary teams devoted to the care of children. The teams could be pediatric specialist only or may involve other disciplines to encourage buddy

systems to care for children in a disaster, promoting more individuals to be prepared to care for children in the future. Children's hospitals and their staff are wealth of knowledge in the care of pediatric patients and using this knowledge and expertise to promote pediatric disaster preparedness is a vital to healthcare of the USA and the global community.

AAP, American Academy of Pediatrics; CDC, Center for Disease Control; CHA, Children's Hospital Association; EMR, electronic medical record; JIT, just-in-time training; MCI, mass causality incident; MOU, memorandum of understanding; PDSA, Plan-Do-Study-Act; PICU, pediatric intensive care unit; PPE, personal protective equipment; PTSD, post traumatic stress disorder.

Compliance with Ethical Standards

Conflict of Interest
Deanna Dahl Grove declares no potential conflicts of interest.

Human and Animal Rights and Informed Consent
This article does not contain any studies with human or animal subjects performed by any of the authors.

References and Recommended Reading

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1. On children and disasters - AHRQ Archive–Home Page. https://archive.ahrq.gov/prep/nccdreport/nccdreport.pdf. Accessed 29 Apr 2017.
2. "Hospital Preparedness Program (HPP)." *Hospital Preparedness Program (HPP) - PHE*. N.p., n.d. Web. 01 May 2017.
3. Johnston C, Redlener I. Critical concepts for children in disasters identified by hands-on professionals: summary of issues demanding solutions before the next one. Pediatrics. 2006; doi: 10.1542/peds.2006-0099w.
4. "Overview." CMS.gov Centers for Medicare & Medicaid Services. N.p., 17 Mar. 2017. Web. 29 Apr. 2017.
5. Center for new media and promotions (C2PO) (2009) US Census Bureau 2010 Census. In: Visit Census.gov. https://www.census.gov/2010census/. Accessed 20 Apr 2017.
6. Pediatric Disaster Preparedness Toolbox. In: EIIC: Emergency Medical Services for Children | Innovation and Improvement Center. https://emscimprovement.center/resources/toolboxes/pediatric-disaster-preparedness-toolbox/. Accessed 20 Apr 2017.
7. Brantley MD, LU H, Barfield WD, Holt JB, Williams A. Mapping US pediatric hospitals and subspecialty critical care for public health preparedness and disaster response, 2008. Disaster Med Public Health Prep. 2012;6:117–25.
8. •• Lyle KL, Milton J, Fagbuyi D, LeFort R, Sirbaugh P, Gonzalez J, et al. Pediatric disaster preparedness and response and the nation's children's hospitals. Am J Disaster Med. 2015;10:83–91.

This article highlights not only the areas where children's hospitals are in disaster preparedness but also the work that needs to be done.

9. • Bartenfeld MT, Griese SE, Krug SE, Andreadis J, Peacock G. Establishing a hospital response network among children's hospitals. Health Secur. 2017;15:118–22.

This reference highlights the coordinated efforts to support preparedness for children's hospitals.

10. Herberg JA, Emonts M, Jacobs M, Riordan A. UK preparedness for children with Ebola infection. Arch Dis Child. 2015;100:421–3.
11. Goralnick E, Halpern P, Loo S, et al. Leadership during the Boston marathon bombings: a qualitative after-action review. Disaster Med Public Health Prep. 2015;9:489–95.
12. Biddell EA, Vandersall BL, Bailes SA, Estephan SA, Ferrara LA, Nagy KM, et al. Use of simulation to gauge preparedness for ebola at a free-standing children's

hospital. Simul Healthc J Soc Simul Healthc. 2016;11:94–9.

13. Shah VS, Pierce LC, Roblin P, Walker S, Sergio MN, Arquilla B. Waterworks, a full-scale chemical exposure exercise: interrogating pediatric critical care surge capacity in an inner-city tertiary care medical center. Prehosp Disaster Med. 2014;29:100–6.
14. Gardner MAH, Fitzgerald PMR, Schwartz MHP, Timm MNL. Evaluation of regional hospitals' use of children in disaster drills. Am J Disaster Med. 2013;8:137–43.
15. Burke, Rv , Kim TY, Bachman SL, Iverson EI, Berg BM. Using mixed methods to assess pediatric disaster preparedness in the hospital setting. Prehosp Disaster Med. 2014;29:569–75.
16. Kenningham MK, Koelemay K, King MA. Pediatric disaster triage education and skills assessment: a coalition approach. J Emerg Manag. 2014;12:141–51.
17. Kelen GD, Sauer L, Clattenburg E, Lewis-Newby M, Fackler J. Pediatric disposition classification (reverse triage) system to create surge capacity. Disaster Med Public Health Prep. 2015;9:283–90.
18. Kelen GD, Troncoso R, Trebach J, Levin S, Cole G, Delaney CM, et al. Effect of reverse triage on creation of surge capacity in a pediatric hospital. JAMA Pediatr. 2017;171:E1–8.
19.• Johnson EM, Diekema DS, Lewis-Newby M, King MA. Pediatric triage and allocation of critical care resources during disaster: northwest provider opinion. Prehosp Disaster Med. 2014;29:455–60.

Description of a regional approach to pediatric disaster preparedness education.

20.•• Toltzis P, Soto-Campos G, Kuhn EM, Hahn R, Kanter RK, Wetzel RC. Evidence-based pediatric outcome predictors to guide the allocation of critical care resources in a mass casualty event. Pediatr Crit Care Med. 2015;16:e207–16.

This is a potential scoring system that may be used to identify the use of pediatric critical care beds during an event where crisis standards of care are implemented.

21. Gall C, Wetzel R, Kolker A, Kanter RK, Toltzis P. Pediatric triage in a severe pandemic. Crit Care Med. 2016;44:1762–8.
22.• Charney RL, Rebmann T, Flood RG. Emergency childcare for hospital workers during disasters. Pediatr Emerg Care. 2015;31:839–43.

Evaulation of one aspect of institutions mitigation for staff in preparation for a disaster.

23. Zaffina S, Camisa V, Monducci E, Vinci MR, Vicari S, Bergamaschi A. PTSD prevalence and associated risk factors after a fire disaster that broke out in a pediatric hospital: a cross-sectional study. Med Lav. 2014;105:163–73.