

Evacuation of a Neonatal Intensive Care Unit in a Disaster: Lessons From Hurricane Sandy

abstract

NICU patients are among those potentially most vulnerable to the effects of natural or man-made disaster on a medical center. The published data on evacuations of NICU patients in the setting of disaster are sparse. In October of 2012, New York University Langone Medical Center was evacuated during Hurricane Sandy in the setting of a power outage secondary to a coastal surge. In this setting, 21 neonates were safely evacuated from the medical center's NICU to receiving hospitals within New York City in a span of 4.5 hours. Using data recorded during the evacuation and from staff debriefings, we describe the challenges faced and lessons learned during both the power outage and vertical evacuation. From our experience, we identify several elements that are important to the functioning of an NICU in a disaster or to an evacuation that may be incorporated into future NICU-focused disaster planning. These include a clear command structure, backups (personnel, communication, medical information, and equipment), establishing situational awareness, regional coordination, and flexibility as well as special attention to families and to the availability of neonatal transport resources. *Pediatrics* 2014;134:e1662–e1669

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KEY WORDS

NICU, neonatology, neonates, vertical evacuation, Hurricane Sandy, disaster preparedness, power outage

ABBREVIATIONS

FEMA—Federal Emergency Management Agency

HFOV—high-frequency oscillator ventilation

NYULMC—New York University Langone Medical Center

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Hospital evacuations occur globally with surprising frequency in response to both external (man-made or natural) and internal factors, with Sternberg et al¹ reporting that 275 evacuations occurred internationally in the period between 1971 and 1999. Despite this fact, published data on hospital evacuations are scarce.² Bagaria et al² found only 69 cases of hospital evacuation published globally between 1979 and 2009, 15 of these occurring in response to hydrometeorologic events. The published data on evacuation of NICUs are even fewer and have come almost exclusively from experiences during Hurricanes Katrina³⁻⁶ and Rita^{7,8} in 2005. In a period of 15 months, the city of New York was impacted by 2 severe coastal storms: Hurricane/Tropical Storm Irene in August 2011 and Hurricane Sandy in October 2012. The scale of impact of the latter was larger and consequently more widely discussed.⁹⁻¹¹ In both instances, our hospital, New York University Langone Medical Center (NYULMC), was evacuated.

This report is a firsthand descriptive account and analysis of the processes and challenges of the Hurricanes Irene and Sandy evacuations. Objective data and data compiled during debriefings of medical, nursing, and ancillary staff involved in the evacuations are used to distill useful lessons from our experience. Our objective is to identify from our experience key elements that may be applied to future disaster planning focused on the NICU population.

PREVIOUS EVACUATION EXPERIENCE

Hospital Background and Geography

The NICU at NYULMC, the primary teaching hospital for New York University School of Medicine, is a 29-bed level III C NICU. It is a referral NICU and Regional Perinatal Center supervised by 7 full-time

neonatologists and 6 neonatal fellows. It is staffed by a medical team of 4 to 6 residents plus nurse practitioners/physician assistants together with 8 to 12 nurses on duty per shift, respiratory therapists, and additional ancillary staff. The average daily census is ~25. The hospital is located in midtown Manhattan along the East River, lying within “zone 1” of New York City’s Office of Emergency Management flood evacuation maps, the area of the city most susceptible to coastal flooding.

Hurricane/Tropical Storm Irene

Although it was initially a category 1 hurricane, Irene was downgraded to a tropical storm by the time of landfall in southeastern New Jersey. With New York City directly in its path, on the morning of August 26, 2011 (1 day before landfall), city authorities ordered the evacuation of 4 medical facilities within Flood Zone 1, including NYULMC. At the time, the NICU census was at 19, with 3 mechanically ventilated premature infants including 1 infant receiving high-frequency ventilation. In addition, 1 infant was receiving nasal continuous positive airway pressure and 1 infant was receiving oxygen via nasal cannula, with the remainder being convalescing preterm infants (“feeder-growers”) or full-term infants undergoing sepsis evaluations.

Notification of the evacuation order was given by 6:30 AM, allowing ~36 hours before landfall within which to coordinate the first large-scale evacuation in the history of NYULMC. In the NICU, the 2 major challenges that needed to be met within that period were as follows: (1) finding alternate hospital beds and (2) coordinating transportation to receiving hospitals.

Alternate beds were found by the attending physician’s telephone calls to regional NICUs. As a tertiary referral NICU, we are normally a receiving center and as such not well acquainted with

other hospitals’ receiving capabilities and contact personnel. At that time, a single directory of regional NICUs and their capabilities was lacking. In addition, different institutions had different procedures when it came to accepting multiple transfers in the setting of an emergency. For some, the decision was left to the service or on-call attending physician. For others, approval to accept patients came from hospital administration. Competing requests from other institutions for beds further complicated matters.

Transport team personnel and equipment availability proved to be a major rate-limiting factor. Two ambulance companies contracted by our medical center provided ground transportation. Transport arrangements were made by the Hospital Incident Command Center, freeing the NICU staff for other tasks. In addition to ambulance crews, infants were accompanied by a neonatal fellow, nurse, and if needed, a respiratory therapist. Intravenous medications, oxygen, monitors, and emergency equipment accompanied each infant as needed.

Our NICU maintains 2 ambulance-ready transport isolettes that were prioritized to smaller infants or those who required respiratory support or intravenous infusion. While these were in use, transfers continued by transporting larger infants without ventilatory needs while being held by their mothers secured to stretchers. Warming pads and skin-to-skin contact were used for thermoregulation. In addition, critical care transport resources of receiving hospitals were used when available (4 patients). Infants were transferred to 8 receiving institutions in total, the farthest being Westchester Medical Center, which was 29 miles north. In total, the evacuation was carried out over a period of 18 hours.

Despite these challenges, a safe pre-emptive evacuation of 19 NICU infants occurred successfully without adverse events. Logistical and procedural

experiences gained during this evacuation would prove useful during the emergent evacuation that would occur 1 year later. These included (1) familiarization with regional hospital capabilities, personnel, and transfer procedures; (2) familiarization with our own incident command system and command structure; and (3) familiarization with practical aspects of mass interhospital transport, including overcoming the rate-limiting factors of equipment and personnel.

HURRICANE SANDY

In October of 2012, 15 months after Irene, New York City prepared for the arrival of another, more severe, coastal storm. We describe our response to Sandy in 3 phases: (1) pre-landfall preparation, (2) power outage and immediate response, and (3) vertical evacuation.

Pre-Landfall Preparation

Preparations were made at the regional, hospital, and unit levels for 2 scenarios: (1) shelter in place, meaning the continuation of hospital operation during the storm, and (2) evacuation, either preemptive or emergent. At the start of the weekend before landfall, the Hospital Incident Command System was established and all staff was put on alert. Frequent briefings of department and unit heads were held, and dormitories and provisions were provided to allow adequate staffing.

In the NICU, appropriately stable infants were discharged ahead of landfall. These were few, given the nature of the NICU patient population. In addition, the obstetric service transferred high-risk pregnant women to minimize the chances of delivery room resuscitation or new NICU admissions. All medical records and discharge summaries were updated and prearrangements were made with other NICUs to accept our patients in the event of mass transfer. One affiliate, Maimonides Medical Center in Brooklyn,

made preparations to accept more than half of our census. Ventilators, medication pumps, backup batteries, and other equipment were checked. Flashlights and batteries were made readily available. All red (emergency generator) outlets were checked, and all ventilators and essential equipment were plugged into them. Attending staff (most living within 20 minutes of the hospital) were on alert and stayed within the city, and many fellows and nurses stayed in in-house dormitories to ensure adequate staffing.

Storm Arrival, Power Failure, and Immediate Response

By the morning of October 29, governmental authorities had decided that NYULMC and other hospitals within the flood zone would shelter in place. The NICU census was 21, with 2 infants mechanically ventilated: 1 receiving conventional ventilation and 1 receiving high-frequency oscillator ventilation (HFOV). Four infants were receiving nasal continuous positive airway pressure. The remainder consisted of convalescing preterm infants receiving oxygen via nasal cannula or room air. Four infants had congenital heart disease, both pre- and postoperative, and 1 infant with necrotizing enterocolitis had undergone laparotomy that day.

A few minutes before 7:00 PM, at change of shift, the first signs of electrical power loss came as lights flickered and computers and monitors rebooted. The backup generators activated as the electrical grid for lower Manhattan went off-line. Immediately, staff made preparations in anticipation of a possible complete power loss. Handheld radios and flashlights were distributed. Pharmacists ensured that keys to the electronically controlled medication lock boxes were available. The single infant receiving HFOV was switched to conventional ventilation because HFOV does not have backup battery supply.

While backup generators were on the roof, fuel supplies were, by regulation, below ground and pumps became incapacitated by the unprecedented "500-year" level of storm surge. At ~8:30 PM, complete power loss was experienced and all lights, computers, monitors, telephones, electronically powered doors, and elevators were nonfunctional. The immediate response can be described as focusing on 5 priorities: (1) patient safety, (2) equipment and supplies, (3) communication, (4) alerting reserve personnel and organizing a command structure, and (5) continued patient care.

1. Patient safety: The neonatal fellow on call, together with the residents, senior nurses, and respiratory therapists, made quick patient assessments of each infant's vital signs and status, providing stabilization measures when needed.
2. Equipment and supplies: Respiratory support, oxygen supply, intravenous pumps, portable monitors, and backup batteries were checked.
3. Establishing communication and situational awareness: NICU personnel, specifically the clinical commander, maintained communication with the Hospital Incident Command System via handheld radio. Personal mobile phones were also used by individual staff.
4. Alerting reserve personnel and organizing a command structure: Neonatal faculty who had been on alert were notified and together with off-duty fellows and nurses who had been staying in makeshift dormitories reported to the NICU. Because the power outage coincided with change-of-shift, a double complement of nurses and respiratory therapists were on hand. Dr Pradeep Mally, the neonatology division chief and senior physician on site, assumed the role of clinical commander with a direct line to the hospital command center. Also on site were the chair and

vice-chair of the pediatric department helping to facilitate communication with the command center and other resources within the hospital (Fig 1).

- Continuing clinical care: While some were coordinating the emergency response, others were tasked with ensuring that clinical management proceeded uninterrupted. This process included administering feedings and medications, ensuring thermoregulation with extra blankets and warming packs, and checking vital signs manually. Cellular phone contact information was given to the Labor and Delivery Unit to ensure NICU team availability for deliveries. Our team was called to attend 1 delivery under flashlight during the blackout.

Evacuation

By 9:00 PM, the staff in the NICU was informed that the hospital would evacuate and that the NICU would be evacuated first.

Finding Beds

The first task was to find alternate hospital beds. Patients were prioritized on a white board taking into consid-

eration acuity, degree of respiratory support, and equipment battery life. Because the storm had forced the closure of nearly all bridges and tunnels out of Manhattan, the transfer of the majority of our patients to Maimonides Medical Center in Brooklyn as previously arranged was precluded. With hospital telephones inoperative, faculty members undertook the search for hospital beds using personal cell phones. Attending staff placed direct calls to regional NICUs using a regional NICU directory created after Irene. With good communication with the hospital command center allowing for situational awareness, physicians did not waste time contacting inaccessible hospitals or hospitals also affected by the power outage.

Factors limiting rapid hospital assignment included adequacy of surge staffing at potential receiving units and variability in the acceptance procedures. Just as in Irene, although in some hospitals agreement of the on-call neonatologist or NICU director sufficed, decisions in others were deferred to the hospital administration/command center. Despite these challenges, each patient was assigned to 1 of 6 receiving hospitals: New York Presbyterian Hospital–Weil

Cornell Medical Center, Morgan Stanley Children's Hospital at New York Presbyterian, Mt Sinai Hospital, St Luke's Hospital, Lenox Hill Hospital, and Montefiore Medical Center.

Transfer of Medical Information

The transfer of medical information is crucial to the safe evacuation of patients to another hospital. Our electronic medical records went offline with the electrical power loss. To overcome this challenge, the resident team used the day's printed hand-off sheets to prepare handwritten transfer summaries. In addition, they were tasked with giving verbal handoff to the receiving physician by cellular phone. Both of these tasks were accomplished by flashlight.

Vertical Transport

After making alternative hospital assignments and transferring medical information, the process of evacuation began by first determining the method of physically removing infants from the NICU and hospital. This meant movement of infants from our ninth floor unit to waiting ambulances at street level and from there to receiving hospitals. Under normal circumstances, temperature-controlled transfer isolettes with capabilities for vital sign monitoring and mechanical ventilation/oxygen delivery would be used. Although 2 of these are typically on hand in our NICU, the unavailability of functioning elevators precluded their use. The only evacuation route was via unlighted stairwell. Med Sleds (ARC Products LLC, Des Peres, MO) were available and were used in the other hospital units. However, without the preinserted infant inserts and any staff training in their use, we considered them unsuitable for infant transfer. The use of evacuation vests with pockets for 6 to 8 infants was also ruled out because we had a several-hour time window to allow for safe individual patient transport.

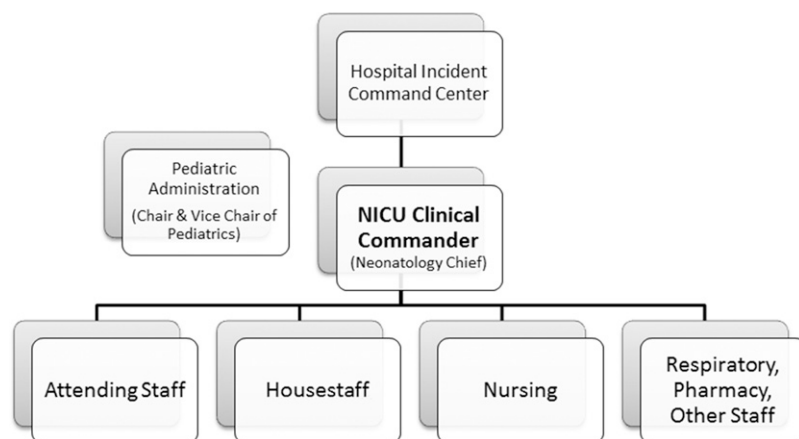


FIGURE 1

The unit command structure in the NYULMC NICU during Hurricane Sandy. The senior neonatologist was designated the local commander with the responsibility of directing all efforts and making decisions at the local level. He had a direct communication line with the Hospital Incidence Command Center. Other senior department leaders were present for assistance but did not overrule the unit commander's decisions.

We determined that the safest mode of evacuation was to have each infant hand-carried by a nurse, accompanied by a physician, a respiratory therapist, and additional nurses carrying monitors, intravenous pumps, oxygen tank, and respiratory supplies as needed. Temperature control was provided by swaddling and thermogenic warming packs. Endotracheal tubes were tested for security before movement and were held in place during transfer by the carrying nurse. Accompanying physicians provided positive pressure breathes to intubated infants with Ambu-bag or Neopuff (Fisher & Paykel Healthcare, Irvine, CA) device. For the sickest infants, evacuation involved up to 6 staff members walking together down 9 flights of stairs, a process that took ~10 minutes per patient. Stairwells were illuminated by flashlights held by students at each landing.

Interhospital Transport

Patient information and receiving hospital assignments were recorded and tracked upon leaving the NICU and again when leaving the ground floor staging area. On the ground floor, patients and teams were assigned to 1 of >60 waiting ambulances contracted by the Federal Emergency Management Agency (FEMA) in advance of the storm. Although in ordinary transport circumstances, a NICU patient might be transported via specialized critical care ambulance and crew, none were available during the evacuation. Instead, each infant was accompanied by a NICU nurse and physician (and respiratory therapist, as needed). The accompanying nurse held the infant while secured to a gurney. At receiving hospitals, transfer of medical information was made face to face by the transporting physician to the receiving physician.

With the aforementioned process, evacuation and transfer of all 21 infants were completed safely within <6 hours. There were no fatalities during or obvious

immediate adverse consequences to transfer. A timeline of the evacuation is provided in Fig 2.

Postevacuation

The NYULMC NICU remained closed for 2.5 months. Anticipating a quick reopening, all hospital employees remained on the payroll. Nurses and fellows were redeployed to other hospitals and faculty attended to their nonclinical duties in the interim. Although no longer involved in the infants' care, we followed up with weekly phone calls to the accepting hospitals. One infant, an ex-24-week infant with bilateral grade IV intraventricular hemorrhage evacuated at 40 weeks' post-conceptual age, expired at the receiving hospital 5 weeks later due to severe pulmonary arterial hypertension secondary to chronic lung disease. By the time of our reopening, only 1 infant remained hospitalized: an ex-24-week infant with history of necrotizing enterocolitis, total anomalous pulmonary venous return, and chronic lung disease who was evacuated at 29 weeks' post-conceptual age. This infant was back-transferred and hospitalized in our NICU for 2 weeks before expiring secondary to sepsis. All other infants were discharged well from their receiving institutions during the period of our closure.

CHALLENGES AND THE LESSONS LEARNED

Many of the challenges faced in our NICU's emergent evacuation during

Sandy were similar both to those we had experienced during Irene and to those experienced by others previously in similar circumstances. The major rate-limiting factors in executing a speedy evacuation in our and others' experience were as follows: (1) time spent finding accepting hospital beds, (2) transportation deficits, and (3) communication difficulties and maintaining situational awareness.^{4,7}

In our experience, finding hospital beds was the most time-consuming step. The varying procedures in different institutions for accepting mass transfers as well as individual hospitals' surge capacities and staffing impacted the speed of finding beds. Although attending staff did accomplish the task of finding alternate beds during both Sandy and Irene, central/regional coordination or management of mass transfer and bed assignments would be preferable. This situation would be particularly true should multiple hospitals need to evacuate and compete for beds concurrently, as was the case during Irene.

We found several key elements that facilitated the safe and timely evacuation of our NICU, as similarly described by Downey et al^{7,8} in their analysis of the evacuations during Hurricane Rita. These include the following: (1) familiarity with an evacuation plan, including triage strategies; (2) awareness of and determination of appropriate receiving hospitals; (3) determination of transportation resources; and (4) medical

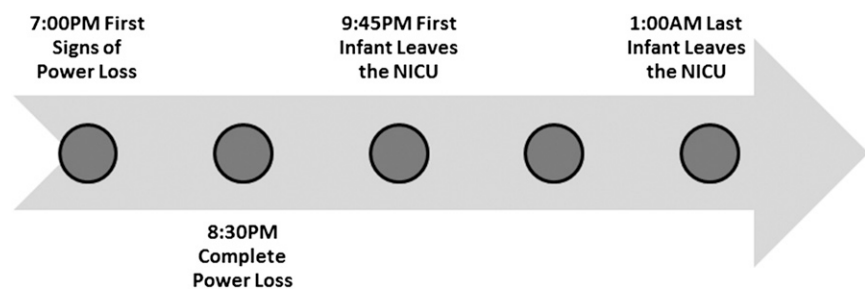


FIGURE 2

The timeline of the NYULMC NICU power outage and evacuation.

record transfer and patient tracking. Elements 2 and 3 are preferably arranged in advance of a potential disaster. In our case, advance alternate bed arrangements were put aside because of circumstances during the disaster. Transportation elements arranged beforehand by a FEMA ambulance contract were crucial to a timely mass transfer of patients.

Triage and prioritization strategies may vary from situation to situation and should be spelled out. During Sandy, we evacuated our most critical infants first. Under more immediate threats (eg, fire or explosion), utilitarian principles might prioritize evacuation of as many non-critical infants as possible within a short time frame.^{12,13}

Complementing those described above, we identify additional elements from our experience that are important to a disaster response within the NICU (Table 1) even without evacuation. First, a clear organization and command structure is critical. In addition to a hospital command center, the NICU must have a clearly identified “commander.” This can be the unit director, most senior neonatologist, or senior nurse. This person should have a direct line to the hospital command center and full decision-making ability within the unit.

Second, “backups” are critical for any eventuality. These include backup personnel, equipment, and batteries in addition to analog backups for computer-dependent systems such as electronic medical records and medication ordering systems. Communication backups are also critically necessary to communicate effectively within the hospital and to the outside. Based on our experience, our NICU has developed checklists to be used in preparation of a power outage and/or evacuation. These checklists focus on making sure appropriate backups in each of these areas are available before an emergency (copies available on request).

TABLE 1 Key Elements of NICU Disaster Response and Evacuation

| Disaster Response | Evacuation |
|---|--|
| <ul style="list-style-type: none"> • Clear organization and command structure • Backup systems (medical records, equipment, personnel) • Communication and situational awareness • Coordination with obstetric service • Communication with families • Flexibility and adaptability | <ul style="list-style-type: none"> • Familiarity with an evacuation plan and triage strategies • (Advance) determination of appropriate receiving hospitals • (Advance) determination of transportation resources • Medical record transfer and patient tracking |

Closely tied to command structure and backups are communication and situational awareness. Those in the unit must be clearly informed of the situation of the hospital as a whole and the region. Clear lines and backup methods of communication are essential. In our experience, situational awareness allowed those in the unit not to waste time contacting inaccessible or other adversely affected facilities. In addition, clear communication with the hospital command center kept us informed of what elements of the evacuation had already been arranged at a higher level (ie, ambulances).

A major consideration when dealing with a pediatric population, communication with parents, must be an essential component of disaster response and planning. At the time that Sandy made landfall, only 1 parent was present in the NICU whereas others were at home. With the loss of electricity, contact information maintained in the electronic medical record was unavailable. As a result, communicating with the majority of our patients' parents and providing them with necessary information regarding their infants' well-being and transfer was limited. However, with adequate tracking at both the point of exit from the NICU and the ground floor staging area we were able to provide information to the parents at a later time that night.

Regional coordination was also a crucial element of our response to the disaster. Analyses of previous disaster experiences reveal that those hospitals that incorporate the fewest outside

agencies in developing their disaster contingency plans required the longest time to evacuate their patients.⁷ During Irene, our preemptive evacuation was sped up by using the transportation resources of receiving hospitals to complement our own. During Sandy, the availability of FEMA-contracted ambulances was critical. In addition, after Irene, the New York City Pediatric Disaster Coalition compiled an NICU Resource Directory with essential statistics and contact information for NICUs within the region (<http://www.nyc.gov/html/doh/downloads/pdf/em/dir-nyc-nicu-hosp.pdf>). This centralized directory was useful in finding appropriate contact information in the midst of our power outage during Sandy.

As we did during Sandy, the NICU must also coordinate closely with the obstetric service. Coordinated planning and communication accomplish 2 purposes: (1) minimizing the expansion of the NICU census during a disaster and (2) ensuring delivery room coverage for neonatal resuscitation.

Last, in the NICU, flexibility and on-the-spot improvisation may be required. Despite all efforts at preparedness, one cannot predict every eventuality. Although we were fortunate not to have had to improvise methods of evacuation to the degree of those heroic neonatologists and nurses involved in Hurricane Katrina,^{4,6} on-the-spot thinking was crucial in determining how to safely transport our patients down 9 flights of stairs without transport isolettes or infant-sized evacuation equipment.

Areas of future development of regional disaster preparedness planning could include creation of a central bed management authority or system to facilitate mass transfers of patients. This system would relieve the “in the unit” clinicians of the task of navigating the labyrinthine processes between hospitals and allowing them to focus on transfer of medical information and stabilizing patients for physical transfer, allowing for more rapid evacuation. In addition, although transportation of our infants without standard transport isolettes and in non-critical care-specific ambulances was accomplished successfully and safely, this is not the ideal. In general, there is a scarcity of the transportation equipment for critically ill neonatal and pediatric populations necessary to manage a mass critical care event.¹⁴ Allocation of these resources should be a priority in the preparation for a disaster. Pediatric and neonatal critical transport ambulances are maintained by several tertiary care hospitals within Manhattan and were used in our evacuation during Irene. During Sandy, however, they were grounded by their home institutions due to safety considerations. Although all infants were transferred safely by using FEMA-contracted ambulances, special-

ized neonatal critical care transport ambulances and equipment would be preferable and their use could be appropriated from hospitals by a governmental authority during a disaster.

In the year since Hurricane Sandy, we have taken the lessons learned from our experience and incorporated them in our future preparedness plans. NICU-specific evacuation and surge plans have been formalized in coordination with the New York City Pediatric Disaster Coalition. In it, we have explicitly detailed our NICU Incident Command Structure, which includes the designation of our staff social worker as liaison to NICU families. NICU-specific evacuation equipment has been stocked in an easily accessible location and our disaster plans include strategically placing transport isolettes on the ground floor in advance of an emergency in case elevators are nonoperational. Evacuation and power outage checklists have been adopted and our simulation center is being used to practice preparing neonates for vertical evacuation. New flood barriers have been built and construction continues on a new 500-year flood-resistant “energy building.” Servers have been relocated to New Jersey to ensure medical record access.

CONCLUSIONS

Our experiences during Sandy and Irene show that an evacuation of an NICU can be executed in a safe and timely manner during a disaster. Rate-limiting factors common to our and others’ experiences include time spent finding alternate hospital beds, transportation limitations, and establishing communication and maintaining situational awareness. Disaster planning at each level should take into consideration the specific needs of NICU patients (and critical pediatric patients in general) with particular attention to family support and neonatal/pediatric-specific transportation resources. Consistent with the experiences of others, backups, clear command structure, communication and situational awareness, regional coordination, and flexibility are identified as critical elements in ensuring that continued care of critically ill neonates and, if needed, their evacuation can be carried out in an emergency.

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REFERENCES

1. Sternberg E, Lee GC, Huard D. Counting crises: US hospital evacuations, 1971–1999. *Prehosp Disaster Med.* 2004;19(2):150–157
2. Bagaria J, Heggie C, Abrahams J, Murray V. Evacuation and sheltering of hospitals in emergencies: a review of international experience. *Prehosp Disaster Med.* 2009;24(5):461–467
3. Gershanik JJ. Escaping with VLBW neonates: caring for and transporting very low birth weight infants during a disaster. *Pediatrics.* 2006;117(5 pt 3):S365–S368
4. Bernard M, Mathews PR. Evacuation of a maternal-newborn area during Hurricane Katrina. *MGN Am J Matern Child Nurs.* 2008;33(4):213–223
5. Barkemeyer BM. NICU care in the aftermath of Hurricane Katrina: 5 years of changes. *Pediatrics.* 2011;128(suppl 1):S8–S11
6. Barkemeyer BM. Practicing neonatology in a blackout: the University Hospital NICU in the midst of Hurricane Katrina: caring for children without power or water. *Pediatrics.* 2006;117(5 pt 3):S369–S374
7. Downey EL, Andress K, Schultz CH. External factors impacting hospital evacuations caused by Hurricane Rita: the role of situational awareness. *Prehosp Disaster Med.* 2013;28(3):264–271
8. Downey EL, Andress K, Schultz CH. Initial management of hospital evacuations caused by Hurricane Rita: a systematic investigation. *Prehosp Disaster Med.* 2013;28(3):257–263
9. Redlener I, Reilly MJ. Lessons from Sandy—preparing health systems for future disasters. *N Engl J Med.* 2012;367(24):2269–2271
10. Ofri D. The storm and the aftermath. *N Engl J Med.* 2012;367(24):2265–2267
11. Powell T, Hanfling D, Gostin LO. Emergency preparedness and public health: the lessons of Hurricane Sandy. *JAMA.* 2012;308(24):2569–2570
12. Femino M, Young S, Smith VC. Hospital-based emergency preparedness: evacuation

of the neonatal intensive care unit—the smallest and most vulnerable population. *Pediatr Emerg Care*. 2013;29(1):107–113

13. Antommaria AH, Powell T, Miller JE, Christian MD. Ethical issues in pediatric emergency mass critical care. *Pediatr Crit Care Med*. 2011;12(6 suppl):S163–S168

14. Lowe CG. Pediatric and neonatal interfacility transport medicine after mass casualty incidents. *J Trauma*. 2009;67(2 suppl):S168–S171

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