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Closing and Reopening of a Children's Hospital During a Disaster

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CHILDREN'S HOSPITAL of New Orleans (CHNO) is a 201-bed general pediatric hospital that provides inpatient and outpatient medical and surgical care to more than 56 000 children per year. In 1 recent year, children came from at least 40 different states and 5 foreign countries. Critical care is provided in CHNO's 25-bed PICU, the 21-bed NICU, and an 8-bed spinal unit.

PREPARATIONS

New Orleans has had many hurricane threats over the years, leading hospitals and physicians to develop emergency plans to deal with the rare but predictable consequences of hurricanes. CHNO has an extensive inclement-weather plan ("Code Gray") that is updated and reviewed regularly. For a hurricane that is stronger than Category 3, there is an automatic coordination of activities with the State of Louisiana Emergency Operations Plan and the City of New Orleans Office of Emergency Preparations.

CHNO sits 12 feet above sea level, and the building is designed to withstand up to 14 feet of water. With each major construction project during the last 20 years, the hospital has incorporated new components of their hurricane-protection master plan. Some of the projects included:

- Moving chillers to the second floor.
- Installing 5 generators on the second floor that will allow the hospital to run the air conditioning while on emergency power.
- Installing a 50 000-gallon diesel tank to augment the existing 20 000-gallon tank, which provides emergency power for 2 weeks.
- Moving the information technology department to the second floor.

- Putting in place procedures and equipment to obtain nonpotable water from the Mississippi River.
- Installing 4 water tanks (4000 gallons each) to provide fresh water for emergencies.
- Installing a redundant telephone system on an upper floor.

AUGUST 27: 2 DAYS BEFORE LANDFALL

When the staff left the hospital that Friday afternoon, the assumption was that the storm was heading to the Florida panhandle or would make landfall in Alabama. There was little probability that New Orleans would be impacted. When there is a threat of a hurricane approaching New Orleans, it is the responsibility of one the vice presidents of hospital operations to ensure that the Web site be updated with current information. When Katrina started changing course, the Web site was updated to advise staff to stay in contact and be prepared for an upgrade in the disaster plan.

AUGUST 28: 1 DAY BEFORE LANDFALL

In the morning it was clear that CHNO would be impacted. Steve Worley, CHNO's president and CEO, decided that Code Gray would go into effect that afternoon. The department heads were contacted ahead of time so that they could initiate preparations. Although

Key Words: Hurricane Katrina, disaster planning, children's hospital, evacuate

Abbreviations: CHNO, Children's Hospital of New Orleans; UH, University Hospital

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this procedure has been performed successfully several times in the last few years, it was evident that, because of the magnitude of this impending storm, CHNO would need to implement a vertical evacuation.

Staff generalists and pediatric specialists began preparing for Code Gray with their staff and patients. Everyone assumed that there would be the usual citywide evacuation but that everyone would be back to work in 2 to 3 days. Hospital-based pediatricians and residents were selected and assigned duties as detailed in the CHNO Code Gray manual. CHNO hospital-based physicians communicated with their peers throughout the community to compare activities, census, bed availability, and the medical capability for specific patients.

All of these preparations were occurring on a Sunday, which added additional complications to preparing for the disaster. Having put staff on notice via the Web site was most helpful.

Code Gray was officially called over the hospital's public-announcement system at 4:00 PM.

Before announcing Code Gray, there were 130 inpatients. Thirty patients were discharged by early evening. There were 16 patients from the PICU who were relocated from the first to the second floor, thus beginning the vertical evacuation. One patient was moved to fourth floor because of isolation requirements.

Code Gray preparations did not only include discharges. CHNO oversees an active home-ventilator program, so predictably, as the storm approached New Orleans, 3 ventilator-dependent patients were carefully transported from their group home and admitted to the PICU.

Although the staff had practiced many mock vertical evacuations, this was the first one that was executed. Everyone lent a helping hand to ensure a successful move. Everyone was primarily concerned for the patients' safety even as concerns were rising for their own families. Many family members had evacuated the city, and communication was sparse. It was difficult for the staff to be reassured about their own family's safety. Although there were horrendous reports on the news, the staff continued to be committed to taking care of the patients. Their role went further than the patients' medical needs: they also provided comfort and support as needed. The overwhelming success of disaster preparedness would not have happened if it weren't for the strength and courage of the staff, who turned it into a reality.

AUGUST 29: LANDFALL

Normal power was lost at 8:30 AM, just before the eye of the hurricane made landfall east of CHNO. The generators, which have so much capacity that staff, patients, and their families were almost totally unaffected, started immediately. Air conditioning worked in almost all ar-

reas. All the emergency red-light switches worked, and even the clinic side of the hospital had power.

Once the eye of the hurricane passed New Orleans, a temporary feeling of calm ensued. The weather cleared a bit and winds began to diminish, which allowed our administration to assess damage reported by department heads. Communications with families and other hospitals were possible and, relatively speaking, positive. Our building suffered minimal damage, there was no flooding in the immediate area, and even the cars in the parking lots were not flooded or damaged.

The situation dramatically changed with news of the city flooding.

The mayor came on the news and reported that our worst fears had been realized: our levees had been breached. What had been feared for decades had now happened. The bad situation would get worse.

The last of the hospital's supplies and support systems were vertically evacuated. Employees carried everything upstairs including huge crates and boxes. Everyone was stressed, very tired and anxious, and hadn't had much sleep in the last few days.

The media had already reported flooding in nearby neighborhoods before the news of the breaks in the levees. Staff members were hearing about flooding in the areas in which either they or some of their relatives lived. These reports added to the stressful situation. Some staff heard reports that their families were wading through the contaminated water en route to the Louisiana Superdome. Telephone communications were down, and cell coverage was at a minimum.

In the midst of all this stress, an emergency call made it through from University Hospital (UH) describing 2 neonates who would be in danger of dying if their portable generator power stopped. The risk of transport was felt to be less than the risk of staying at UH. Although CHNO was now on emergency power, the physicians involved felt it was best to attempt a transfer. The city was in chaos, the water was rising, and because of the flooding, rescue vehicles could get no closer to UH than 3 blocks. The neonates would have to be evacuated by boat.

During the evening, preparations for transporting the neonates began. An improvised rendezvous site was arranged, and bassinets were prepared at CHNO with the necessary ventilator equipment.

AUGUST 30: 1 DAY AFTER LANDFALL

When the relative safety of daylight returned, a CHNO team waited for the UH rescue team to arrive. What they saw was 2 residents paddling a boat and another manually ventilating an infant. The infants were canoed 1 at a time to the waiting fire truck, where CHNO personnel carefully and safely completed the transfer of both infants (see "The University Hospital NICU in the Midst of

Hurricane Katrina: Caring for Children Without Power or Water," pp S369–S374).

The days after Hurricane Katrina became the most challenging. With the lack of basic utilities, the deteriorating security situation, and the flooding, it was apparent that most other New Orleans hospitals would have to evacuate. Because of the rapidly changing events, the CEO began meeting with the staff. Communication was frequent with the hospital's department heads throughout the storm. There were 2 "town hall" meetings held per day. Mr Worley communicated as much information as he knew to be accurate and allowed as many questions as employees, medical staff, and patients' parents needed to ask. Obviously, frequent open communication between staff and administration is of critical importance for service, safety, and staff morale.

The hospital received very little damage during the storm, and it was believed that the rising water would not reach the campus because it is above sea level. After a call to the Office of Emergency Management, a fuel tanker was able to reach the hospital and deposited enough diesel fuel to operate the hospital's generators for 2 weeks. The CHNO pharmacy director was able to restock medication that was necessary for the next few weeks. The staff continued to fulfill their responsibilities to provide medical care for the patients and their families.

The dietary director was challenged to provide 3 nutritious meals per day for those who remained at the hospital. Additional deliveries of food to the hospital were cancelled because of the mandatory evacuation.

That night, the city's infrastructure began to crumble with looting, violence, and fires. There were serious concerns that CHNO would be looted, but fortunately it did not happen. Hospital leaders were unsuccessful in obtaining additional security from the already overworked and overcommitted Federal Emergency Management Agency, National Guard, New Orleans police, or state troopers. The dedicated staff were left to their own security. Employees and family members became even more anxious with the reports they were receiving. Patient care was not compromised after the storm, but the fear was that the unrest throughout the city would migrate to CHNO. The hospital's security team, although unarmed, did a superior job maintaining order and keeping a watchful eye over the campus throughout the ordeal.

AUGUST 31: 2 DAYS AFTER LANDFALL

With the storm over and the hospital functions leveling off, it was felt that the worst was over. Then, the city's water pumps ceased functioning. The problem with lack of city water was not that of hand cleaning or having enough drinking water but rather that the hospital's air conditioning system would not function. The system uses 150 000 gallons of water per day to cool the chillers.

There was an option to use the Mississippi River water to cool the chillers, but the impure water would soon clog the system and make it nonfunctional.

At this point, Mr Worley met with his staff, and the decision was made to evacuate CHNO. He then met with the patients' families to explain that the hospital was going to be evacuated. The families were reassured of their child's safety and medical care. CHNO staff began contacting children's hospitals around the region and country for assistance in evacuating 100 patients and their remaining families. This list included 21 PICU and 26 NICU patients. The response was overwhelming: a total evacuation of all the patients was completed in less than 24 hours (see "Preparing, Improvising, and Caring for Children During Mass Transport After a Disaster," pp S421–S427; "Interstate Transfer of Pediatric Patients During Hurricane Katrina," pp S416–S420; and "Caring for Displaced Neonates: Intrastate," pp S389–S395). There were no deaths during the entire evacuation and transporting of CHNO's inpatients.

Because the telephones in the New Orleans area were working only intermittently, the National Association of Children's Hospitals and Related Institutions and Child Health Corporation of America aided CHNO with outside communications and other assistance. Texas Children's Hospital agreed to coordinate the effort and act as the point of contact. Conference calls were held with the involved hospitals on an hourly basis.

Transportation was arranged for 9 cardiac patients to go to Our Lady of the Lake in Baton Rouge, Louisiana, via Acadian Ambulance. Woman's Hospital in Baton Rouge took over the evacuation of 26 NICU infants and safely transported them by ground.

Children's Mercy Hospital in Kansas City, Missouri, with support from administrative leadership and cooperation from Senator Bond and Governor Blunt, deployed 2 C-130 aircraft from the 138th airlift wing of the Missouri National Guard. Four Nurses, 3 respiratory therapists, and a PICU pediatrician were flown to New Orleans, as was another fixed-wing medical transport aircraft. A medical convoy transported 26 patients with diagnoses such as asthma, dialysis-dependent renal failure, leukemia with bone marrow transplant, and chronic respiratory failure requiring mechanical ventilation from CHNO's PICU. Employees volunteered to help drive patients and their families to the airport. All patients survived the incredible, rapidly arranged transport, and all but 1 survived to discharge.

During the time of CHNO's evacuation, the New Orleans airport had closed its runways to civilian aircraft. So staff set up a makeshift heliport on the grassy field next to the hospital (Fig 1). Lights for use at special events were erected to direct helicopters flying at night. The helicopters ferried patients to the Baton Rouge airport, where airplanes waited to transport them to various hospitals around the country. PICU patients were



FIGURE 1
An improvised helipad for transport of hospitalized children.

transported to Texas Children's Hospital via 2 fixed-wing planes.

Cook Children's Health Care in Fort Worth, Texas, sent a plane, Miami Children's Hospital provided 2 helicopters, and Arkansas Children's Hospital sent 2 planes and a helicopter.

Louisiana hospitals in Baton Rouge, Alexandria, Lafayette, Lake Charles, and others accepted the remaining patients. Other hospitals were on stand-by to assist if needed.

Some families of CHNO's patients had been evacuated, leaving their children to ride out the storm in the safety of the hospital. As part of the evacuation, it was the staff's responsibility to contact each family to let them know the destination of their evacuated child (Fig 2).

Seventy-two children were evacuated to hospitals out of town. By midnight, there were only 4 patients left in the hospital. They had to spend the night because of



FIGURE 2
Comforting patients during the evacuation.

limits on flying time for pilots and refueling issues. The last patients were transported via helicopter at 8 AM the following day.

Refrigerated drugs from the pharmacy were sent with patients so that the receiving hospitals could use them. The director of the Dietary Department handed out food to staff and families before leaving, because many people would be beginning a long drive to safety outside of the city.

The CEO communicated via e-mail that arrangements had been made for office and clinic space to open in Baton Rouge. He stated that the hospital was fully committed to its employees and would continue to communicate through the closure of the hospital.

A private security team was assembled to protect the hospital. The Plant Operations staff turned off the fuel to the generators so that when the reserve tank emptied, the emergency power would cease. The hospital safe was emptied and left open to prevent theft.

Once everyone was out of the building, the doors were locked. For the first time in CHNO's 50-year history, it was closed for business.

SEPTEMBER 1 THROUGH 7: 1 WEEK AFTER LANDFALL

No, that wasn't the end; it was another beginning for CHNO. More than 350 employees and physicians had worked tirelessly for days to provide superb care to our patients and as much comfort as possible to their families. We then needed to relocate our business offices to a convenient place that was not affected by Katrina. Baton Rouge was selected, and efforts were immediately initiated to acquire office space. The Louisiana Hospital Association, which is located in Baton Rouge, provided temporary space within their offices. They also gave us assistance in a wide variety of important areas. Eventually, the Louisiana Hospital Association leased 10 000 square feet of office space to CHNO.

At that point, staff of the CHNO attempted to contact specialists to inform them of the new locations. The American Academy of Pediatrics set up a Listserv to help facilitate communications between pediatricians. Evacuees were scattered primarily throughout Louisiana, Texas and northern Mississippi.

Contact was made with local hospitals in Baton Rouge and Lafayette to explain our intentions and solicit their support. The decision was made to open specialty clinics in these major locations. Within 2 weeks, CHNO was holding its first clinic in Baton Rouge.

Lafayette General Hospital was extremely helpful. CHNO currently holds clinics on their campus, and they immediately provided us with additional leased clinic space.

Three moving vans were sent to CHNO, where we loaded supplies and equipment from the ambulatory care center that were needed to open the new clinics in Baton Rouge and Lafayette.

OCTOBER 5 THROUGH 10: 5 WEEKS AFTER LANDFALL

The CHNO's Metairie Center, a specialty clinic located in a suburb of New Orleans, reopened on October 5. CHNO also provided office space for 15 general pediatricians who were unable to return to their offices. There are 25 pediatricians on CHNO's staff who currently have no practice to which to return.

CHNO reopened as a full-service pediatric hospital on October 10, 2005.

LESSONS LEARNED

Normalcy to the New Orleans area has not returned as of the writing of this article in December 2005. There are many questions as to what the future holds as the pediatric community fights to return to normalcy.

Disaster plans were essential, and most institutional plans functioned well. Such plans need to be practiced and updated regularly, and they need to provide for a complete evacuation of the facility. Hospitals function 24/7, but Katrina demonstrated that hospitals may need to evacuate and close their doors.

There was no uniform method for evacuating patients, particularly for the critically ill ones. Once all hospitals in an entire city require evacuation, usual transport is overwhelmed. Hospitals in New Orleans depended on their contacts in other states or their parent organizations or associations to help them in this emergency. The last hospital to evacuate newborns was the state-run UH, which did not have such resources.

Hospitals in New Orleans had additional problems that had not been anticipated in disaster planning. Management of patient's family members, children of staff, and pets became problems. Most staff members experienced much more stress when they received information about missing family members' homes that were totally destroyed. These areas must be addressed for the future.

Architectural design for a hospital in a flood area needs to include a power plant well above the category

5 storm-predicted water level and backup generators to run all essential equipment and fuel for at least 2 weeks. An alternative water supply such as a well should be included so that there is an alternative supply of potable water and water for plumbing services.

During a catastrophic event such as this, communication is crucial. The Internet functioned better than telephone systems. Vendors need to be chosen for their reliability, as well. A common question that has been added for interviewing prospective vendors is, "How easy was it to get in touch with your company after Katrina?" Employee communications were difficult when home telephones or a near-relative's telephones were the only numbers available. The Internet proved to be the best means of communication and a way to reestablish contact with personnel.

In many cases, physician records were destroyed, damaged or unavailable, which created an information gap. The electronic medical chart, in many ways, could prevent this from creating a larger problem. Access was provided to out-of-state providers through the Louisiana immunization registry, which highlights the value of such registries. Children with special health care needs should be the first to have their basic health information on a retrievable database system.

COMMENTS

New Orleans has undergone challenges since it was first founded, and Hurricane Katrina represented yet another challenge. With the spirit of the people shown in this article, people caring for New Orleans' youngest and most vulnerable, New Orleans will rise again.

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