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## **Sweating It out in a Level III Regional NICU: Disaster Preparation and Lessons Learned at the Ochsner Foundation Hospital**

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# Disaster Preparation and Lessons Learned at the Ochsner Foundation Hospital

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**P**REPARATIONS: In New Orleans, Louisiana, we had been through the drill many times before. Annually, disaster preparation is undertaken in conjunction with our Office of Emergency Preparedness when an imaginary hurricane strikes our city and causes catastrophic damage. Sometimes life imitates art. When Hurricane Katrina crossed the state of Florida and entered the Gulf of Mexico, New Orleans had a metropolitan population of 1.3 million, with 484 000 inside the city limits. Much of the city lies slightly below sea level, whereas the level of Lake Pontchartrain typically is 1 foot above sea level.

The Alton Ochsner Foundation Hospital is a 531-bed teaching hospital that is situated on the east bank of the Mississippi River, just west of New Orleans in the Parish of Jefferson. Providing incalculable benefit, the first floor of our hospital stands approximately 6 feet above sea level—12 feet above some of the lowest parts of the city of New Orleans. The NICU, located on the 10th floor of this 11-story hospital, was supporting 25 neonates, many of whom were on mechanical ventilation as Katrina approached the Gulf Coast of the United States. One infant was requiring extracorporeal membrane oxygenation (ECMO). The institution had established an emergency-management manual that, although remaining a perpetual work in progress, is currently 122 pages in length and addresses many topics including responses to loss of utilities, external and internal disasters, and severe weather conditions.

The Ochsner model of medical care includes many satellite clinics and a closed medical staff for the hospital. Preparing for a natural disaster involves having a facility that would withstand the storm (externally and internally) and having a staff that can care for patients, their families, and all personnel on campus. According to our procedures, after deciding the “essential staff,” “A” and

“B” teams are created. The A-team members are staff remaining during the storm, and the B-team members evacuate, report their final destination to their unit directors, and then return to relieve the A-team members once it is deemed safe to travel.

## CHRONOLOGY OF EVENTS

### August 27: 2 Days Before Landfall

Katrina became a category 3 hurricane, and its projected path has shifted westward. New Orleans, along with others on the Gulf Coast, are beginning to realize that there is likely to be a sizable impact from the storm. The administrators at Ochsner decide to implement the severe-weather policy and assemble department chairmen (or their designee) to assign essential staff physicians. The pediatricians include a generalist/hospitalist, an intensivist, a cardiologist, a hematologist, a neonatologist (myself), and 4 neonatal nurse practitioners. In addition, general and specialist medical and surgical physicians and staff were appointed.

Our Section of General Academic Pediatrics had rehearsed and implemented the hurricane drill numerous times in the past. The pediatric hospitalist would assume care of the in-house general pediatric patients and the nursery infants, and the pediatrician on-call would be

**Key Words:** Hurricane Katrina, emergency preparedness, disaster planning

**Abbreviations:** ECMO, extracorporeal membrane oxygenation; FEMA, Federal Emergency Management Agency

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responsible for telephone calls. Because the evacuation was mandatory, all others would leave the designated hazardous area. It was a weekend, so we hoped all would be back in clinic by Tuesday morning doing business as usual.

Institutional plans were placed into effect regarding security, housing, communications, food services, and utilities. Team A members were reminded to bring their personal supplies (nonperishable food, water [1 gallon per person per day], blankets, pillows, sheets, mattress, flashlight with batteries, medications, toiletries, extra clothes [shorts/sandals/sneakers], radio or small battery-powered television, and pocket change). Bringing family and pets into the facility was discouraged; however, single A-team parents and others with no alternatives were given this opportunity. If a family arrived with small children, it was expected that age-appropriate supplies would accompany them.

#### **August 28: 1 Day Before Landfall**

Katrina was upgraded at 1 AM to a category 4 storm, and 6 hours later her sustained winds reached 175 mph, exceeding category 5 classification. Beginning at 7 AM, Ochsner Security posted guards at the entrance of the parking garages to ensure that all those entering were members of the essential personnel team. We had learned from previous hurricanes that many non-Ochsner personnel would attempt to use the safety of an elevated garage for parking such items as recreational vehicles and even boats. This created a situation that prevented Ochsner health care workers from finding a place for their own vehicle. A-team members arrived, and housing arrangements were made by using unoccupied interior patient rooms as well as rooms in our adjoining hotel. By using inflatable or foam mattresses, some physicians elected to set up sleeping quarters in their offices. SpectraLink wireless phones (which can be programmed to be similar to an office extension) were distributed to essential personnel.

That afternoon, the NICU hurricane shutters were closed, and although they were made to withstand winds in excess of 100 mph, the decision was made to transfer the 25 NICU patients to the postanesthesia care unit (recovery room), which was located on the second floor in the central portion of the hospital (where there are no windows). The move went smoothly, including the hand cranking of the pump for the infant on ECMO. After settling all the infants in their new "home," our staff prepared for the inevitable by charging up their cell phones and making sure all vital telephone numbers were posted in multiple locations.

Ochsner's food and nutrition department normally keeps a food inventory on campus that should support the patients, their families, and routine support personnel for more than 2 months. Additional cold-food-storage capacity was increased by using 2 refrigerated trail-

ers. All dietary production and refrigeration equipment was supported by emergency generator power. It was anticipated that the food and nutrition staff would be feeding approximately 500 persons per meal. Unbeknownst to our dietary staff, they were about to prepare more meals than ever anticipated and for a much longer time period than ever planned.

For security purposes, everyone was reminded to make sure that their picture identification card was in plain view wherever they went. Nonmedical personnel were tagged with specifically color-coded identification bracelets that afforded them the safety and amenities of the institution. Clinic administration held an evening meeting for all medical and unit directors to ensure that we were all well versed on the latest hurricane and facility information. We planned to meet at least 3 times daily into the foreseeable future so that a consistent message could be brought back to the personnel on the front line. This allowed leadership to remain visible and address concerns—both real and imagined.

#### **August 29: Landfall**

Katrina's eye crossed the Louisiana coast at 5 AM as a category 3 storm with winds that had "weakened" to 125 mph. Naturally, the outer bands of the hurricane arrived many hours before. With no tall buildings near us, there was little buffering of the winds taking place on the 10th floor. The ferocious winds were heard howling in the stairwells and near any windows. Electricity from our utility company failed at 7:45 AM, and our 3 diesel-powered generators (which are situated 12 feet above ground level and consume 100 gallons of diesel per hour) began functioning immediately. An underground supply of 60 000 gallons of diesel fuel was kept by the hospital for just such an occasion. The generators provided power for limited air conditioning, emergency electrical outlets and lighting, air and vacuum pressure, and oxygen. Although emergency lighting allowed for work to continue, having a flashlight was a necessity for performing certain tasks.

It was not long, however, before we began to feel the temperature and humidity rising. As fate would have it, after settling all the infants in the new NICU, the ceiling over the patient on ECMO began to leak. The nurses and respiratory therapists obtained large plastic sheets and created a makeshift tent, which kept the patient and all the equipment dry, relatively speaking.

Water pressure dropped midmorning when power failed at city-run water-pumping stations, and the flow from faucets dwindled to a trickle. Without water pressure, toilets could not refill, and because most new toilets in institutions do not have tanks, there was a major problem developing. A few hours later, there was discolored water flowing from the taps, and toilets once again could be flushed. Thankfully, some years ago as part of disaster planning, a well was dug, and although

“well water” was not potable or suitable for bathing infants, it certainly was adequate for showering and flushing toilets.

Methods and sources of communication varied. Local telephone service, especially for incoming calls, became very sporadic, and communication with the outside world became more difficult. We found that calling long distance had a higher likelihood of success than a call within the same area code. The cable company supplying the television signal failed, and we were restricted to our CBS affiliate, which began to give us a skewed vision of the local outside world. There were very few radio stations broadcasting originally, and ultimately this dwindled to the CBS affiliate as well. Most of the information provided was anecdotal and originated from callers to the show. There were reports and then pictures of a section of Interstate 10 between New Orleans and Slidell that had been washed away, which meant that rescue personnel could not enter from the east and evacuation in that direction would be impossible.

Our Ochsner Security force amounted to 36 in-house armed officers. These friendly faces worked rotating 12-hour shifts and provided the staff with as much of a sense of comfort as was feasible under the circumstances. Most of us got little sleep that first night post-Katrina, and the temperature in the NICU continued to rise.

### **August 30: 1 Day After Landfall**

Reports of the broken levees with subsequent massive flooding throughout the area had a major dampening effect on the optimism that many were feeling from having just survived the storm. We could see the rising water level in the street outside, but it had not reached our front door. We were told by administration (correctly) that because of the elevation of the campus, flooding was not expected to reach the hospital. Nonetheless, there were sandbags available.

We reopened and returned to the 10th-floor NICU and began to open the storm shutters. We could still hear the wind outside, but the rain was limited to a passing sprinkle. Although we found no broken windows, water had seeped through the windows and even in between some bricks in the wall. We were even more astounded to find blades of grass and leaves stuck to the outside of our windows 10 floors up!

Our census grew late in the morning when there was a delivery of a near-term infant. The infant had the audacity to develop respiratory distress and subsequently required endotracheal intubation. Gowning for the placement of central lines was not much fun, because the environment of our NICU was starting to feel like a typical New Orleans summertime 90–90 day (90 degrees, 90% humidity). Acceptable attire in the NICU was now sandals, shorts, and T-shirts.

The utility status remained unchanged; we were still

using generator power, well water, and telephones (when you could connect). Because of the heat, a cold well-water shower was a luxury item (but you needed your flashlight close by, because most bathrooms were not on the generator circuit). The Internet miraculously continued to function with only very brief interruptions. Streaming video provided a connection to the outside world but only served to depress the morale of the team. We were beginning to see the devastation imparted by Katrina, and then we learned that there had been serious breaches of some of our levees.

The National Guard arrived with 8 soldiers to bolster our security force. Unfortunately, this group of 8 soldiers was young, inexperienced, and lacked the training needed for the magnitude of this situation. The National Guard soldiers were soon dispatched to the city. Because of social unrest in the downtown section of New Orleans and reports of looting in hospitals, Ochsner went into a “lock-down” mode after dark and maintained security guards at all entrances. With minimal fire protection available, everyone was cautioned repeatedly about the use of anything flammable.

By early evening, the temperature in the NICU was above 95 degrees. Because of the humidity, any item that was stuck to the wall with tape soon found its way to the floor. Although other areas of the hospital were slightly air conditioned, the general activity of all the health care workers and equipment kept our area from ever feeling any flow of air; not even warm humid outside air. The building was designed, like many others, for air conditioning, so windows do not open. Floor fans helped but could not improve the environment sufficiently for our patients. Soon the infants began telling us that the situation was becoming intolerable. Sponge baths were not feasible because of the unknown elements in the well water. The baseline body temperatures of the infants began to rise despite being clothed only in diapers. Many of the infants became increasingly irritable and then feeding-intolerant. Shortly thereafter, we were informed that because of the heat and lack of fresh water, the analyzers in the laboratory were shutting down. We then were limited to bedside point-of-care testing only.

I met with our NICU staff and made the difficult decision to begin evacuation proceedings. We were tasked with moving 26 infants to safer situations, which meant placing our infants and others at risk (but less risk than not moving). After more than 3 decades of being known as an NICU that accepted all ill newborns, we were faced with a large-scale evacuation. As the message circulated that we were looking for help, the telephone began to ring, and many of the friends whom we had helped over the years were anxious to return the favor. Teams from as far west as Houston, Texas, and as far east as Birmingham, Alabama, and many places in between, were making plans to send physicians, nurses, and neo-

natal nurse practitioners to rescue our little patients (see “Interstate Transfer of Pediatric Patients During Hurricane Katrina,” pp S416–S420; “Preparing, Improvising, and Caring for Children During Mass Transport After a Disaster,” pp S421–S427; and “Caring for Displaced Neonates: Intrastate,” pp S389–S395). Because of limited ability to communicate with our patients’ parents, when we were unable to contact them, we used the face sheet in each patient’s chart and determined whether to send the patient to a level 3 NICU east or west from New Orleans. Teams from Birmingham, Baton Rouge, Louisiana, and Houston arrived by fixed-wing plane, helicopter, or ambulance that night, and none of the crews left empty-handed (Fig 1). After experiencing the conditions that we had been working through, each of the transport teams vowed to return. The majority of our infants were transported to safety on this first day after landfall. With the skies over New Orleans having been commandeered by the Federal Emergency Management Agency (FEMA), this took much more coordination than any transports we had ever arranged.

#### August 31: 2 Days After Landfall

True to their words, every transport team returned on the second day. On their return, our staff was treated to



**FIGURE 1**  
Members of the University of Alabama at Birmingham transport team, Ochsner transport team, and nursing staff escorting 4 infants on a stretcher.

ice chests full of cold drinks and chocolates, and one team even brought us T-shirts (with their group’s logo). Their generosity struck us all deeply and brought many to tears. By midday, the only remaining patient was the infant who required ECMO (Fig 2). Many of our nurses were requested to assist in other areas of the hospital while discussions began regarding the downsizing of our staff.

One of the generators had an electrical failure, so we were down to 2 functioning sources of power. The temperature in the NICU remained above 90 degrees but was a bit more tolerable because of the lack of activity. Because of the restrictions from lack of laboratory support, other areas of the hospital also found it impossible to care for their sickest patients, and a limited evacuation of these patients took place during the day. With the help of our biomedical department, we evaluated the NICU from an electrical standpoint and found that the heat and humidity kept the monitors from functioning properly, which made returning to the 10th floor impractical.

Voice communication continued to be difficult. Landlines had collapsed, and cell phones became largely inoperable because of tower failures. We learned that the success rate of communicating with the outside world was much higher using text messaging than with a telephone call. Surprisingly, the Internet stayed functional throughout the storm and aftermath. Not only could we get messages out, but streaming video also gave us a glimpse of how post-Katrina New Orleans and the Gulf Coast appeared. The levee breaches were extensive, and flooding of homes was horrific. Most of us were speechless while watching the unimaginable and seeing the despair. Some of the staff had not heard from loved ones for days. Between what we saw and had heard (or in some cases did not hear), the staff began to need each other more than ever. Most of us found it close to impossible to sleep that night because of accommoda-



**FIGURE 2**  
An infant on ECMO even while in a disaster is cared for by one of the NICU nurses.

tions as well as the psychological effect the storm and its aftermath were having on us.

### **September 1: 3 Days After Landfall**

With the population in the NICU reduced to our lone ECMO patient, we were able to allow for the departure of more than 50% of our staff. Enough personnel were kept on campus because we were unsure of when utilities would return (thereby making the keeping of patients possible once again). With the very limited and sometimes terribly inaccurate information provided by the news media, most did not wish to leave alone. Caravans of cars and buses were scheduled and departed at specific times. As we learned that travel to the east was impossible, only leaving to the west and north was feasible. Caravans headed toward Baton Rouge had little difficulty reaching their destination, although reports of scattered debris never did justice to seeing the destruction firsthand.

Emotions were overflowing as many felt like they were leaving one family in search of another. By now, the satellite photographs were becoming available on the Internet. With enough perseverance, neighborhoods and individual homes could be identified. For those of us remaining, the next wave of emotions hit. Some of us found our homes seemingly unscathed, while others discovered severe damage and flooding.

From an institutional standpoint, the generator that failed was brought back online when the part and technician were helicoptered in from Alabama. It did not make a noticeable difference in the section of the hospital where our patients had resided. The well water continued to serve its purpose, and as long as the Internet functioned, communication was still readily available. Instant messaging was a valuable tool to have at one's disposal. Some telephone service was returning, but it still worked best when calling areas outside of the local area code. Our security team was supplemented by 23 out-of-state contract officers.

Food and nutrition services reestablished their supply chain as shipments of food and dairy products arrived from Dallas, Texas, and Baton Rouge, respectively. We discovered how talented one member of our housestaff really was when he volunteered to operate a forklift to unload a food shipment. Other staff physicians became food servers to give the dietary staff a well-deserved break. By now the dietary staff had truly risen to the top of the food chain (pun intended); during peak times they demonstrated the ability to feed up to 1500 people within 30 minutes.

Our B team assembled in the Ochsner Clinic in Baton Rouge. This center became the peripheral command site that coordinated physician staffing, housing, and transportation to the New Orleans hospital and clinic. The B team traveled in caravans using buses and private cars from Baton Rouge to New Orleans during daylight hours

with National Guard escort. Their arrival was just what the members of the A team needed.

### **September 2: 4 Days After Landfall**

At 10:30 AM, we had normal power restored to the campus when the first feeder line from Entergy was connected. By late in the afternoon, we could feel the heat and humidity dropping. As the day went on, there were more fresh faces appearing by the hour, and few members of the A team remained. For dinner that night, the clinic and hospital administration held a barbecue, which provided welcome relief from cafeteria-style and canned food that had sustained us for the previous 5 days. Just the smell of burning charcoal was worth the trip to the parking lot where the small crowd of 2500 was being fed. No one complained about the wait.

### **September 3: 5 Days After Landfall**

Our first post-Katrina infant was delivered weighing 683 g (1 lb, 8 oz) and brought a new sense of life to our NICU. With the air conditioning returning to the facility, we were able to care for her. The patient did well and was discharged from the hospital in early December.

### **September 4: 6 Days After Landfall**

We began calling the staffs of all hospitals that referred infants to us pre-Katrina to inform them that we were fully staffed and operational. We had also recovered the use of our helicopter and air space, because FEMA was allowing us to fly in the area again. We made a decision not to back-transfer patients to our institution, because few of our families had yet been able to return.

### **September 9: 11 Days After Landfall**

City water returned, and it was refreshing to see something colorless flowing from the faucets. Everyone was cautioned about drinking the water for the first 24 hours, because there may have been breaks in the continuity of the underground pipes. The city wanted to be sure that the system had been cleared of any potentially contaminated water, which may have been sitting in the system for the last week and a half.

Feeding and watering of the troops had been flawless. Not only did our food and nutrition staff care for the patients, families, and staff, but they also fed the National Guard, security staff, and FEMA workers who had set up a mobile clinic in front of Ochsner. As part of the meals served, the staff and visitors had consumed 36 000 tomatoes, 7000 melons, and 10 000 apples. Bottled water and sports drinks totaled 45 000 served.

### **September 22: 24 Days After Landfall**

After hearing about Hurricane Rita's possible landfall in northeast Texas, an evacuated New Orleans family (currently residing in Houston) requested the transport of their premature 29-week-gestation twins. We returned

the favor afforded to us previously by Houston's neonatology staffs and were able to charter a jet to evacuate these infants and bring them closer to home. These infants brought our census to 10 patients, which was about one third of the norm.

### **CURRENT STATUS**

By early December, our NICU census had grown to 35 infants. Our obstetric staff expanded because we accommodated some of our area's displaced physicians. With the expected increase in the number of NICU patients, we recently petitioned the State of Louisiana for licensing of additional beds at our institution.

The infant that stayed with us in his own private NICU while on ECMO is now home and doing well.

### **LESSONS LEARNED AND FUTURE ACTIONS PLANNED**

Our institution has addressed many of the infrastructure issues that Katrina raised. The following changes are being made as we update our emergency-management manual.

#### **Power**

- We need to move feeder lines provided from Entergy above ground, because below-ground lines may be unreachable.
- Although we had 3 generators, they were insufficient to carry the air conditioning to parts of the institution; this is being resolved with the purchase of a fourth generator and the possibility of adding 2 portable generators for additional air-conditioning support.

#### **Water**

- A backup well-water pump motor was purchased.
- Fresh water storage tanks are being fitted for more pumping capacity.
- Installation of a pump that is capable of pumping fresh water out of bulk tanker trucks has taken place.

#### **Sewerage**

- We need to purchase gas-fired sewerage-ejection pumps for when power to the city pumping station fails.

#### **Communication**

- External: We must evaluate the use of satellite phones.

- Internal: We need more SpectraLink phones, which would be assigned by function, not by person.
- Command center: We need to establish a command center for preparing a list of functions and scheduling meetings.

#### **Laboratory**

- Waterless analyzers are currently available and are being considered for purchase.

#### **Security**

- Installation of perimeter fencing with lock-down gates should be considered.
- We need National Guard presence sooner.

### **COMMENTS**

Unfortunately, there will be disasters like Hurricane Katrina in the future. Whether they are natural or man made, these catastrophes will not be as important as how we as a society prepare, cope, and respond to them. The decision to evacuate a patient should be based on the expectation of the magnitude of the impending disaster, the institution's ability to handle its patients, families, and medical personnel during and after the catastrophe, and understanding what the local surroundings may be like throughout the aftermath. No one person or institution will be able to anticipate and respond to every challenge that awaits those who attempt to weather the storm. Indeed, no one geographic area has the capacity to provide hospital care to children in a major disaster. By planning ahead, being able to respond quickly to a changing set of circumstances, and learning from others' experiences, we can create an environment that will allow for a successful outcome from a seemingly hopeless situation. There is no doubt that we will be judged by our actions during a crisis situation, with ramifications likely being long lasting. Once the immediate threat has passed, the continuation or restoration of patient services requires planning, leadership, patience, flexibility, and commitment.

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