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## **Getting Kids From the Big Easy Hospitals to Our Place (Not Easy): Preparing, Improvising, and Caring for Children During Mass Transport After a Disaster**

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# Preparing, Improvising, and Caring for Children During Mass Transport After a Disaster

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THE INCAPACITATING BLOWS dealt to the New Orleans, Louisiana, health care infrastructure by Hurricane Katrina and its aftermath are unprecedented in the United States. Much can be learned about disaster preparedness from the events that unfolded in New Orleans after Katrina swept the Gulf shoreline. Problem areas in the management of this disaster such as internal and external communication failures, transportation, triage, personnel allocation, and resource allocation have long been identified in the literature as core disaster-response issues.<sup>1-3</sup> In addition, damage to the physical plant, water and power system failures, and hazardous-materials exposure are encountered commonly in the face of disaster.<sup>1</sup>

Between 1950 and 2005, 286 hospital evacuations have been described, including horizontal evacuation (within the same floor), vertical evacuation (between floors), evacuation of a ward or wing, and complete hospital evacuation.<sup>4-10</sup> Of the 286 between 1971 and 1999, 275 were reviewed by Sternberg et al.<sup>8</sup> There are 22 reported cases of complete hospital evacuation since 1950; of these, 1 occurred in Canada and 8 resulted from the 1994 Northridge, California, earthquake.<sup>4,5,7-18</sup> Of 43 reported incidents for which duration is known, only 12 evacuations lasted longer than 24 hours.<sup>8</sup> Eleven percent of evacuations in the series reviewed by Sternberg et al listed at least 1 casualty, and the deadliest reported hospital disaster occurred in 1971, when partial collapse of a California Veteran's Administration hospital claimed 49 lives.<sup>8</sup>

Hurricanes are the third most common cause for hospital evacuation, accounting for 38 of 286 reported evacuations; only internal fire and internal hazardous-material events are more common. It is notable that only 3 evacuations since 1950 involved 1000 or more patients.<sup>8</sup>

## LOCAL EXPERIENCE WITH DISASTER

Over a 5-day span in June 2001, Tropical Storm Allison brought nearly 39 inches of rain to Houston, Texas, including the Texas Medical Center (a consortium of health care institutions comprised of 2 medical schools and 13 hospitals with more than 6000 licensed beds). Tropical Storm Allison's record rainfall and subsequent flooding, estimated by flood experts to be in the 300- to 500-year range, claimed 22 lives and caused more than 2 billion dollars in damage to the Texas Medical Center alone.<sup>4,19</sup> Disaster-management issues identified during Tropical Storm Allison served as the impetus for improved interinstitutional coordination among local hospitals during disaster and ensured that institutional investment in ongoing preparedness remained a priority.

Such preparedness in each of these areas was integral to the overall positive outcome experienced by Texas Children's Hospital (TCH). Our ability to respond to Hurricane Katrina effectively was the result of previous experiences and a specific focus on disaster preparedness over several years. Our response to Hurricane Katrina resulted in additional changes in our approach to disaster planning that will be described for each aspect of disaster preparedness.

**Key Words:** Hurricane Katrina, pediatrics, mass transport, disaster planning

**Abbreviations:** TCH, Texas Children's Hospital; CHNO, Children's Hospital of New Orleans

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### AUGUST 26 THROUGH 29: 3 TO 0 DAYS BEFORE LANDFALL

Preparations were in place as TCH monitored Hurricane Katrina's path through the Gulf of Mexico. Early reports on the day of landfall in New Orleans suggested minimal damage and flooding to the city infrastructure. TCH received no requests to evacuate pediatric patients; in fact, we spoke with 1 hospital that was functioning on emergency generator power without disruption. Confident of their ability to withstand the flooding, it was not until 2 days after landfall that the flooding and general deterioration of civil order required a reversal of the original decision to "defend in place."

### AUGUST 30: 1 DAY AFTER LANDFALL

#### Interfacility Transport

On the initial day of flooding during the Katrina disaster (1 day after the hurricane), TCH received a call from the Federal Emergency Management Agency requesting rotor-wing aircraft. The TCH program consists of fixed-wing and ground vehicles, both of which were offered for relief efforts.

Later that same morning, calls requesting transport relief from TCH and other facilities started; the volume of calls and requests for assistance quickly overwhelmed the hospital's conventional transport process. TCH's internal hospital disaster plan was activated simultaneously to facilitate the increased need for services expected with the new arrivals. Concomitant with the hospital activation, the transport teams were notified to prepare for extended operations.

#### Communication

Initial and ongoing communication with the referring hospitals was difficult because of loss of power and normal transfer center operations. Fax communications delineating patient demographics were invaluable in planning the patient transport and assimilation process. Concurrent with the ongoing assessment of patients' needs at New Orleans' institutions, an ad hoc working group of multiple children's hospital transport teams was formed expeditiously. This group met via an extended continuing conference call both separately and simultaneously with Tulane University Hospital and the Children's Hospital of New Orleans (CHNO). The group was able to define priorities, assess patient needs, and dedicate appropriate transport resources.

The working group of 5 children's hospital transport teams enabled evacuation of most pediatric patients from Tulane University Hospital and CHNO within a 48- to 72-hour time frame, with little governmental assistance (see "Closing and Reopening of a Children's Hospital During a Disaster," pp S381-S385). This ad hoc group and the mechanism for timely accurate communication were the most important ingredients to the

timely evacuation of the children from hospitals in the New Orleans area.

#### Evacuation Process and Equipment

Because of flooding and impassable roads, the only evacuation route by the end of that day was rotorcraft from helipads. An obstacle to timely evacuation was obtaining sufficient rotorcraft (and rotorcraft organization) to evacuate patients. Although multiple children's hospitals were attempting to get to the New Orleans facilities, landing space and simultaneous evacuation of other hospitals proved to be challenging obstacles. The distance from New Orleans to Houston was prohibitive for helicopter transport. Therefore, an initial triage/staging area was set up in the Baton Rouge, Louisiana, airport (Fig 1) because of the lack of an operational landing field in New Orleans. TCH fixed-wing aircraft were stationed in Baton Rouge. Patients were flown by helicopter from New Orleans to Baton Rouge and then were transferred to airplanes and subsequently flown to Houston. Toward the end of the day, fuel shortages for helicopters and fixed-wing aircraft were evident. The fixed-wing aircraft began refueling only in Houston with enough fuel for both trips. At nightfall, gunfire directed at the helicopters and patients forced the termination of any transports until the second day.

### AUGUST 31: 2 DAYS AFTER LANDFALL

#### Interfacility Transport

Two days after landfall, the intermediate staging area was moved to Houma, Louisiana. Houma is a 20-minute helicopter trip from New Orleans, compared with Baton Rouge, which is 30 minutes away. Houma's closer location to New Orleans (allowing for shorter helicopter rides) and its lack of congestion offered an advantage over Baton Rouge. A TCH respiratory therapist and nurse were left on site at Houma, which permitted on-site triage and an open line of communication for incoming transports and immediate determination of fixed-wing needs. Throughout the 48 to 72 hours, we became more efficient; with each trip we could better anticipate patient requirements and prepare for them.

Later in the day, our fixed base of operations again



FIGURE 1  
Map of the region including New Orleans, Baton Rouge, Houma, and Houston.

changed to Baton Rouge with the evacuation of CHNO. By this time, we had refined our fax intake form and could begin the process of moving children with greater efficiency. When the helicopters were returning to New Orleans after dropping children off at Baton Rouge, we were able to stock them with disaster provisions from TCH supplies, thus making the return trip just as valuable for those remaining in New Orleans.

During the entire process, our partnering transport teams from other children's hospitals ferried patients to our interim fixed base of operations, to TCH, or to other children's hospitals in the Southwest. Some teams only had the capacity for neonates or pediatrics, whereas others were dedicated teams that could manage children of all ages. During the evacuation efforts, we occasionally had multiple transport teams from several different children's hospitals arriving in Houston simultaneously. Flight Explorer (McLean, VA), a software program, enabled radar visualization from our home hospital base to track and anticipate timing of incoming flights. Multiple ambulance services in the Houston area were enlisted in addition to our own preexisting ground crews to ferry children from the airport.

Flexibility was an essential factor in evacuating the infants and children. Most transport teams carried 2 children; some were ambulatory and others were immobile. Every child had at least 1 medical device; many depended on multiple medical support systems. Because of space constraints on the helicopters, families could not accompany their children on the transports.

Larger aircraft without a medical configuration were borrowed during the evacuation process (Table 1). These jets had increased ability to carry more than 2 patients, so triage for fixed-wing transport was made on site as children arrived from the helicopters. A large military aircraft such as a C-130 would have been particularly useful but could not be commandeered during the evacuation process despite repeated requests made to many levels of the Federal Emergency Management Agency and the military command structure. Although we did not have access to military aircraft, several generous philanthropists donated the use of their aircraft to expedite the transport process.

At the time of departure from the New Orleans hos-

pitals, efforts were made to preassign each pediatric patient to a specific fixed-wing aircraft. Predictably, in a disaster and with poor communications, some of the patients who arrived did not match the initial descriptions. Our team quickly triaged each patient on arrival at the airstrip by using the patient's age, physical size, medical status, and number of medical devices that accompanied the patients to make an assignment to a specific aircraft. This information was relayed to the accepting facility and the referring hospital to ensure that the medical personnel, hospital command-center staff, and families were given accurate information regarding each patient's current location and destination (Fig 2).

### Health Care Personnel

Three essential components to the evacuation process were (1) the transport team (registered nurses, respiratory therapists, and physicians) from multiple children's hospitals who performed in an exemplary fashion, (2) central communication/coordinating direction from TCH's home base, and (3) on-site triage at Houma and/or Baton Rouge or in New Orleans itself.

There was no shortage of volunteers to staff the transport teams; everyone wanted to participate. Transport personnel were limited to those with specific transport experience. Trainees were prohibited because of space limitations. Supervisory transport personnel led the central communication/coordination command center at TCH 24 hours per day and provided real-time advice to the transport teams as various issues arose.

### Family Support

Families were unable to accompany their child during the medical evacuation because of space constraints in the aircraft and the logical prioritization of moving critically ill pediatric patients before healthy adults. Family members sought transportation from other families as well as from strangers and were reunited with their children at TCH and other facilities as quickly as possible. Unfortunately, some family members who themselves were homeless were estranged from their child and/or from other family members and even occasionally came to the wrong hospital to find their child. This disheart-

**TABLE 1** Type of Aircraft, Air Speed, Capacity, and Average Range

Aircraft	Type	Air Speed, mph	No. of Seats	No. of Aircraft Used	Average Range, Miles
Sikorsky S-76	Rotor wing	178	4	2	200
Bell 430	Rotor wing	160	4	1	150
King Air B200	Fixed wing	330	5	2	1200
King Air E90	Fixed wing	300	3	2	800
Premier 1A	Fixed wing	500	3	1	1100
Learjet 35A	Fixed wing	510	3	1	1500
Cessna Citation 3	Fixed wing	480	8	1	1500
Merlin 4 Turboprop	Fixed wing	300	13	1	1900

	Patient's Name	Age or DOB	Medical Record	Diagnosis	Sending Hospital	TCH Location	Mode of Transp.	Depart Time	Comments Weight/Car Seat/Sit/Stretch Special Equipment Needs
1									
2									
3									
4									
5									

FIGURE 2  
Patient transfer tracking sheet.

ening situation created the need for a more structured and comprehensive approach to family support. Recognizing that the needs of these families were both basic and complex, hospitality services, patient relations, child life, and social work took the lead in implementing a comprehensive support program.

Within hours a large conference center room was transformed into a support center that provided family members with multiple computers, telephones, fax machines, resource information, and basic supplies that included clothing, personal hygiene items, toys, and meals. This center was staffed 24 hours per day during the initial phase of the recovery to aid families in their very difficult hours. Notable was the opportunity to assist families in making connections with their loved ones, provide clean clothing for individuals of all ages, answer telephones from desperate family members who were out of town, and offer any other support that was requested.

After the initial recovery efforts, the main family support center closed and was replaced with the Katrina support service. This center was covered by a social worker 8 hours per day, 5 days per week, and was operational for 5 weeks. During this time, more than 100 families whose children were at TCH were provided continued assistance to recover, relocate, and restore their lives after this terrible storm.

## DISCUSSION

### Long-term Preparation

Institutional preparation for disasters must be focused on several areas including (1) preparing and securing the physical plant, (2) securing necessary supplies, food, and other essentials, (3) ensuring the availability of necessary health care personnel, (4) an effective communication strategy, (5) an effective leadership structure for disaster management, and (6) patient evacuation and transport issues.

### Physical Plant

Typically, the physical plant issues that must be addressed for effective disaster management include the ability to provide emergency generator backup for the hospital, the ability to ensure an adequate fuel supply for extended generator use, a back-up source of clean water, and the adequacy of the physical plant to withstand high winds, flooding, and other deleterious effects of disas-

ters. In Hurricane Katrina, emergency power and the ability to sustain a functioning hospital were of paramount importance. Unfortunately, the majority of hospitals in New Orleans were unable to sustain generator power once the loss of normal power and/or water occurred. The minority of hospitals that were functioning efficiently on emergency generator power found themselves in a unique situation as the external environment around their hospital deteriorated rapidly, forcing the evacuation of all hospitalized patients from New Orleans.

Helicopter transport became the only viable option for safe patient evacuation because of impassible roads and rapidly changing external conditions. Hospitals with helipads were fortunate; others relied on parking garages and adjacent buildings for landing sites. Skilled helicopter pilots, often flying with coordinates to makeshift landing sites, navigated across broken power lines and, in some cases, ignored sniper fire to offer safe passage to critically ill patients.

Security issues such as perimeter management and personnel access to the facility were vital to ensuring safety for hospital staff, patients, and families. The unanticipated civil unrest experienced during Hurricane Katrina impeded patient evacuation from New Orleans hospitals, thwarting medical transport team efforts, and discouraging some hospitals from participating in evacuation efforts because of the potential for harm of their personnel in the New Orleans "war zone."

### Supplies and Staff Provisions.

TCH has experimented with various approaches to meet the urgent need for supplies during a disaster and has developed an approach that includes the availability of at least a 3-day food supply at all times. This requires frequent checks for expiration dates, regular rotation of stock, and strong vendor relationships to augment the supply on short notice in the case of impending disaster. In the case of Katrina, the need for supplies in the disaster zone was identified as a priority versus the need for supplies at our own hospital. TCH was able to mobilize necessary supplies such as headlamps for health care staff, packaged foods, fluids, and other essentials to respond to the needs of New Orleans facilities, most of which were anticipated by TCH because of our previous experience and as a result of the supply stockpiles that we maintain routinely.

### Health Care Personnel

Obviously, health care personnel of all disciplines must be available and knowledgeable about their role in disaster management. Historically, our organization has taken a traditional approach to staffing during disasters including early identification of staff who are on the "ride-out" team during the height of the disaster, with the assignment of the balance of staff that have respon-

sibility for postdisaster patient care to the “relief team.” In addition, our personnel have been categorized as “essential” or “nonessential.” Essential personnel consist primarily of direct patient care providers and associated support and ancillary personnel. Recent disaster experience suggests that communities and individual institutions require an abundance of staff to ensure the uninterrupted provision of patient care when a disaster threatens its own facility for a period of time or when it is responding to support the needs of others.

Caring for families of staff who are asked to respond to a disaster such as Hurricane Katrina is an important issue. Many staff members have young children or older parents and are unable to take care of their family and report for disaster duty simultaneously. To address this need, temporary day care for children of staff and physicians was established during this disaster response. Coordinated through the child life department, it provided necessary support for staff, particularly single parents.

### *Communication*

The need for accurate and timely communication during a disaster cannot be overstated. Key leadership and staff are assigned to groups that are paged simultaneously to alert personnel of an impending disaster. Once staff receive the page, they have been directed to call into the command center for specific instructions. This approach has proven successful in the past for alerting key staff. However, the logistics of answering multiple telephone calls overwhelmed the command-center staff, and as a result, we now have a dedicated telephone number established for physicians and hospital staff to access that contains general information regarding the disaster and their role in responding to it. In addition, satellite phones are a necessity, because the volume of traffic stimulated by an impending disaster quickly overwhelms cell-phone systems.

Regular communication to staff, physicians, families, and the communities is critical. Within hours of learning that TCH would be airlifting pediatric patients, local and national news reporters arrived at the hospital. The 5-member public relations team went into a crisis communication mode and guided more than 100 journalists through the hospital’s relief efforts on behalf of New Orleans and the surrounding area. The most common requests were for live reunions, which were arranged after parents and family members arrived to be with their children. Members of the media also requested to ride along with the air-transport team during the evacuation of patients. This request was denied because of space limitations on the aircraft.

Media from all over the world continued to cover hospital relief efforts through Labor Day weekend (7 days after landfall). Overall, TCH was featured in multiple national news programs. In addition, more than 350 stories on TCH efforts ran in print and broadcast outlets

throughout the United States. Developing teams to work with external media inquiries while simultaneously managing the need for timely internal communications was an unforeseen challenge.

As a result of this experience, our communications team recently divided their efforts into an internal and an external communication group. A newly organized format for internal communications has been developed to allow staff to find critical information quickly. Teams that focus on external inquiries now are formalized for the duration of a disaster. In addition, TCH has developed a Web site that addresses specific clinical questions that staff may have related to the treatment of victims of any disaster including exposure to biological, chemical, or nuclear agents.

### *Disaster Leadership Team*

One of the most critical aspects of successful disaster management involves the quality, diversity of knowledge, and formal structure of the leadership in place. Our organization historically has assigned the key leadership role to the administrator on call for the hospital, an assignment that rotates weekly. In the event of a disaster, the administrator quickly accesses the back-up administrator, the physician leadership, and any additional executive resources needed. If the administrator on call is a nonclinical administrator, a clinical counterpart is added quickly to the command center’s leadership structure.

Additional key positions include an executive to manage communication, supply-chain issues, facilities, and external organizations such as the city government, police department, and others. The physician-in-chief (or designee) is a vital part of the senior disaster-management team and, as such, plays an integral role in prioritizing risks to patients and the institution for the duration of the event. During Hurricane Katrina, the medical director for transport services joined the senior leadership team to develop an approach for assisting with evacuation, identification of available TCH staff for transport, and prioritization of patients who required evacuation from New Orleans. Other decisions such as how to stage evacuated patients were discussed and directed by the medical director of the emergency center.

In addition to the composition of the leadership team, the physical location of the command center is an important consideration. It must have auxiliary power, be located centrally but not be accessible to casual traffic, and have adequate telephone lines. Ongoing access to news media coverage is critical to monitor and respond to changes in the external environment. Access to all hospital policies is important, including a hard copy of key policies in the event that an electronic copy is not available. Traditionally, the majority of decisions regarding all aspects of disaster management have emanated

from our command center. Although this has resulted in well-coordinated decisions, it also creates a highly interactive environment in which multiple conversations may occur simultaneously. The end result often can lead to a lack of clarity about the decision, confusion related to which personnel are responsible for addressing each issue, and a generally noisy environment that detracts from concise, effective communication.

In an effort to decrease the confusion in the traditional command-center structure, TCH recently developed 4 subcommand posts that focus on patient care staffing needs, facilities operations, family/physician support, and communication. The head of each subcommand center interfaces at predetermined times throughout the day to exchange information and ensure that the subcommand centers and central command center are in alignment. Early use of this approach during subsequent crises has yielded positive results.

### *Patient Evacuation and Transport Issues*

#### *Internal*

To create hospital capacity for incoming critically ill patients from New Orleans, patient-transport requests unrelated to the disaster were reviewed on a case-by-case basis by the medical director of transport services at TCH. This modification of our existing process created a single point of triage for all critically ill patients, whether local or from the disaster zone, thus ensuring that the most critically ill patients received the highest priority for transport.

#### *External*

Regionalization of pediatric subspecialty care has driven the development of high-quality pediatric transport teams throughout the United States. TCH has had unit-based neonatal and pediatric transport teams for more than 15 years, providing a mobile ICU for children who require specialized services throughout the Southwest.

Development and maintenance of a transport program is a dynamic process, and the single most important element of preparation is high-quality, well-trained personnel who can execute their skills in the stressful transport environment. Ongoing matriculation of new personnel and continuing opportunities for education are paramount to the skills of any transport team. Multiple staffing paradigms exist, but the common denominators are training and expertise. Collaborative leadership of physicians, directors, and team members working with personnel and providing program oversight and ongoing performance improvement is integral to the success of any program.

The personnel must be given the opportunity to execute transports within a well-defined infrastructure provided by the home institution. High-quality equipment that can withstand the rigors of transport, includ-

ing safe, efficient vehicular transport (via rotorcraft, fixed-wing planes, or ground ambulances) is essential to the working environment. Transport crews require a support system of personnel at the home institution that can facilitate and coordinate dynamic issues that require frequent updated communication and assistance. Transports are affected uniquely by out-of-hospital conditions including weather, traffic, topography, and the relationship of the referring hospital and personnel.

Before Hurricane Katrina, our disaster-planning efforts had focused on preparedness for an emergency with our own transport team, but a delineated local or national disaster transport response had not been executed previously.

### **LESSONS LEARNED**

The experiences during Hurricane Katrina reinforced the importance of long-term disaster preparedness as well as flexibility in managing unique conditions that accompany any disaster. With Katrina, internal hospital preparedness was supplanted quickly by the need for rapid patient evacuation. Hospitals with informal or formal affiliations with other hospitals were able to mobilize transport resources. The regional network of children's transport teams emerged in response to the need to provide safe and timely evacuation of pediatric patients from the disaster zone. Conference calls with participating children's hospitals' transport teams, with the TCH command center serving as regional coordinator, afforded some organization in the patient-evacuation efforts. Formalization of this approach would create a "safety net" for pediatric patients and should be considered in future planning for effective disaster response.

The need for accurate information during relief efforts cannot be overemphasized. The dynamic external conditions such as broken levees and civil unrest added to the proliferation of misinformation during the Katrina disaster. Lack of satellite phones and intermittently functioning cell phones thwarted timely and accurate communication throughout the disaster. A secure means of communication is critical to successful disaster relief and must be part of the first line of defense for any organization.

The value of having an on-site presence in any of the intermediate stations also cannot be overemphasized. A secondary assessment at the transfer site greatly aids the receiving hospital's ability to appropriately prepare for the inbound child, which ensures better use of staff and allows for more efficient care.

Finally, teamwork and flexibility was integral to all aspects of the relief effort. The leadership demonstrated by New Orleans hospitals and the immediate responsiveness of the transport teams from many children's hospitals, along with loaned aircraft from the community, leveraged new and established partners to create a safe passage for the critically ill pediatric patients of New

Orleans; every hospitalized patient survived, and all were reunited with their families.

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