Special FOCUS

Evolving Need for Alternative Triage Management in Public Health Emergencies: A Hurricane Katrina Case Study

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ABSTRACT

In many countries, traditional medical planning for disasters developed largely in response to battlefield and multiple casualty incidents, generally involving corporal injuries. The mass evacuation of a metropolitan population in the aftermath of Hurricane Katrina evolved into life-and-death triage scenarios involving thousands of patients with nontraumatic illnesses and special medical needs. Although unprecedented in the United States, triage management needs for this disaster were similar to other large-scale public health emergencies, both natural and human-generated, that occurred globally in the past half-century. The need for alternative triage-management processes similar to the methodologies of other global mass public health emergencies is illustrated through the experience of disaster medical assistance teams in the first 3 days following Katrina's landfall. The immediate establishment of disaster-specific, consensus-based, public health emergency–related triage protocols—developed with ethical and legal expertise and a renewed focus on multidimensional, multifactorial matrix decision-making processes—is strongly recommended. (*Disaster Med Public Health Preparedness.* 2008;2(Suppl 1):S40–S44)

Key Words: homeland security, mass casualties, triage, surge capacity, public health emergencies

The World Health Organization defines a disaster as "any occurrence that causes damage, ecological disruption, loss of human life or deterioration of health and health services on a scale sufficient to warrant an extraordinary response from outside the affected community or area."[1] Medically, a disaster exists when the emergency care system cannot offer even minimal care for patients without external assistance.[2] It has been stated that disasters "keep governments and planners honest by defining the public health (system) and exposing its vulnerabilities," and "It's the vulnerabilities" that "drive and define the goals of the triage-management process."[3] Accordingly, the triage-management demands faced by the medical care system in a catastrophe can, in part, be a key marker of the sophistication of the disaster preparedness provided by the responsible government.

A variety of public health emergencies (PHEs) share a common thread by "adversely impacting the public health system and its protective infrastructure (eg, water, sanitation, shelter, food, and basic health)." In turn, health consequences result when "the protective public health infrastructure and/or system is destroyed, overwhelmed, not recovered or maintained, or denied to populations under a nation-state's control."[4] Accordingly, this common thread also applies in defining the triage-management goals that are inextricably related to the public health and medical vulnerabilities exposed by the disaster. The consequences of any catastrophic event will vary in scope, nature, and severity. As such, disaster-specific triage-management goals will differ from one disaster to another, making it critical to identify both goals and disaster-specific resources as early as possible. In PHEs in which the destructive elements directly affect medical and public health protections, health priorities quickly emerge, dominate, and force reconsideration of triage decision-making processes and protocols.

Not until Hurricane Katrina ravaged Louisiana's coastline in August 2005 had there been a modern disaster during which critical public health infrastructures and governance collapsed, requiring the evacuation of an entire major US metropolitan area. The following case report, which is the assimilated experience of 4 of the on-scene responders (K.R.K., P.E.P., N.E.N., R.E.S.), outlines the immediate consequences of the related post-Katrina infrastructure collapse that required alternative triage-management protocols for an extraordinarily large number of evacuees, many of whom were older adults with chronic medical problems and special needs.

NEW ORLEANS AIRPORT EXPERIENCE: THE FIRST 72 HOURS

First 24 Hours (August 29, 2005)

New Orleans levees failed following the morning landfall of Hurricane Katrina. Despite the urging of government officials, in the immediate New Orleans area alone, an estimated 250,000 people remained behind in temporary shelters, hospitals, nursing facilities, and private homes. Massive flooding ensued during the next 24 hours.

Before the hurricane made landfall, the Federal Emergency Management Agency (FEMA) had activated the National Disaster Medical System (NDMS), deploying multiple Disas-

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ter Medical Assistance Teams (DMATs) to staging positions in nonthreatened, in-land positions around the Gulf of Mexico. Within 48 hours of the levee breaks, most of the teams had arrived in temporary mass shelter locations including the Louis Armstrong International Airport (MSY) where 3 DMATs had been deployed. According to the concurrent NDMS inventory resourcing, each team had a medical cache capable of treating up to "250 patients per day." However, as the DMATs arrived, officials were already predicting the arrival of tens of thousands of evacuees.

FEMA had chosen MSY because it had the advantages of roadway access from the lesser-flooded south side of New Orleans, and the logistical advantage of having long runways from which large military aircraft could provide secondary evacuation to distant venues across the United States, a strategy compatible with the concurrent national response plan. At this early juncture, FEMA officials instructed the teams to organize a patient receiving area and prepare to receive 2000 to 2500 patients per day. However, leaving medical decisions to the medical providers, probably by default, no specific information or instruction was provided by the FEMA commanders regarding guidelines for treatment strategies, resupply, or transport dispositions.

Arriving in the early morning of day 3 (August 31), DMAT crews encountered exhausted airport firefighters, extreme heat and humidity, no air conditioning, and no potable water or operating toilet facilities. Airport emergency generators were only capable of powering minimal lighting, a few large stand-alone fans, and essential firefighting equipment. DMAT leaders immediately assessed the utility of the airport's physical layout to accommodate DMAT portable medical facility components and the level of medical care that would be provided.

Ensuing discussions focused on 2 potential strategic options. Option 1, based on traditional DMAT deployment philosophy, called for the airport facility to become a field hospital and teams would attempt to provide high-level medical care for the sickest patients based on the available medical cache. In this paradigm, patients were stabilized for secondary evacuation or received ongoing care at the site. Option 2 revolved around the developing information that patient volume demands would soon outstrip available DMAT resources. Accordingly, DMATs would provide only basic lifesaving medical care and emphasize rapid assessment and secondary patient evacuation to NDMS receiving points around the nation. Due to unexpected communication failures, DMAT leaders were unable to discuss these options with FEMA/NDMS commanders in Baton Rouge, and DMAT leaders therefore assumed the traditional default of option 1.

In turn, two thirds of the DMAT personnel were assigned to provide medical care in the upper airport (departure) level, where there was ample space for medical tents, supplies, and a makeshift pharmacy. The remaining personnel were assigned to the patient staging and incoming helicopter flightline operations sector on the lower (tarmac) level. Nonambulatory patients were transported from that tarmac staging area by a van, which carried only 4 litter patients at a time and took a circuitous 5-minute route through a maze of full ambulances that had bypassed the staging area, also offloading patients on the upstairs ramp adjacent to the treatment area. After 12 hours, the medical floor already was unable to safely accommodate any new patients whether arriving by air, private vehicles, bus, or ambulance. The lower area was retasked to act as a staging area, with the deceased transferred by refrigerated truck to the NDMS Disaster Mortuary Operational Response Team site outside the airport property.

In addition to the escalating arrival of people who were ill and people with special needs, many thousands of relatively well evacuees seeking transport to other sites also were brought to MSY, confounding the circumstances, as did the arrival of media and other observers and volunteers.

> Between 125 and 175 helicopters were landing and off-loading 600 nonambulatory patients every hour, collapsing the traditional DMAT system within the first day

Next 24 to 48 Hours

Within 24 hours of DMAT arrival, helicopters were landing and offloading hurricane victims every 90 seconds, day and night. DMAT leaders and the Federal Aviation Administration estimated between 125 to 175 helicopters were landing and offloading 600 nonambulatory patients every hour, collapsing the traditional DMAT system within the first day.[5] Until additional teams and resources arrived several days later, accurate records could not be kept. Ability to triage patients based on their medical condition began to unravel. There were only a few remnants of necessary supplies left to treat the patients, and there was a rapidly dwindling ability to transport the patients immediately out to a higher level of care. DMAT medical caches were almost exhausted within the first 24 hours. Basic supplies such as latex gloves, paper gowns, urinals, bedpans, oxygen, and infant diapers were in short supply. Medical conditions were compounded by lack of food and water for both patients and rescuers. Absence of toilet facilities further deteriorated sanitation conditions. It was unclear whether any resupply actually was being dispatched to the site and only a limited number of medical personnel were available to provide basic care to nonambulatory individuals.

Despite these conditions, nonambulatory patients kept arriving and psychological strain increased. Stretchers were no longer available. Patients were placed on the floor so that stretchers could be recycled back to helicopters to retrieve more patients. Under these deteriorating conditions, an expectant category was established for those patients who were critical but judged to be untreatable or unlikely to survive transport. During the first night, the expectant area was staffed by a nurse with palliative care experience who received standing orders for general palliative care and morphine for pain. Within 12 hours, however, the nurse was retasked and the DMAT chaplain assumed sole charge. When airport power was restored several days later, the expectant area was moved to a quiet, air-conditioned, carpeted hall and staffed by a dedicated group of volunteers and medical personnel.

Most arriving patients, especially those transported directly from acute and chronic care facilities, were experiencing various degrees of clinical dehydration and suspected electrolyte imbalances, exacerbated by underlying chronic conditions and a lack of routine medical attention and access to daily medication regimens. Ironically, most dialysis-dependent patients generally were asymptomatic despite no treatment for more than 1 week. Likewise, by direct observation, in the opinion of the DMAT team members on scene throughout this initial 100-hour period (eg, K.R.K., N.E.S.), mental health patients did not require any special needs or create any disturbances, despite lack of medication.

Acuity evolved further as incoming transports began to include those in coma requiring intensive care as well as spinal injury patients who needed chronic ventilator support. Many patients had to be ventilated manually with bag-valve devices by the evacuating nurses and doctors, who themselves complained of dehydration and exhaustion. These rescuers also stated their own need to be evacuated from New Orleans themselves, hoping to join their own families who had evacuated earlier to distant locations. In terms of the ventilator support, until the Strategic National Stockpile was deployed and inventoried in Baton Rouge, mechanical ventilators were not available for several days, placing further strain on DMAT personnel.

Within the first 48 hours of operations, the number of extremely ill, nonambulatory patients in the baggage claim staging area alone exceeded 400, with only an average of 4 DMAT personnel staffing the area at any given time. One of those 4 often would be occupied providing manual mechanical ventilation.

Hours 72 to 96 of DMAT Operations

Approximately 72 hours into the DMAT operation, relief workers and supplies arrived en masse. A massive evacuation from the airport, involving ground and air, ensued. However, it would take another 24 hours for the thousands of ill patients, including those in the expectant area, to be retriaged and evacuated to definitive medical care sites.

DISCUSSION

As one of the first true tests of the National Disaster Medical System, the Katrina experience clearly reflected the need to reevaluate classical disaster planning and teaching. In particular, this unprecedented challenge, involving thousands of patients with significant, nontraumatic, life-threatening medical concerns, underscored the need to reappraise the appropriateness of traditional triage-management techniques, methods that have evolved primarily from wartime and civilian experience with multiple injury incidents, not PHEs such as Katrina. Although many international disaster events and recently developed US-based national training courses have explored the challenges of large scale PHEs, disaster experiences in the United States generally have been characterized by multiple people with severe injuries.[6] Many of the on-scene DMAT team members, including those with previous deployment experience, were recognized as medical and disaster experts. However, due to the infrequency of large-scale US catastrophes, few possessed significant previous encounters with large-scale disasters or even the benefit of mentored, formal, specialized training in disaster medicine.

> What occurred post-Katrina should no longer be considered an unprecedented event

In the Katrina incident, "third world" disaster conditions were created by the understandable inability to provide immediate mass evacuation and resources for thousands of patients with a myriad of nontraumatic medical conditions and complex degrees of acuity. The initial use of limited medical supplies to provide the usual standard of care rapidly depleted available resources. The lack of resupply and relief personnel for several days evolved into a situation that forced medical teams to perform mass triage based on resources rather than medical necessity.

Moreover, consensus guidelines or training standards for these types of triage decisions were not available. The displacement of massive numbers of vulnerable people with nontraumatic medical illness is now clearly a major concern for disaster planners, researchers, and educators, Furthermore, the threat of other public, mass population events such as pandemics or highly contagious bioterrorist threats also heightens the need for improved disaster-specific triage planning.[7,8] With increasing densities and sizes of populations worldwide, as well as increasing longevity in many nations, there are now more older adult and medically vulnerable subpopulations. These populations usually are not self-sufficient and may totally depend daily on a medical, public health, and social infrastructure, not only for quality of life but also for survival.[9] With the worldwide publicity and

media attention, what occurred post-Katrina should no longer be considered an unprecedented event, even among those whose experience is limited to their own nation. Future disaster planning for PHEs must anticipate care requirements, operationally, for tens (or even hundreds) of thousands of vulnerable and displaced people suffering both illness and injury or simply requiring day-to-day needs for chronic conditions and sustenance to be met.

At MSY, new patients generally resulted from acute deterioration of underlying chronic problems brought about by exposure to heat and humidity, deprivation of water and sustenance, and interruption of the daily requirements for medical support, including special needs care and routine medications. Worldwide algorithms to guide the relevant mass medical triage under such complicated circumstances are lacking. The MSY-Katrina experience clearly emphasizes that triage assessment tools should be developed and stratified, not only according to patient conditions but also for access to definitive care and resources (ie, supplies, staffing, and transportation). Also, it must be understood that such triage processes are dynamic. For example, patients who initially are, by necessity, categorized as "expectant" must be reassessed and retriaged when resource availability changes, which was done at the MSY.[10,11]

Despite the lack of nontraumatic triage guidelines for major catastrophes, the concept of complex nontraumatic triage is not entirely foreign to those working in emergency care systems. Even in relatively wealthy nations, practitioners routinely perform triage based on resources. Examples include situations in which the receiving facilities request that incoming ambulances divert and transport patients to other hospitals or when intensive care specialists, due to extraordinary patient care volumes, decide which patients are more deserving of scarce ventilator or intensive care resources.

This article clearly accentuates the need for alternative, multidimensional triage-management protocols based on the complexity, dynamics, and extenuating circumstances under which such PHEs occur. However, there remains a paucity of studies that help to resolve how responders actually perform such triage-management duties. Once resources become available, decisions can be modified and triage protocols adjusted accordingly. In large-scale PHEs, an early lack of resources should be assumed and anticipated by disaster managers. At MSY, DMAT resources were consumed rapidly in an attempt to meet the expected daily standard of care. As the massive scale of the evacuation became evident, the focus of decision making would have been best directed toward critical and timely transport dispositions. If additional supplies cannot be delivered, then the limitations in terms of delivering the usual standard of care on-scene should be recognized and the strategic plan altered accordingly until those resources become available. Clearly, this poses many ethical dilemmas such as those experienced by the DMAT personnel discussed herein. In turn, it prompts the need for developing prospective consensus among disaster experts as well as ethicists, legislative specialists, intensivists, and even lay population representatives.

In addition to the magnitude of the event and dynamics of delays in resources, confounding environmental, security, and logistical concerns become commonplace in large-scale PHEs and will have an adverse impact on and complicate triage decisions. Most important, it is the vulnerable older populations with chronic illnesses who are at greatest risk in these circumstances. The multiple overlapping medical conditions make such decisions multifactorial in themselves, regardless of timing or logistics.

For example, what are the treatment and transport triage-management criteria for an otherwise healthy, functional 80-year-old man with a first-time tachyarrhythmia and mild hypotension or a 53-year-old diabetic woman with severely altered mental status and a normal glucose (according to the last reagent strip in the inventory supply)? Does one consider chronological age or potential for life expectancy based on underlying comorbidities? Many decisions will be made under stress and with limited and possibly inaccurate information.

Multiplying this scenario by hundreds of people, all with a myriad of illnesses both acute and chronic, the triage management will require some degree of prospective consensus decision making and creative operational research. Simple triage algorithms or pocket guidelines will not suffice for responders facing hundreds, if not thousands, of complex patients. More important, because disasters are infrequent, few people have significant empiric experience and leadership skills for such circumstances. Accordingly, these triage-management challenges for future major PHEs would benefit from legal review, ethically driven, consensus-based training modules, and realistic exercises for would-be rescuers.[12]

Historically, despite the traumatic nature, the prototype for PHEs actually is found in wartime experiences in which the public health infrastructure and system is destroyed outright. As demonstrated in the present case study, PHEs also occur as a consequence of large-scale natural disasters. Public health consequences characteristically remain as long as it takes to recover and rehabilitate the public health infrastructure.[4] Two years after Hurricane Katrina, studies report a 47% rise in local mortality rates, a consequence resulting in part from a poorly recovered public health infrastructure and surveillance system.[13] Despite an unprecedented robust donor program, Indian Ocean countries affected by the December 2004 tsunami still experience preventable mortality and morbidity resulting from loss of health professionals and decreased availability of health care facilities, shelters, clean water, and sanitation.[14]

The international humanitarian relief and disaster management community has come to expect and routinely prepare for broad health and public health consequences that include management of massive internally displaced and refugee pop-

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ulations. In the developed world, where PHEs are rare occurrences, sensitivity to the catastrophic nature and consequences of PHEs is less likely. During the post-Katrina phase, many undamaged communities such as Dallas and Houston, hundreds of miles from New Orleans, were affected both in the short and long term by arrival of evacuees who—without homes, without employment, and without their usual health care access—adversely affected the economic and public health infrastructure and systems.[15,16]

Even with newly developed triage guidelines, data collection and analysis of triage protocols leading to measures of effectiveness will be required. Data from other PHEs will be helpful, especially those from international complex humanitarian emergencies, in which population shifts, acuity and complexity of illnesses, and poor resources are commonplace.[4,17]

CONCLUSIONS

Traditional medical planning and related training for disasters have been developed largely in response to the need for treatment and evacuation prioritization in battlefield and trauma-related multiple casualty incidents. It became rapidly evident in the aftermath of Hurricane Katrina that the thousands of patients with nontraumatic illnesses and special medical care needs required alternative triage-management protocols. With the risk for nontraumatic mass triage events ever increasing worldwide, the Katrina experience provides compelling evidence for the immediate consensus-based development of more disaster-specific and sensitive PHE-related triage protocols. These protocols must be developed with ethical and legal expertise and with a renewed focus on multidimensional, multifactorial matrix decision-making processes that responders can use and appropriately adapt to the inevitable complexities of triage management that will arise during large-scale PHE events.

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Authors' Disclosures

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