

THE NATIONAL DISASTER MEDICAL SYSTEM: PAST, PRESENT, AND SUGGESTIONS FOR THE FUTURE

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This article reviews the history and structure of the National Disaster Medical System (NDMS), with an emphasis on its definitive care component. NDMS's capacity to handle very large mass casualty events, such as those included in the National Planning Scenarios, is examined. Following Hurricane Katrina, Congress called for a reevaluation of NDMS. In that context, we make three key suggestions to improve NDMS's capacity to respond to large mass casualty disasters: (1) increase the level of engagement by the private (i.e., nonfederal) healthcare system in preparedness and response efforts; (2) increase the reliance on regional hospital collaborative networks as part of the backbone of the NDMS system; and (3) develop additional, alternative patient transportation systems, linked to the overall NDMS patient tracking effort, to decrease the sole reliance on DoD long-haul air transport in medical evacuation.

THE NATIONAL DISASTER MEDICAL SYSTEM (NDMS) is designated as the primary federal response mechanism for mass casualty events. The NDMS components include deployable medical response teams, a patient evacuation system, and definitive hospital care. This analysis reviews the present structure and functions of NDMS, with an emphasis on the definitive (hospital) care component. It highlights a number of the probable limitations of NDMS capacities in responding to very large mass casualty events and suggests ways NDMS might be changed to help the country better respond to large-scale disasters involving thousands of sick or injured people.

NDMS was originally developed to supplement and support the medical care of evacuated military and civilian casualties from an overseas war.¹ NDMS has never been used for its original purpose, and its mission has since evolved away from military support and toward civilian medical support following disasters. With this evolution, NDMS

has become the federal government's primary medical response system for large regional and national disasters. In the current National Response Plan (NRP), NDMS is responsible for providing emergency medical response, transportation and evacuation, and coordination of patient distribution for definitive care in the federal medical response in disasters, as part of the Emergency Support Function #8 (ESF-8), Public Health and Medical Services, directed by the Department of Health and Human Services (HHS).²

The medical evacuation of hospital and other acute care patients in the aftermath of Hurricane Katrina, centered at the New Orleans airport, was the first time a full-scale operation using the NDMS patient movement capability had ever been initiated. A Senate report following the federal response to Hurricane Katrina noted that, while the operation succeeded in moving thousands of patients, medical teams were overwhelmed, overall command structure was absent, a tracking system was not accessible for all patients,

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and as a result there was no systematic way of knowing where patients had been transported, raising questions about the mission, scope, and capability of NDMS.³

In the following year, the Pandemic and All-Hazards Preparedness Act of 2006 (P.L. 109-417)⁴ was passed, containing a provision calling for HHS, in partnership with the Department of Homeland Security (DHS), the Department of Defense (DoD), and the Veterans Administration (VA), to reevaluate NDMS. HHS has taken the lead in this effort and is in the process of reviewing the current NDMS system and considering ideas for its future development.

On October 18, 2007, the White House released Homeland Security Presidential Directive 21 (HSPD-21), which calls for HHS to submit within 270 days of the completion of the NDMS review a concept plan that coordinates all government and private sector medical and public health resources.⁵

The Homeland Security Council, in conjunction with DHS, has established National Planning Scenarios to guide federal, state, and local disaster planning.⁶ Several scenarios describe events that are geographically limited in scope but are projected to produce between 10,000 and 100,000 live casualties who would need inpatient hospital care. These scenarios include a large-scale anthrax attack, a blister agent release, a chlorine tank release, a major earthquake, and the detonation of an improvised nuclear device. Such disasters would lead to medical casualties beyond local and state healthcare capacity and would test the limits of multiple state and federal response efforts, including NDMS as it is currently structured.

HISTORY AND STRUCTURE OF NDMS

NDMS was formed in 1984 as a part of the Public Health Service in HHS as a public-private partnership between several branches of the federal government and private healthcare institutions; its purpose was to provide medical evacuation and definitive care in the U.S. for military casualties returning from an overseas war. A secondary mission of the system was to supplement state and local medical resources during disasters and emergencies.

Currently, federal agency participants include HHS as the lead response agency; DHS as the overall coordinating agency; and DoD and the Veterans Administration healthcare systems as the agencies responsible for logistics and transportation. Federal resources are to be supplemented, if needed, by private nonfederal hospitals that have signed agreements with NDMS to provide hospital beds if they can be made available. After the terrorist attacks of 2001, the NDMS mission was expanded to include medical response to terrorist attacks, as well as pre-staging for national security “special events” such as political conventions.

NDMS consists of three components: deployable medical response, patient evacuation, and definitive care.

Deployable Medical Response

A variety of NDMS medical response teams can be deployed to a disaster site with a cache of equipment and supplies to provide emergency healthcare and triage of victims. Medical response teams take time to deploy and have limited capacity and capabilities. The entire NDMS system includes 55 general Disaster Medical Assistance Teams (DMATs) and 35 specialty care teams (see Table 1). DMATs, which account for the great majority of these teams, are regionally organized groups of specially trained healthcare professionals and support personnel who volunteer for deployment during disasters. Once they are deployed, they become federalized for the mission and receive federal payment for their services. A typical DMAT deployment consists of 35 professional staff plus additional support staff who are equipped and trained to operate independently for up to 72 hours in austere environments. The rate at which patients can be treated by a DMAT depends on the severity of illness or injury of the patients. A fully functional DMAT can treat and release approximately 250 patients per day with predominantly minor or nonacute conditions.¹

In addition to the deployable teams, the federal government is developing deployable medical facilities called Federal Medical Stations or Shelters (FMSs). Each FMS contains equipment, patient beds, medical supplies, and a limited stock of pharmaceuticals that can be used in a building of convenience or an alternate care site. There are four types of FMS in various stages of development: Type I, which are being developed to provide advanced intensive care and operating room services; Type II, which have not yet been developed, would provide specialty care such as infectious disease isolation; Type III, which provide basic low-acuity care; and Type IV (medical needs shelter), which provide shelter to those with chronic medical condi-

Table 1. NDMS Deployable Medical Response Teams

Disaster Medical Assistance Teams (DMATs)	55
National Medical Response Teams (NMRTs)	4
Burn teams	5
Pediatric DMATs	2
Crush Medicine Team	1
International Medical/Surgical Teams (IMSurTs)	3
Mental health teams	3
Veterinary Medical Assistance Teams (VMATs)	3
Disaster Mortuary Operational Response Teams (DMORTs)	11
Joint Management Team (JMT)	1
Nurse/Pharmacist Response Teams	3

tions.⁷ FMSs were first used following Hurricane Katrina.⁸ Ten stations were assembled, but, since they were not fully equipped, they were used primarily for evacuee shelter.⁹

There are plans to eventually assemble 40 FMSs. Each FMS is planned to contain up to 250 beds. It is anticipated that FMSs will be staffed by DMATs, the Public Health Service Commissioned Corps, or nonfederal medical volunteers, such as the state or locally organized Medical Reserve Corps (MRC). In addition to the FMSs, there are a variety of other military and state mobile hospitals that, although they are not part of NDMS, could be deployed in a crisis and were used after Hurricane Katrina.⁸

Patient Evacuation

This function includes communication and transportation support to evacuate patients from a mobilization center near the disaster, such as an aeromedical evacuation center at an airport, to another distant location using aircraft provided by the Department of Defense. Approximately 70–72 Federal Coordinating Centers (FCCs) located at Veterans Administration (VA) hospitals and military bases around the country coordinate the transfer of the patients from an aeromedical evacuation center to a receiving site (a military base or other airport facility) and finally to receiving hospitals. FCCs, generally supported by a small staff, are responsible for receipt of evacuated patients, tracking NDMS patient admissions and discharges, transportation of patients back to their place of origin, and assisting the hospitals with reimbursement for patient care.¹⁰

Definitive Care

This term encompasses inpatient medical care beyond emergency evaluation and stabilization and involves placement of patients into NDMS-participating hospitals. Approximately 2,000 hospitals around the country have offered about 100,000 general medical/surgical and specialty beds for NDMS use. However, participating hospitals are free to change the number of beds that are made available to NDMS as circumstances change during an emergency.²

DMATs and other response teams have been deployed in natural disasters many times, most notably for hurricanes. The performance of the teams' members, who often work extremely long hours under adverse conditions, has been universally praised. The teams have proven to be of great value, especially in replacing existing medical facilities that have been damaged or closed. However, the first time that the patient evacuation and definitive care components of NDMS were used to move a large number of civilian patients was following Hurricanes Katrina and Rita.¹¹ In response to requests for assistance from the state of Louisiana, approximately 2,900 patients were transported from the New Orleans airport to military bases or airports near

NDMS-participating hospitals in the aftermath of Hurricane Katrina.¹²

In addition to the NDMS medical evacuation, many other people were evacuated after Hurricane Katrina by a variety of government and private craft acting independently and without any connection to NDMS. The Coast Guard, for example, operating on its own initiative, rescued 6,470 people by helicopter and 22,000 people by surface craft.¹³ In addition, according to the Association of Air Medical Services (AAMS), private air transport companies were able to provide 50 medical helicopters and 13 airplanes, and these aircraft evacuated approximately 2,000 people from New Orleans hospitals over 96 hours. AAMS concluded that these flights were hampered by a lack of planning, coordination, and communication and estimated that its members could have moved "up to 7,000 patients if a better system had been in place."⁸ Only those patients transported on Air Force aircraft were logged into the NDMS patient-movement tracking system, as the system was not accessible for patients moved on National Guard or private aircraft.¹⁴

The medical care of patients in large-scale disasters, beyond what is described above, is not considered a federal responsibility. NDMS plans do not address what hospitals might do to increase capacity during a crisis or how hospitals might work together to maximize the care available to the disaster victims or to minimize the impact on other patients.

NDMS'S DEFINITIVE CARE CONCEPT OF OPERATIONS

The NRP calls for HHS, through its executive agent, the Assistant Secretary for Preparedness and Response (ASPR), to have the lead role in directing medical response in a disaster under the ESF-8 authority. DoD is responsible for patient evacuation and patient movement from the disaster location to sites of inpatient hospital care around the country. The VA and DoD are responsible for coordinating and providing care both in their own facilities and in private hospitals that have signed Memoranda of Agreement (MOAs) with NDMS to provide beds for NDMS patients. VA and DoD share the responsibility for recruiting hospital participation and tracking the availability of beds in hospitals that participate in NDMS. This hospital recruitment and bed-tracking function is coordinated and managed through the FCCs.

Since this program was originally designed to transport military casualties home from an overseas war, the plans focus on long distance transportation with large fixed-wing aircraft. The concept of operations calls for DMATs to stabilize patients for transport at the disaster site and for local

ambulances, bus systems, or helicopters to move patients to staging areas located at nearby large airports (with runways long enough to handle military cargo aircraft). From there, the NDMS concept of operations calls for patients to be evacuated by the DoD aeromedical evacuation system, which consists of large military cargo airplanes converted into flying ambulances and staffed by specially trained military medical personnel. The patients are flown to large airports at or near the FCC facilities at VA or DoD centers around the country and then distributed to the receiving hospitals via short-haul transportation such as ambulances and helicopters. Short-haul transportation, such as the movement of patients from the site of a disaster to an aeromedical evacuation center or to local medical facilities, is considered a state rather than a federal responsibility.

The aeromedical evacuation system is coordinated by the Global Patient Movements Requirements Center, a unit of the U.S. Transportation Command (USTRANSCOM) of the U.S. Air Force located at Scott Air Force Base, Illinois. If necessary, the USTRANSCOM airlift capacity could be supplemented through the activation of the aeromedical evacuation arm of the Civilian Reserve Air Fleet (CRAF) by the U.S. military's Northern Command (NORTHCOM), the joint military command responsible for North America. Along with defending the U.S. from military attack, NORTHCOM has the responsibility for providing military assistance in civil disasters when requested to do so by another federal agency. CRAF consists of commercial airliners that can be reconfigured for military transport during a national crisis. The federal government contracts with 39 airlines to keep approximately 1,400 airplanes available on short notice, including 45 Boeing 767s signed up for aeromedical evacuation. It would take 60 hours for the first CRAF plane to be reconfigured. The remaining aircraft would become available over a period of weeks, as all the planes must go to one contractor in Galveston for the conversion. In addition, it is uncertain the extent to which the conversion kits are still functional.¹⁵

LIMITATIONS OF NDMS IN A LARGE-SCALE DISASTER

Several problems become apparent when this system is applied to a mass casualty disaster involving thousands of casualties.

DMATs Take Time to Deploy and Have Limited Capacity

DMATs are a fundamental component of the NDMS response, particularly in the early stages of a disaster when their work in the field in triage and stabilization of patients at the site of the event is crucial. However, although some

teams can be activated within hours of the recognition of an incident, experience indicates that it will likely be a day or more before most teams reach the disaster site, meet up with their equipment, and are ready to work. The current plan relies on commercial air travel for NDMS teams, which in a mass casualty event may be difficult to arrange. In addition, the teams' equipment may have to travel by truck. The equipment belonging to the Oregon-2 DMAT, deployed to New Orleans after Hurricane Katrina, arrived at the New Orleans airport 5 days after the team arrived.⁸

Once set up, DMATs are limited in the amount and type of care they can provide. If providing only minor treatment and release of ambulatory patients, all the DMAT teams in the country working together could handle about 5,000 patients per day. If, however, the teams are providing inpatient-type care, such as managing continuous IV fluids, pain control, or antibiotics, their capacity would be only about 1,400 patients.¹ Many DMATs are not equipped or trained to provide specialized care for patients in shock or respiratory failure or for burn or pediatric patients.

FMSs Take Longer to Deploy

The Federal Medical Stations (FMSs) would take even longer to deploy and are limited by the equipment and staffing available. Since many of the local medical volunteers who are expected to staff the FMSs (i.e., the personnel who comprise the DMATs, the uniformed public health service corps, or nonfederal medical volunteers such as the state-organized Medical Reserve Corps) will be maximally engaged in their other responsibilities during a disaster, it is likely that additional volunteer staff would have to come from some distance away and would take some time to assemble, if they were available at all. FMSs are not yet fully developed, and the 40 planned will likely include some Type I Advanced ICU-level care units, as well as others that are the Type III and IV first aid, triage, and medical needs shelters.⁶ These facilities may have a significant role in the more frequent smaller-scale events, especially for those in which advance warning and pre-positioning is possible, such as hurricanes or political conventions, but they are unlikely to have a major impact in sudden or massive disasters with many thousands of ill or injured.

A Limited Number of Patients Could Be Transported

The military medical transportation system could transport only limited numbers of patients. Long-haul transportation of patients is a federal responsibility but is constrained by the limited aeromedical evacuation capacity of the U.S. military. Although almost all of the more than 1,000 cargo planes in the U.S. Air Force, Air Force Reserve, and Air National Guard can be reconfigured for medical transportation,¹⁶ trained aeromedical personnel needed to transport

patients are limited in number. Most (65%) of the military aeromedical personnel are in the Air Force Reserve¹⁷ and would likely take some time to be called up in a crisis. For critical care patients, not only is there a limited number of highly trained personnel, but each three-member Critical Care Air Transport Team can only accommodate three ventilator patients or six nonventilator critical care patients per flight.¹⁸ Thus, even if the CRAF were activated to supplement the number of airplanes available, the staff limitations would likely preclude a significant immediate increase in the medical lift capacity.

LIMITATIONS OF THE HEALTHCARE SYSTEM IN DISASTER RESPONSE

Most Hospitals Are Private

Most of the 5,000 hospitals in the U.S. are private institutions over which the federal government has little authority. The vast majority of the medical assets of the country are in the private sector, where the U.S. government has limited authority or capacity to coordinate or direct medical care. Even the states have little authority over private hospitals unless they declare extraordinary police powers as a result of a public health emergency. In addition, there are a limited number of medical personnel in the private healthcare sector who understand the “national disaster system” or their role in it. In a survey of training needs at NDMS participating hospitals, 25% of participating hospitals were unaware of their designation as an NDMS hospital.¹⁹

Few Incentives for Private Healthcare Systems

There is little incentive for the private healthcare system to fully engage in disaster preparedness. Many hospital administrators are not convinced that a disaster affecting their own hospital is likely and view spending on disaster preparedness as a luxury they cannot easily afford. In our own analysis of the cost of hospital preparedness for pandemic influenza alone, a stockpile of personal protective equipment, basic supplies, and support for planning and training personnel would cost the average U.S. hospital about \$1 million.²⁰ If patients are admitted to NDMS participating hospitals during a crisis, there is reimbursement for care, but there is no funding provided to hospitals for NDMS enrollment and ongoing training.

Hospitals Are Not Interconnected

Most hospitals are not interconnected in such a way as to be able to respond collaboratively. In recent years, both the Joint Commission and the federal government have in-

cluded communitywide preparedness and interhospital collaboration as key preparedness goals. Nascent efforts at regional cooperation between hospitals are beginning across the country, but regions are pursuing collaboration with different levels of resources and different purposes.²¹ Hospitals in many communities and regions have not yet begun to plan together or in conjunction with public health or emergency management agencies. Few regions have developed the communication or administrative capabilities required for a joint response.

CONCLUSIONS: NDMS GOING FORWARD

In its current ongoing review of NDMS, the U.S. government should consider a few key changes to NDMS that could improve the transportation, tracking, and definitive care capacity of NDMS and of healthcare entities around the country to care for the sick or injured in large mass casualty events. These changes include: (1) an increased level of engagement by the private (i.e., nonfederal) healthcare system in preparedness and response efforts; (2) an increased reliance on regional hospital collaborative networks as part of the backbone of the NDMS system; and (3) development of additional, alternative patient transportation systems, linked to the overall NDMS patient tracking effort, to decrease the reliance on DoD long-haul air transport in medical evacuation.

The NDMS could be strengthened by increasing the level of engagement of local and regional private (nonfederal) hospitals and public health agencies to carry on and supplement care initiated by deployable teams. A national “concept of operations” for NDMS could be developed to include an explanation of the expected role of every regional group and every hospital in the country (e.g., what is expected of them if they are in a disaster affected zone, what is expected of them if they are outside of a disaster affected zone but their help is needed).

Within each hospital there should be at least a few medical professionals trained in disaster preparedness and who are familiar with the operational details of the new system. This could be accomplished through creating a national training curriculum derived from the national strategy and concept of operation for hospitals, which would be taught in medical and nursing schools, residency programs, and through continuing education of healthcare personnel. The American Medical Association’s National Disaster Life Support Education Consortium has developed curricula for individual training and institutional training that could serve as a basis for this continuing education initiative.²²

Engagement of the private healthcare system beyond the current role as registrants in the definitive care system could have significant benefits to NDMS, such as making regions and communities less reliant on the arrival of external

teams and resources in the event of a disaster. An organizing structure for the emergency medical response efforts of usually separate private healthcare institutions is a prerequisite for this type of increased engagement.

The NDMS would be more resilient and capable of functioning in a crisis if it was built on strong regional emergency healthcare partnerships. As HHS has recognized by the recent “Partnership Awards,” regional partnerships could become a critical means of intraregion resilience, communications, and resource-sharing (medical personnel, medicines, equipment) in a crisis. When catastrophes are large enough that they are beyond the capacity of a region’s healthcare system, adjacent regions may be best poised to provide additional medical care. If the NDMS system becomes structured to support such region-to-region collaboration, regions could provide a great deal of medical care assistance without requiring the federal government to direct and execute all or most of the effort. Many such regional coordinating groups, in varying stages of development, already exist in metropolitan areas, regions prone to natural disasters, and other jurisdictions.²¹ Ultimately, it would be logical if all parts of the country belonged to some functional healthcare region, with a clear map and points of decision and contact in each region, and such regions would have strong working relationships not only with all hospital and health entities in their own regions, but also with other regional directors and the NDMS as well. The existing network of NDMS FCCs at VA and DoD medical treatment facilities could be enhanced to function as the backbone of a national network of Regional Hospital Coordinating Groups both for planning and for operational response in the time of a crisis.

In the event of catastrophes affecting multiple adjacent regions with significant destruction of medical facilities and infrastructure, the movement of large numbers of patients outside of the affected area to get medical care will still be required. It would be advantageous to lower the expectations now placed on the federal government (in this case, DoD) with regards to transportation by large aircraft, and to increase the expectation that we will use a wide and innovative variety of means of transporting ill people to hospitals where care can be provided. Using such an approach, patients would be moved outward from the site of catastrophe only as far as they needed to be, in an expanding circle as contiguous regional groups are recruited into the response. Plans would allow the use of federally owned transport as well as privately owned means of transport by ground, rail, and/or air.

Experience with disasters such as Hurricane Katrina reveals that spontaneous efforts to transport patients with private, state, and other equipment frequently develop, but because these systems are not part of the organized planning effort, there is little coordination and patients are not logged in to federal NDMS patient tracking systems. Coordination of this public-private patient transportation, including short distance and land transport, perhaps could be coordinated in some way by a federal coordinating system analogous to the way the air traffic control system manages the private airline traffic. This will require development of additional systems for tracking equipment and transported patients and distribution of response assets.

The current HHS review of the NDMS system and the concept plan called for in HSPD-21 are important opportunities to review the many past successes of the NDMS system, to consider critical threats and disasters that the NDMS could be required to face in the near or long-term future, and to examine possible changes to the system that would make it better equipped to address such challenges. NDMS and the broader medical system in the U.S. will be at the center of the response to nuclear or biological terrorism, major earthquakes, large-scale industrial accidents, or other serious mass-casualty-causing catastrophes that the country could confront. Working to strengthen NDMS and the medical system to prepare for such events is critical work in the time ahead.

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GLOSSARY

AAMS	Association of Air Medical Services
ASPR	Assistant Secretary for Preparedness and Response
CRAF	Civilian Reserve Air Fleet
DHS	Department of Homeland Security
DMAT	Disaster Medical Assistance Team
DMORT	Disaster Mortuary Operational Response Teams
DoD	Department of Defense
ESF-8	Emergency Support Function #8
FCC	Federal Coordinating Center
FEMA	Federal Emergency Management Agency
FMS	Federal Medical Station
HHS	Department of Health and Human Services
HRSA	Health Resources and Services Administration
HPP	Hospital Preparedness Program
ICS	Incident Command System
MOA	Memorandum of Agreement
MRC	Medical Reserve Corps
NBHPP	National Bioterrorism Hospital Preparedness Program
NDMS	National Disaster Medical System
NGO	nongovernmental organization
NMRT	National Medical Response Team
NORTHCOM	U.S. Northern Command
NIMS	National Incident Management System
NRP	National Response Plan
RHoC group	Regional Hospital Coordinating Group
USTRANSCOM	U.S. Transportation Command
VA	Veterans Administration
VMAT	Veterinary Medical Assistance Teams