c. Encourage proper personal hygiene among infected persons.

C. Design and evaluate improved prevention and control measures.
   1. Develop and evaluate better approaches for detecting infection.
      a. Determine antigenic, genetic, and other variation among HTLV-III isolates.
      b. Develop and evaluate new antigen tests.
      c. Cooperatively develop guidelines for use of currently available and new tests.
   2. Develop and evaluate active immunoprophylaxis.
      a. Convene scientific advisory committees to plan for development and evaluation of vaccines.
      b. Characterize HTLV-III antigens biochemically and structurally to determine the specific component parts of the virus against which the antibodies generated by a vaccine would react.
      c. Develop specific candidate vaccines including subunit products, synthetic peptides, genetically synthesized antigens, and others.
      d. Develop new means of preparing, packaging, preserving, and transporting vaccine.
      e. Develop new, effective methods for delivering vaccine to substantial numbers of people.
   3. Develop and evaluate passive immunophylaxis, using artificially prolonged antibody.
   4. Develop and evaluate drug and biologic therapy including antivirals, immune stimulants, and combinations of these.
      a. Evaluate existing candidate compounds in laboratory systems and clinical trials.
      b. Design, produce, and evaluate new drugs based on results with existing compounds.
      c. Develop new immune stimulants and test available stimulants in animals or clinical research objects; investigate reconstitution of immune system, e.g., bone marrow transplantation.
      d. Test immune stimulants combined with antiviral therapy against HTLV-III.
      e. Evaluate host factors and possible cofactors.
   5. Develop and improve animal models to accomplish studies that cannot be done with humans or *in vitro* systems.
      a. Test candidate vaccines and drugs in chimpanzee and rhesus monkeys, which are the only animals shown thus far to be infected with HTLV-III.
      b. Use existing animal models and seek new species for study of animal retroviruses related to HTLV-III, e.g., feline leukemia in cats and retrovirus infection in nonhuman primates. Study agents that control these viruses.
   6. Assure that adequate facilities exist to support studies in the development and evaluation of vaccines, antivirals, and immune stimulants listed above.

D. Design and promote prevention and control programs that will enhance effectiveness by incorporating new intervention tools (vaccines/antivirals) as they become available.

Designing a National Disaster Medical System

EDWARD N. BRANDT, Jr., MD, PhD
WILLIAM N. MAYER, MD
JAMES O. MASON, MD, DrPH
D. EARL BROWN, Jr., MD
LOUIS E. MAHONEY, MD, DrPH

Dr. Brandt was formerly Assistant Secretary for Health, Department of Health and Human Services, and Chairman of the Principal Working Group on Health of the Emergency Mobilization Preparedness Board. He is currently Chancellor of the University of Maryland at Baltimore. Dr. Mayer is Assistant Secretary of Defense for Health Affairs. Dr. Mason is Acting Assistant Secretary for Health at the Department of Health and Human Services, and Acting Chairman of the Principal Working Group on Health of the Emergency Mobilization Preparedness Board. Dr. Brown is Associate Deputy Chief Medical Director for Programs, Planning and Policy Development of the Veterans Administration. Dr. Mahoney is Special Assistant to the Chairman of the Manpower Task Force of the Principal Working Group on Health of the Emergency Mobilization Preparedness Board.

Tearsheet requests to Dr. Mahoney, National Disaster Medical System, Rm 18-74, Parklawn Bldg., 5600 Fishers Lane, Rockville, MD 20857.

Synopsis

The National Disaster Medical System (NDMS) is a partnership of private and public sectors to provide care to the victims of great disasters. The system is being developed as a voluntary cooperative effort of four major Federal agencies, State and local governments, and the American professional and hospital communities.

A medical response component will include 150 disaster medical assistance units capable of clearing or staging operations in a disaster. Each unit will comprise three 29-person teams containing physicians, nurses, medical technicians, and support personnel and will include a 16-person unit command and support element. An evacuation component will be founded on the military aeromedical evacuation system, augmented by civilian aircraft and other transportation resources. A hospital component will enroll 100,000 pre-committed beds in hospitals throughout the nation.

The system is designed to care for up to 100,000 casualties arising from a massive peacetime disaster or an overseas conventional military conflict.

The National Disaster Medical System will be implemented over a period of 3 to 5 years. The authors recommend that all parts of the American health care community join in support of the system.

CATASTROPHIC MASS-CASUALTY INCIDENTS have been rare in the United States. There have been numerous disasters that have caused enormous property losses with limited injuries and loss of life. In the last two decades, the nation has experienced several well-publicized but relatively small incidents, including the 1980 Mt. St. Helens eruption (65 dead and missing) (*1*), the 1971 San Fernando earthquake (64 deaths) (*2*), and the 1964 Alaskan earthquake (130 dead, including fatalities from tsunamis in Alaska, Oregon, and California) (*3*). Greater losses of life have occurred in other disasters in the last 100 years, such as the Texas City ship explosion (512 dead and missing), a 1928 Florida hurricane (1,810 dead), and the San Francisco earthquake (498 dead) (*4,5*). Other earthquakes, tidal waves, volcanic eruptions, storms, fires, industrial accidents, and a myriad of disasters have struck the United States. These have not, however, caused the massive casualties of similar European or Asian incidents.

Our land use patterns, not national good fortune, have spared us in such incidents. Our disasters have generally affected areas sparsely populated either in time or place.

For example, on January 9, 1857, a great earthquake (Richter magnitude estimated 8 or higher) occurred at Fort Tejon, CA, approximately 100 miles northwest of the center of Los Angeles. The area was essentially uninhabited at that time. Although casualties were not reported, they were probably negligible.

Urbanization and population growth make us much more susceptible now to high-casualty disasters. A modern recurrence of a similar earthquake at Fort Tejon could cause from 3,000 to 14,000 dead and from 12,000 to 55,000 persons hospitalized with injuries. (Moreover, the current annual probability of such an event is 2 to 5 percent (*6*)). As another example, a repetition of the Texas City explosion could cause about 2,000 deaths and 6,000 major injuries, because of population growth in the affected area.

Disasters causing large numbers of casualties could affect almost any settled area of the nation. Major earthquake risks exist in the West, in southern Missouri, in South Carolina, and perhaps in the New York-New England area. Major risks of weather incidents occur in most areas of the nation east of the Rocky Mountains. Transportation-related accidents could happen in any area. In addition to these established hazards, modern society is exposed to new hazards, such as nearby dams, chemical plants, or power generating facilities that multiply risk of incidents. The numbers of casualties from such events are largely determined by the size of the populations at risk. As most areas of the nation continue to grow, we must be prepared for massive casualties accompanying some disasters.

Our nation cannot prepare for events of this magnitude on a local or even on a State level. The problem is not just that hospitals may be damaged or compromised at and near a disaster site. Our urban areas are well provided with health resources and hospital beds. Each urban area, however, lacks capacity to deal with a disaster-caused surge of casualties proportional to its population. This incapacity extends to the State level in many cases; for instance, California possesses a total of 67,112 general medical and surgical beds (*7*), excluding intensive care, with which to deal with possible incidents that might generate casualties in the tens of thousands. A system for dealing with disaster casualties must therefore be national in scope, and it must be able to handle a surge of patients in numbers sufficient for the greatest plausible incident.

A Military Model

Military health planners are familiar with surge demands, but the rising costs and complexity of medical care have made an adequate surge capability economically impossible within the Department of Defense (DoD). The U.S. military hospital establishment currently totals approximately 18,000 beds, 2,000 of which are overseas. These beds, and their staffing, are scaled for the care of a relatively healthy peacetime active duty population. They are inadequate for military contingencies. Expansion of hospital capacity takes time and would be inordinately expensive. After considering these issues, the Department of Defense established the Civilian-Military Contingency Hospital System (CMCHS) in 1980.

CMCHS is a military medical support program operated by DoD, with the assistance of the Veterans Administration (VA), in partnership with the civilian hospitals of the nation. CMCHS is coordinated locally by major military or VA hospitals in urban areas. Each Federal coordinating hospital is responsible for recruiting local general hospitals to

participate in the system. Upon activation, the coordinating hospitals are also responsible for patient reception, for sorting and assignment of patients to appropriate hospitals, and for patient administration. CMCHS participating hospitals agree to accept patients in proportion to their licensed bed capacity in the event of a military emergency, and to participate in educational and exercise programs in mass casualty care. Participating hospitals are paid their regular charges for medical treatment.

The American hospital community has been receptive to this program. The CMCHS program was initially planned to comprise 50,000 beds; as of January 1, 1985, it comprised a network of 65,000 hospitals beds in 814 participating civilian general hospitals in 48 urban areas.

CMCHS is a system of limited scope; it is designed to access civilian hospital beds to care for military casualties exceeding the capacity of DoD and VA hospitals. In its present form, CMCHS is of limited utility in a civilian disaster. It contains only administrative components outside of its participating hospitals and coordinating centers. Logistic support is generated within DoD and VA and is concentrated on the functions of patient regulation (matching patients with available hospital resources), patient transportation, and patient administration (financing treatment and coordinating personnel matters for military patients). The system has no deployable elements capable of on-scene response. For a civilian emergency, it is therefore a resource for acute-care hospital beds only. CMCHS has, however, awakened strong interest in emergency preparedness in the American health care community. This interest has led to the establishment of the National Disaster Medical System (NDMS) and has provided a model for the design of the NDMS hospital component.

The NDMS Concept

In 1981, President Reagan established the Emergency Mobilization Preparedness Board (EMPB) and charged it to develop national plans and programs to improve emergency preparedness. Health program development was delegated to the Board's Principal Working Group on Health (PWGH). The PWGH is chaired by the Assistant Secretary for Health, Department of Health and Human Services (HHS). Major members of the body include HHS/Public Health Service (PHS), DoD, the Health Care Financing Administration, the VA, and the Federal Emergency Management Agency (FEMA). All other Federal agencies concerned with health services participate in the Principal Working Group and its Task Forces. The Principal Working Group on Health has developed the National Disaster Medical System design in response to the charge of the Emergency Mobilization Preparedness Board.

NDMS is designed to fulfill three main objectives:

- to provide assistance to a disaster area in the form of medical assistance teams, supplies, and equipment,
- to evacuate patients who cannot be cared for in an affected area to designated locations elsewhere in the nation, and
- to provide hospitalization in a national network of hospitals that have agreed to accept patients in the event of a national emergency.

The system is designed to care for the victims of any incident that exceeds the medical care capability of the affected State, region, or Federal medical care system. In general, the system exists to support State and local governments in a catastrophic disaster. The Federal government does not intend to preempt State governments' constitutional authorities and jurisdictional controls over an incident.

The system may be used in a variety of emergency events, such as an earthquake, a technologic disaster, a military contingency, or some other kind of public health emergency. We consider the "maximum plausible incident" to be a very large California earthquake, which might create 100,000 major injuries (*8*). We therefore scaled the system to accept a surge demand up to 100,000 seriously injured patients requiring hospitalization. This renders NDMS consistent with DoD needs for medical backup, and enables CMCHS to be used as the foundation for NDMS. However, the system is in no way designed or capable of caring for victims of nuclear warfare.

We identify five medical care functions involved in mass casualty care:

- field rescue and first aid,
- casualty clearing, which encompasses triage, medical stabilization, and temporary care at the first point of medical care,
- emergent surgical stabilization, which may have to be done in the disaster area to save life and render critically injured patients fit for evacuation,
- medical staging, which encompasses sorting and temporary care of stabilized casualties at transfer points in the evacuation system, and

• definitive care, which encompasses all remaining medical care required for proper care of the victim during the acute phase of an injury.

In addition, a disaster medical care system encompasses a myriad of logistic support functions; the most important are communications, finance, equipment, supply, and transportation.

NDMS will augment these medical care and logistic functions through a coordinated program involving major Federal agencies, State and local governments, and the private sector.

System Development

Overall planning of NDMS will be continued by the Principal Working Group on Health.

Development of the system is being carried out by an Implementation Task Force staffed by HHS, DoD, VA, and FEMA. The Implementation Task Force is charged with developing informational materials, developing an implementation schedule to integrate CMCHS areas into NDMS and recruit new areas, writing procedure and operations manuals, and developing a data system for managing the system.

The NDMS was formally announced on June 14, 1984. Organization of the facilities component of the program commenced at that time. Two pilot Clearing-Staging Units were developed and tested within PHS in 1984, and organization of the manpower element then began in mid-1985. Most of the system will be developed over a 3-year period, with development of surgical units delayed approximately 2 years more for solution of funding and logistic support issues.

American medical facilities and manpower resources are highly decentralized, and primarily under the control of the private sector and of State and local governments. Logistic support resources and command and control resources are strongly centralized, although they are divided between several large corporations and governmental agencies. NDMS will therefore develop facilities and manpower on a regional basis, while managing logistics and system coordination centrally.

NDMS Patient Reception Areas

The nation contains 210 Standard Metropolitan Statistical Areas of 150,000 or more population. Many of these cluster in large conurbations that can be considered as single regions. NDMS has established criteria for patient reception areas to be included in the system:

• available beds. Each NDMS area should have a minimum of 2,500 acute care hospital beds in facilities offering a full range of general medical and surgical services.
• coordinating center. The area must have a Federal or non-Federal institution capable of acting as a coordinating center, to link hospital beds with transportation, communication, and other resources, and to establish patient administration procedures.
• air access. The area must possess an airport capable of accommodating heavy aeromedical aircraft.

A total of 67 urban areas meet these criteria, 23 of which do not now participate in CMCHS. Four other urban areas fall slightly below the 2,500-bed threshold but now participate in the CMCHS system; such areas will be included as exceptions to the criteria. The map shows the locations of the 71 selected NDMS areas.

Medical Facilities

Hospital enrollment will be patterned after CMCHS and will build upon the existing system. Licensed and accredited hospitals of 100 or more beds may participate voluntarily in the program, if they agree to participate in a specified training and exercise program and to accept NDMS patients in proportion to specialty service needs and their available bed capacity at the time of activation of the system.

Medical Manpower

The manpower-intensive elements of the national system are medical clearing, medical staging, and field surgical stabilization. Without casualty clearing in the disaster area, patients cannot enter the disaster medical care system; without medical staging, an evacuation component cannot function; and (in dire catastrophe) without surgical stabilization in the field, some salvageable victims may die before they can be transported to definitive care. NDMS will first develop organized medical assistance teams capable of medical clearing in a disaster area or medical staging for the evacuation system. Later, should resources permit, it will develop assistance teams to provide field surgical services in

circumstances where local facilities are unable to provide sufficient surgical stabilization.

The NDMS Disaster Medical Assistance Team. NDMS has designed a 29-person medical assistance team capable of clearing or staging operations. Three such teams are grouped in an NDMS Clearing-Staging Unit. Each 29-person team comprises a balanced medical care force of physicians, nurses, medical technicians, and support personnel. At the level of the Clearing-Staging Unit, a 16-person command and support element adds limited internal support functions, including supply, communications, and feeding.

Each team can operate a staging site of a nominal 80-patient capacity around the clock at an undamaged intermediary or receptor airport. The team can also run a two-shift remote clearing operation in a disaster area, when supported by the unit headquarters element.

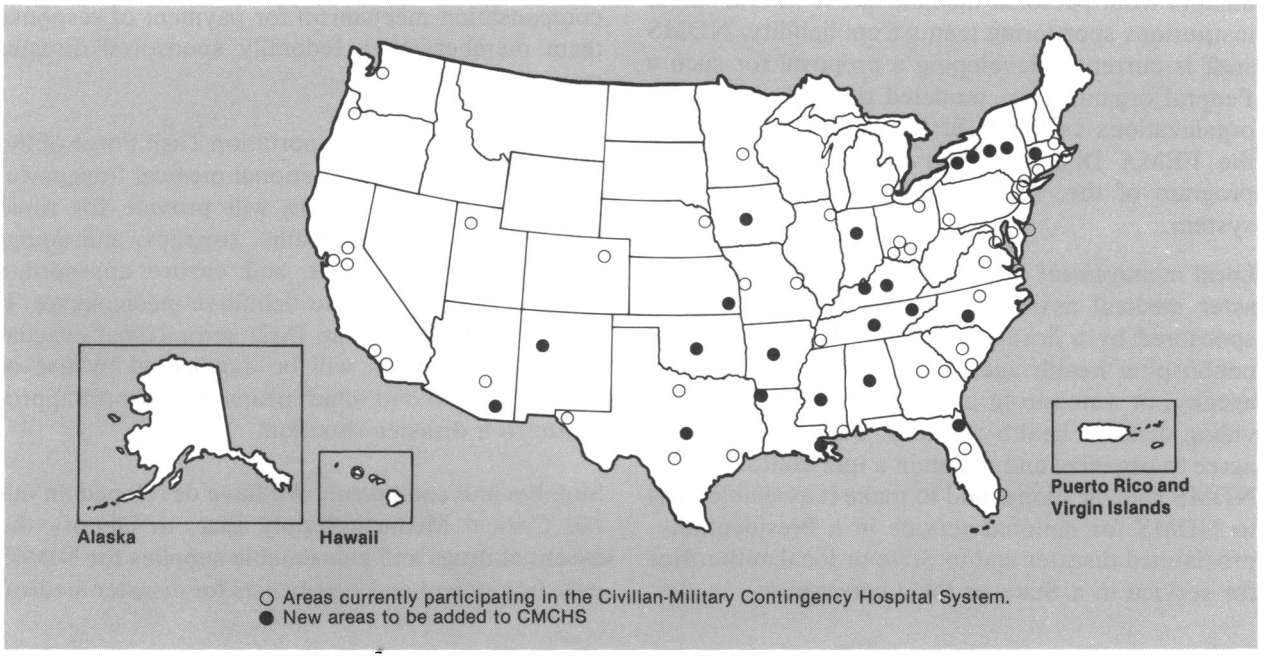
The entire unit can operate a large clearing station in a disaster area, a standard 250-patient aeromedical staging unit, or (when appropriately augmented) a fixed medical care site, providing screening, ambulatory medical care, and intermediate nursing care for a population of 10,000.

We will ask participating hospitals, voluntary agencies, and health departments to form volunteer disaster medical assistance teams. We will suggest that each larger hospital form one team from among interested clinical personnel. We will seek major medical centers, health departments, and voluntary agencies willing to provide headquarters units from among their administrative and support personnel. Our team designs are recommendations, not absolute standards and we encourage sponsors to adapt team composition to fit local conditions, requiring only that functional capacity be preserved.

NDMS is developing a training and exercise program to ensure that medical response teams and units and all participating hospitals are skilled in disaster health care.

Each NDMS area should form at least one Clearing-Staging Unit (three teams) to enable it to receive casualties at its principal airports. Large metropolitan areas should form more than one unit, thus creating organized medical resources deployable to a disaster site upon need. The maximum plausible 100,000-casualty scenario requires 150 Clearing-Staging Units nationwide, half to remain at home to receive patients, and half capable of deployment to the disaster area. This degree of system

Proposed National Disaster Medical System service areas



development would require formation of one unit for each 4,300 beds of licensed capacity in NDMS areas. Studies by HHS demonstrate that this level of manpower development would not significantly deplete medical resources in participating areas, in almost all areas requiring less than 1 percent of available personnel.

The NDMS Mobile Surgical Unit. In a very large scale disaster (such as a great earthquake), needs for emergent surgical care will far exceed the capabilities of surviving hospitals in the affected area. Field surgical services must be provided in such circumstances to render unstable but salvageable patients fit for evacuation. Such services can be provided most efficiently by a highly mobile and surgically intensive field unit. NDMS has designed a 215-person mobile surgical unit similar to a Mobile Army Surgical Hospital. Development of this component awaits resolution of cost, equipment, and deployability issues.

A Federal management organization. For medicolegal reasons, it is desirable to create a Federal management organization which would contain and manage response teams and their personnel in a disaster. Such an organizational umbrella is necessary to render interstate deployment a Federal activity, bringing into play the Federal supremacy clause of the Constitution in order to obviate the need for licensure of professional volunteers in all 50 States. This organization would also create appropriate channels for logistic support, protect volunteers from personal medicolegal risk, and shield institutions sponsoring teams from liability. NDMS staff is currently developing a proposal for such a Federal organization, modeled on such successful organizations as the U.S. Coast Guard Auxiliary, the FEMA Disaster Reserve, and the volunteer program of the Veterans Administration hospital system.

Local management organizations. Each NDMS disaster medical assistance team or unit should be sponsored by a licensed hospital, a State-approved nonhospital health agency, an emergency service agency, or a nonprofit corporation capable of providing disaster health services. The sponsor must agree to organize and maintain a unit conforming to NDMS specifications, and to make it available both to NDMS for national service in a Presidentially-proclaimed disaster and to State or local authorities for service in a State or local emergency.

Logistic Support

The principal logistic functions include finance, transportation, supplies and equipment, and communications. Plans for each logistic component are under development by interdepartmental task forces, and will be in place at the time formal organization of NDMS is completed.

Finance. The PWGH is developing policy options and systems for compensation of participating hospitals and individuals. Its principal policy decisions at this time follow:

- All disaster victims and relief workers will be eligible for NDMS services until adequate medical care is available within the affected State.
- Hospitals will be compensated at their usual rates for all NDMS patients.
- The system will recover its hospital service expenses from third-party payors to the extent required by Federal law.
- Members of assistance teams will be recruited and trained as volunteers, but a standby compensation method will be developed for ready use in an actual emergency.

The staff is presently working to implement these policies. A claims processing system structure similar to the CMCHS reimbursement system is being developed for NDMS. A fiscal intermediary has been engaged to develop a hospital- and provider-payment system. The staff is developing a standby compensation mechanism for payment of response team members in a federally sponsored disaster response.

Transportation. A Transportation Task Force of the PWGH has designed a national medical transportation system. This system will provide for rapid movement of medical teams, supplies, and equipment to a disaster site and ensure appropriate evacuation of patients to definitive medical care. It will rely initially on the DoD aeromedical evacuation system, which will be augmented by use of civilian aircraft and other means of transport appropriate to a disaster situation.

Supplies and equipment. We have developed an initial Critical Medical Supply List, to identify the essential drugs and consumable supplies for NDMS use. Equipment and supply lists for disaster medical

assistance teams are under development. Design parameters call for the maximum possible in durable equipment to be drawn from existing packaged disaster hospitals and available surplus to minimize equipment expense. Consumable supplies are to be kitted at depots and drop-shipped to destinations at activation, to minimize warehousing and perishability problems.

NDMS Activation

There are three methods of activating NDMS. In the event of a major disaster, the Governor of an affected State may request Federal assistance under the authority of the Disaster Relief Act of 1974 (Public Law 93-288, as amended). Pursuant to this act, the Governor requests a Presidential declaration of a "major disaster" or an "emergency" through the FEMA Regional Director. Upon receipt of a FEMA recommendation, the President may make a declaration of emergency. This Presidential declaration triggers a series of Federal responses coordinated by FEMA. These may include the activation of NDMS when appropriate. Generally, NDMS will only be called on in conditions of "major disaster" as defined in PL 93-288. However, some public health emergencies may not qualify for a disaster declaration under PL 93-288. In such a case a Governor may request emergency assistance of the Secretary of Health and Human Services, and the Secretary may activate the system under the authority of the Public Health Service Act. In the event of a national security emergency, the Secretary of Defense would have authority to activate the system.

Upon system activation a National Disaster Medical Operations Center (NDMOC) will become operational. NDMOC is tasked to coordinate Federal health responses to medical care needs in the affected area. NDMOC will include representatives of HHS/PHS, DoD, VA, FEMA, and the American Red Cross, as well as other Federal and private agencies concerned with medical services or medical logistics. NDMOC will work in cooperation with the affected State emergency medical authorities, the Armed Services Medical Regulating Office, and the Federal Coordinating Officer responsible for management of the disaster.

Conclusion

This paper has reviewed the planning and design of the National Disaster Medical System (NDMS).

'We believe that such a system is necessary to deal with the need for medical care foreseen in disasters of great magnitude. We have based the system design on the model of the Civilian-Military Contingency Hospital System, augmented by manpower and logistic elements that adapt it to serving a large civilian disaster.'

We believe that such a system is necessary to deal with the need for medical care foreseen in disasters of great magnitude. We have based the system design on the model of the Civilian-Military Contingency Hospital System, augmented by manpower and logistic elements that adapt it to serving a large civilian disaster. The system will be developed as a voluntary cooperative effort of HHS, DoD, the VA, State and local governments, and the private sector. The system will serve national needs in the event of a massive disaster or a military contingency. We hope that it will enjoy the full support of the American health care community.

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