CHAPTER 6.
MASS CASUALTY MANAGEMENT

Medical treatment for large numbers of casualties is likely to be needed only after certain types of disasters. Most injuries are sustained during impact, and, thus, the greatest need for emergency care occurs in the first few hours. Many lives have been lost because local resources have not been mobilized quickly.

The burden of organizing and delivering transport, first aid, medical care, and supplies falls on the affected country. Help from the international community is unlikely to make a difference in saving lives during the period of greatest need, because of the response time required.

In the classic care approach used most commonly to deal with a huge number of victims after a disaster, first responders are trained to provide victims with basic triage and field care before evacuating them to the nearest available receiving health care facility.

The management of mass casualties is divided into three main areas: prehospital emergency care (search and rescue, first aid, triage, and stabilization of victims); hospital reception and treatment; and redistribution of patients to other hospitals when necessary.

PREHOSPITAL EMERGENCY CARE

Search, Rescue, and First Aid

After a major disaster, the need for search, rescue, and first aid is likely to be so great that organized relief services will be unable to meet more than a small fraction of the demand. Most immediate help will come from uninjured survivors, and they will have to provide whatever assistance possible. Improvement in the quality and availability of immediate first aid services depends on increased training and preparation obtained through specialized agencies, for example, through courses taught to volunteers by fire brigades.

Field Care

Ideally, the transport of victims to the hospital should be staggered, and patients should receive adequate field treatment, allowing them to tolerate delays. However in reality, most injured persons will converge spontaneously on health facilities if they are at a reasonable distance, using whatever transport is available, regardless of the facility's operating status. Some victims may not request or be able

to seek medical care, which makes active case finding an important part of any casualty relief effort. This is sufficient reason for creating mobile health-care teams to be deployed to the disaster site in addition to fixed first aid stations located near existing health facilities.

Providing proper treatment to casualties requires that health service resources be redirected to this new priority. Bed availability and surgical services must be maximized by selectively discharging routine inpatients, rescheduling non-priority admissions and surgery, and fully using available space and personnel. Certain physician responsibilities can be postponed and others can be delegated to health technicians, for example, treating minor wounds.

Provisions should be made for food and quarters for health personnel.

A center should be established to respond to inquiries from patients' relatives and friends; it should be staffed round-the-clock, using non-health personnel as necessary. The Red Cross may be well-equipped to direct this function.

Priority must be given to victim identification, which is becoming an increasingly specialized issue. Adequate mortuary space and services also must be provided.

Triage

When the quantity and severity of injuries overwhelms the operative capacity of health facilities, a different approach to medical treatment must be adopted. The principle of "first come, first treated," which is applied in routine medical care, is inadequate in mass emergencies. Triage consists of rapidly classifying the injured on the basis of the severity of their injuries and the likelihood of their survival with prompt medical intervention. It must be adapted to locally available skills. Higher priority is granted to victims whose immediate or long-term prognosis can be dramatically affected by simple intensive care. Moribund patients who require a great deal of attention (with questionable benefit) have the lowest priority. Triage is the only approach that can provide maximum benefit to the greatest number of injured in a disaster situation.

Although different triage systems have been adopted and are still in use in some countries, the most common classification uses the internationally accepted four-color code system. Red indicates high priority treatment or transfer, yellow signals medium priority, green is used for ambulatory patients, and black for dead or moribund patients.

Triage should be carried out at the disaster site in order to determine transportation priority and admission to the hospital or treatment center where the patient's needs and priority for medical care will be reassessed. Ideally, local health workers should be taught the principles of triage as part of disaster training to expedite the process when a disaster occurs. In the absence of adequately trained field health personnel, a triage officer and first aid workers must accompany all relief teams to the disaster site to make these assessments. Where an advanced medical post is established, medical triage will be conducted at the entrance to the post to determine the necessary level of care.

Persons with minor or moderate injuries should be treated near their own homes whenever possible to avoid social dislocation and the added drain on resources of transporting them to central facilities. The seriously injured should be transported to hospitals with specialized treatment facilities

Tagging

All patients must be identified with tags stating their name, age, sex, place of origin, triage category, diagnosis, and initial treatment. Standardized tags must be chosen or designed in advance as part of the national disaster plan. Health personnel should be thoroughly familiar with their proper use.

HOSPITAL RECEPTION AND TREATMENT

At the hospital, triage should be the responsibility of a highly experienced clinician, as it may mean life or death for the patient, and will determine the priorities and activities of the entire staff.

Organizational Structure

Spirgi notes that effective management of mass casualties demands an organization of services that is quite different from that found in ordinary times. He states that a "hospital disaster plan designates the command structure to be adopted in case of disaster . . . [A] command team (consisting of senior officers in the medical, nursing, and administrative fields) . . . will direct people where to work according to the plan and mobilize additional staff and additional resources as required."[1]

Standardized Simple Therapeutic Procedures

Therapeutic procedures should be economical in terms of both human and material resources, and should be chosen accordingly. Health personnel and supplies should support these procedures. First line medical treatment should be simplified and aim to save lives and prevent major secondary complications or problems. Preparation and dissemination of standardized procedures, such as extensive debridement, delayed primary wound closure, or the use of splints instead of circular casts, can produce a marked decrease in mortality and long-term impairment.

Individuals with limited training can, in many instances, carry out simple procedures quickly and effectively. Certain more sophisticated techniques requiring highly trained individuals and complex equipment and many supplies (e.g., treatment of severe burns) are not a wise investment of resources in mass casualty management. This shift in thinking and action from ordinary practice to mass medical care is not easy to achieve for many physicians.

REDISTRIBUTION OF PATIENTS BETWEEN HOSPITALS

While health care facilities within a disaster area may be damaged and under pressure from mass casualties, those outside the area may be able to cope with a much larger workload or provide specialized medical services such as neurosurgery. Ideally, there will be a metropolitan system of emergency medical treatment

[1] Edwin H. Spirgi, *Disaster Management: Comprehensive Guidelines for Disaster Relief* (Bern: Hans Huber, 1979).

that allows hospitals to function as part of a referral network. At different levels of complexity, a network of prehospital relief teams can coordinate referrals from the disaster area. The decision to redistribute patients outside the disaster area should be carefully considered, since unplanned and possibly unnecessary evacuation may create more problems than it solves. Good administrative control must be maintained over any redistribution in order to restrict it to a limited number of patients in need of specialized care not available in the disaster area. Policies regarding evacuation should be standardized among all agencies providing relief in the disaster area, and hospitals that will receive patients.

The task of matching resources to needs is best accomplished by using a chart similar to that shown in Figure 6.1, which also can be enlarged and displayed on a wall. Hospitals are listed according to their geographic location, starting with those closest to the impact area. A visual display of the number of beds available, medical or nursing personnel required for round-the-clock services, shortages of essential medical items, and other needs will permit the Health Disaster Coordinator to direct external assistance to areas where needs and expected benefits are greatest. Patterns for redistributing resources or patients will emerge from analysis of the data. Such monitoring of hospital resources will be most useful when medical care is likely to be needed for an extended period.

If the Health Disaster Coordinator finds that the country's total health care capacity is insufficient to meet disaster-related needs, several alternatives must be considered. The best is rapid expansion of the country's own permanent facilities and staff, which has the advantage of fulfilling immediate needs and leaving behind permanent benefits. Another alternative, which has proved to be less desirable, may be staffed, self-sufficient, mobile emergency hospitals available from government, military, Red Cross, or private sources. If such a hospital is necessary, one from the disaster-affected country, or a neighboring country with the same language and culture should be considered first, and those from more distant countries considered second.

Foreign mobile hospitals may have several limitations. First, the time needed to establish a fully operational mobile hospital may be several days, while most casualties resulting from the immediate impact require treatment in the first 24 hours. Second, the cost of such a hospital, especially when airlifted, can be prohibitive and is often deducted from the total aid package given by the governmental or private relief source providing it. Third, such hospitals are often quite advanced technologically, which raises the expectations of the people they serve in a way that will be difficult if not impossible for local authorities to meet during the recovery period. Finally, it must be recognized that such hospitals are of great public relations value to the donor agency, which may inappropriately urge their use.

FIGURE 6.1. Monitoring of hospital resources.

1 NAME-PLACE	2 Specialty	3 BEDS a Total	3 BEDS b Available	4 SURGEONS a Present	4 SURGEONS b Required	5 ANESTHESIOLOGY a Present	5 ANESTHESIOLOGY b Required	6 Other medical personnel required	7 Nurses required	8 Essential items in short supply	9 Other requirements or contracts
Hospital "A," Disaster City	General	850	8	5	4	5	4	2 pediatric 1 gynecol.	5	Suturing material, X ray film	Generator
Hospital "X," Normalville	Trauma-tology	450	145	5 (traumatol.)	—	3	—	1 gynecol.	1	Linen	Limited kitchen facilities

CHAPTER 7.
EPIDEMIOLOGIC SURVEILLANCE AND DISEASE CONTROL

RISK OF OUTBREAKS FOLLOWING DISASTERS

Natural disasters may increase the risk of preventable diseases due to adverse changes in the following areas:

1. **Population density.** Closer human contact in itself increases the potential spread of airborne diseases. This accounts in part for the reported increases in acute respiratory infections following disasters. In addition, available sanitation services are often inadequate to cope with sudden increases in populations.
2. **Population displacement.** The movement of disaster victims may lead to the introduction of communicable diseases to which either the migrant or indigenous populations are susceptible.
3. **Disruption and contamination of water supply and sanitation services.** Existing water supply and sewerage systems and power systems are particularly vulnerable, and may be damaged by natural disasters. In the aftermath of the 1985 earthquake in Mexico City, for example, millions of inhabitants remained without a piped water supply for as long as several weeks. Drinking water is prone to contamination caused by breaks in sewage lines and the presence of animal cadavers in water sources.
4. **Disruption of public health programs.** After a disaster, personnel and funds are usually diverted to relief. If public health programs (e.g., vector control programs or vaccination programs) are not maintained or restored as soon as possible, communicable disease transmission may increase in the unprotected population.
5. **Ecological changes that favor breeding of vectors.** Unusual periods of rain, with or without flooding, are likely to affect the vector population density. This may involve an increase in mosquito breeding sites or the introduction of rodents to flooded areas. This will be discussed in Chapter 8.
6. **Displacement of domestic and wild animals.** As with human populations, animal populations are often displaced as a result of natural disasters, carrying with them zoonoses that can be transmitted to humans as well as to other animals.
7. **Provision of emergency food, water, and shelter in disaster situations.** The basic needs of the population are often provided from new or different sources.

It is important to ensure that these new methods are safe and that they themselves are not the source of infectious disease.

Outbreaks of gastroenteritis, which are the most frequently reported diseases in the post-disaster period, are closely related to the first three factors mentioned above. Increased incidence (or at least increased reporting) of acute respiratory infections is also common in displaced populations. Vector-borne diseases will not appear immediately but may take several months to reach epidemic levels. It should be noted that humanitarian workers are at risk following sudden-impact natural disasters as well as the disaster victims.

The principles of preventing and controlling communicable diseases after a disaster are to:

- Implement as soon as possible all public health measures to reduce the risk of disease transmission;
- Organize a reliable disease reporting system to identify outbreaks and to promptly initiate control measures;
- Investigate all reports of disease outbreaks rapidly. Early clarification of the situation may prevent unnecessary dispersion of scarce resources and disruption of normal programs.

SETTING UP A DISEASE SURVEILLANCE SYSTEM

In emergency conditions, the routine disease surveillance system is either not up to the task, is disrupted as a direct consequence of the disaster, or cannot provide data quickly enough for timely decisions to be taken. It is recommended, therefore, that a local, syndrome-based surveillance system be prepared at the national level and temporarily instituted in the disaster aftermath. It should be a more flexible and faster reporting system than used in normal conditions. The routine surveillance system must be reestablished as soon as possible.

In order to collect and interpret data, it is essential that a national epidemiologist be assigned adequate epidemiologic and clerical staff who have transportation to the field and priority access to public or private laboratory facilities. In addition to the national epidemiologic staff, university departments, research centers, and bilateral or international agencies may provide trained epidemiologists and laboratory support nationally or regionally. The national epidemiologist should be the secretary of a disease surveillance and control subcommittee of the Health Emergency Committee (see Chapter 5). The subcommittee should provide direct feedback to hospitals and other health facilities where surveillance data are being collected.

The epidemiologist closest to the local reporting unit should investigate suspected disease outbreaks detected by the surveillance system as soon as possible. Until epidemiological assistance arrives, initial investigation and control measures are the responsibility of the local health unit.

Background data should be collected on the geographical areas affected, the major disease risks in the affected area (e.g., whether cholera or malaria are endemic), available resources, and the at-risk and affected populations. The national epide-

miologist and Health Disaster Coordinator should designate syndromes or diseases to be included in the surveillance system (for example, fever, fever and diarrhea, fever and cough, trauma, burns, and measles). All health facilities and temporary shelters should institute the system, using a standardized form as shown in Figure 7.1.

In addition to information provided by the health system, information from humanitarian workers, NGOs, community groups and from unconventional sources such as newspaper accounts, including unconfirmed public rumors, are important as early warnings.

FIGURE 7.1. Post-disaster disease surveillance daily report.

Date ..... Name of Reporter .....

From: ( ) Hospital .....
( ) Outpatient department .....
( ) Health center .....
( ) Clinic .....
( ) Others (Specify .....)

Locating Address	Telephone No.

Number of new cases with	Under 5 yrs.	Over 5 yrs.	Total
1. Fever (100°F or 38°C)			
2. Fever and cough			
3. Diarrhea with blood			
4. Fever and diarrhea			
5. Vomiting and/or diarrhea			
6. Fever and rash			
7. Dog bite			
8. Snake bite			
9. Burns			
10. Trauma			
11. Jaundice and diarrhea			
12. Deaths			
13. Other Specify:			

Comments: .....
.....

Complete for evacuation centers only

No. of persons accommodated today .....
.....

Report significant changes in water/sanitation/food supply .....
.....

PRESENTATION AND INTERPRETATION OF COLLECTED DATA

Post-disaster surveillance is not designed to provide precise information on the incidence of a disease. However, it is important to have an *early warning* system that identifies when a given symptom complex or disease may be occurring in an affected area. This indication will provide the basis for more intensive investigation and, if necessary, lead to specific control measures. Where the affected population is well defined, as in camps for refugees or displaced persons, it will be both feasible and important for the national epidemiologist to determine rates and their change over time.

If the above-mentioned post-disaster surveillance system is effective, it will invariably result in an increase in the number of reported common and uncommon diseases and syndromes. This results from an increase in the number of reporting units, improved public awareness, and the greater concern and coverage by the mass media. This is not necessarily a reflection of increased disease, but rather the result of enhanced disease reporting compared with the pre-disaster pattern.

Negative reports are as important as positive ones, and each reporting unit should submit reports whether or not it has seen any disease ("zero reporting"). Negative reports will show that the unit is functioning and that health resources can be channeled elsewhere.

The epidemiologist closest to the local reporting unit should investigate suspected disease outbreaks detected by the surveillance system as soon as possible. Until epidemiological assistance arrives, initial investigation and control measures are the responsibility of the local health unit.

Summary reports of the surveillance system's technical findings should be fed back to the National Emergency Committee, hospitals, and health facilities and appropriate action taken to introduce necessary control measures if beyond the immediate competence of the epidemiologists (large sanitation programs, for example). The general public also should be informed of the risk of disease occurrence. The dilemma in some countries is whether an open policy of posting the available information on the Internet or elsewhere is in the best interest of public health. One school of thought is to limit dissemination to "validated data" approved by the health authorities. This approach does not take into consideration the need for rapid access to information and the fact that "invalidated" information will become public knowledge. A liberal policy encouraging NGOs and local authorities to exchange their observations and findings, electronically and otherwise, is to be encouraged. In all instances those reporting the data should state the source of their information.

The Health Disaster Coordinator should advise the national emergency committee on control measures to be taken to prevent the spread of disease.

LABORATORY SERVICES

Access to accurate and discrete rapid laboratory services is essential for public health management. It is important to establish the cause of any disease manifestation so that correct control measures can be taken. However, laboratory diagnosis is not required for subsequent patients who present the same symptoms. Laboratories must be able to diagnose diseases occurring locally, and be able to absorb an

increase in samples when necessary. If access to a local laboratory cannot be guaranteed, reference laboratory assistance may be required.

Some diagnostic tests (ova and parasites in the stool, blood smear) can be made with a minimum of technology by field reporting units, but certain bacteriologic and virologic tests necessary for surveillance must be performed by referral laboratories. It is important to establish coordination with local, regional, national, or international laboratories to provide necessary diagnostic tests for disease surveillance and control. Because of difficulties in access to certain areas, it may be necessary to make special arrangements to transport specimens.

VACCINATION AND VACCINATION PROGRAMS

Special Programs

Health authorities are often under considerable public and political pressure to begin mass vaccination programs, usually against typhoid, cholera, and tetanus. This pressure may be increased by exaggerated reports of the risk of such diseases in the local or international press, and by the "offer" of vaccines from abroad.

Typhoid and Cholera

Rapidly improvised mass vaccination campaigns against typhoid and cholera should be avoided in Latin America and the Caribbean for several reasons:

1. The World Health Organization does not recommend typhoid and cholera vaccines for routine use in endemic areas. The newer typhoid and cholera vaccines have increased efficacy, but because they are multi-dose vaccines, compliance is likely to be poor. They have not yet been proven effective as a large-scale public health measure. In a disaster situation, vaccination might, however, be recommended for health workers. Good medical control must rely on effective case identification and treatment and effective environmental sanitation measures.
2. Vaccination programs require large numbers of workers who could be better employed elsewhere.
3. Supervision of sterilization and injection techniques may be impossible, resulting in more harm than good being done.
4. Mass vaccination programs may lead to a false sense of security about the risk of diseases and to the neglect of effective control measures.

Supplying safe drinking water and the proper disposal of excreta continue to be the most practical and effective strategy to prevent cholera and typhoid fever and should be given the highest priority after a disaster.

Tetanus

Significant increases in tetanus have not occurred after natural disasters. The mass vaccination of populations against tetanus is usually unnecessary. The best protection against tetanus is maintenance of a high level of immunity in the gen-

eral population by routine vaccination before a disaster occurs, and adequate and early wound cleansing and treatment.

If tetanus immunization was received more than 5 years ago in a patient who has sustained an open wound, a tetanus toxoid booster is an effective preventive measure. In previously unimmunized injured patients, tetanus antitoxin should be administered only at the discretion of a physician.

Regular Programs

If routine vaccination programs are being conducted in camps or other densely populated areas with large numbers of children, it is prudent to include vaccination against tetanus, as indicated by public health guidelines, along with the other components of the vaccination program.

Measles, Polio, and Other Diseases Targeted for Eradication

Natural disasters may negatively affect the maintenance of ongoing national or regional eradication programs against measles and polio. Disruption of those programs should be closely monitored and prevented. Prevention and control programs for urban yellow fever, bubonic plague, or other vector-borne diseases should also be maintained to prevent the possible emergence or reemergence of diseases.

Vaccine Importation and Storage

Most vaccines—particularly measles vaccine—require refrigeration and careful handling if they are to remain effective. If cold-chain facilities are inadequate, they should be requested at the same time as the vaccines. Vaccine donors should ensure that adequate refrigeration facilities exist in the country before dispatching vaccines. During the emergency period it may be advisable for all imported vaccines, including those going to voluntary agencies, to be consigned to government stocks if cold-chain facilities are adequate.

The vaccination policy to be adopted should be decided at the national level only. Individual voluntary agencies should not decide to vaccinate on their own. Ideally, a national policy should be included in the disaster plan.

TRANSMISSION OF ZOONOSES

Displacement of domesticated and wild animals increases the risk of transmission of zoonoses, and veterinary and animal health services may be needed to evaluate such health risks. Epidemiologic identification/characterization of zoonoses is critical in evaluating the risks of occurrence of these diseases in areas affected by natural disasters. It is also essential to establish surveillance mechanisms to prevent human cases or outbreaks.

Dogs, cats, and other domestic animals frequently are taken by their owners to or near temporary shelters. Some of these animals are reservoirs of infections such as leptospirosis, rickettsioses, and bubonic plague, which can be transmitted through their excrement and urine or through ectoparasites, contaminating water and food.

Wild animals are reservoirs of infections that can be fatal to man. In searching for food and safety in the aftermath of a natural disaster, wild animals will come closer to affected communities, increasing the chance of transmission of illnesses such as hemorrhagic fever syndrome from the Hantavirus, hemmorhagic arboviruses, equine encephalitis, rabies, and infections still unknown in humans.

CHAPTER 8.
ENVIRONMENTAL HEALTH MANAGEMENT

PRIORITY AREAS FOR INTERVENTION

The continuation or quick rehabilitation of effective environmental health services is of primary importance in emergency health management after the onset of a natural disaster. First consideration should be given to areas where health risks have increased. These are areas with high population densities and severe disruption of services. Secondary priority areas are those with high population densities and moderate disruption, or those with moderate densities with severe disruption. Third priority should be given to areas with low population density and minor disruption of services.

Areas with high population densities are urban areas and their peripheries, camps for refugees and displaced persons, and temporary settlements. Hospitals and health clinics are among the facilities needing priority environmental health services.

Shelters are, by definition, short-term accommodations where the affected population can sit out the event—a hurricane, for example—and return to their homes as soon as possible. Such facilities are not designed to provide the required basic services for hundreds of people for prolonged periods. However, experience has shown that shelters remain occupied long after the event, preventing the resumption of the facility's normal operation.

Temporary camp settlements often create areas of extremely high population density where suitable services may be absent. Lack of water and basic sanitation facilities lowers the existing level of hygiene and increases the risk of communicable diseases. Diseases that are endemic in the areas of origin, transit, and settlement of displaced populations are of special concern. The International Federation of Red Cross and Red Crescent Societies (IFRC) reports that up to 50% of deaths among displaced people are caused by water-borne diseases. In selecting sites for temporary settlements, it is critical to ensure that the camp has access to a dependable water supply and other environmental health services.

Priority Environmental Health Services

Primary consideration should be given to services essential for protecting and ensuring the well-being of the people in high risk areas, with emphasis on prevention and control of communicable diseases. Post-disaster environmental health measures can be divided into two priorities:

1. Ensuring that there are adequate amounts of safe drinking water; basic sanitation facilities; disposal of excreta, wastewater, and solid wastes; and adequate shelter.
2. Providing food protection measures, establishing or continuing vector control measures, and promoting personal hygiene.

A checklist of possible disruptions in environmental health services is presented in Table 8.1.

The following actions are recommended to quickly re-establish adequate environmental health services and conditions:

1. Obtain information on population movements in or near stricken areas and map the location of camps for refugees and displaced persons, partially and/or totally evacuated areas, relief worker settlements, and hospitals and other

TABLE 8.1. Natural disaster effects matrix.

Most common effects of specific events on environmental health		Earthquake	Hurricane	Flood	Tsunami	Volcanic eruption
Water supply and wastewater disposal	Damage to civil engineering structures	1	1	1	3	1
	Broken mains	1	2	2	1	1
	Damage to water sources	1	2	2	3	1
	Power outages	1	1	2	2	1
	Contamination (biological or chemical)	2	1	1	1	1
	Transportation failures	1	1	1	2	1
	Personnel shortages	1	2	2	3	1
	System overload (due to population shifts)	3	1	1	3	1
	Equipment, parts, and supply shortages	1	1	1	2	1
Solid waste handling	Damage to civil engineering structures	1	2	2	3	1
	Transportation failures	1	1	1	2	1
	Equipment shortages	1	1	1	2	1
	Personnel shortages	1	1	1	3	1
	Water, soil, and air pollution	1	1	1	2	1
Food handling	Spoilage of refrigerated foods	1	1	2	2	1
	Damage to food preparation facilities	1	1	2	3	1
	Transportation failures	1	1	1	2	1
	Power outages	1	1	1	3	1
	Flooding of facilities	3	1	1	1	3
	Contamination/degradation of relief supplies	2	1	1	2	1
Vector control	Proliferation of vector breeding sites	1	1	1	1	3
	Increase in human/vector contacts	1	1	1	2	1
	Disruption of vector-borne disease control programs	1	1	1	1	1
Home sanitation	Destruction or damage to structures	1	1	1	1	1
	Contamination of water and food	2	2	1	2	1
	Disruption of power, heating, fuel, water, or supply waste disposal services	1	1	1	2	1
	Overcrowding	3	3	3	3	2

1— Severe possible effect
2— Less severe possible effect
3— Least or no possible effect

medical facilities. This information will assist in determining which localities need priority attention.
2. Carry out rapid assessments to determine the extent of damage to the public water supply and waste disposal systems and the food production, storage, and distribution networks.
3. Determine the remaining operational capacity for delivering these basic environmental health services.
4. Make an inventory of available resources, including undamaged food stocks, human resources, and readily available equipment, materials, and supplies.
5. Determine the stricken population's immediate needs for water, basic sanitation, housing, and food.
6. Meet the needs of essential facilities as quickly as possible after basic human consumption needs are satisfied. Hospitals and other medical facilities may need increased water supplies if there are numerous casualties.
7. Ensure that refugees and displaced persons are properly housed and that the temporary settlements and other identified high risk areas have basic environmental health services.

For the efficient use of overburdened resources, it is important to immediately and accurately assess damages and identify needs for repair. Reports of damage and needs should include the following information:

1. Type, location, and extent of damage;
2. Accessibility and required means of transport to site of damage;
3. Remaining operational capacity;
4. Estimate of resources needed for repairs (personnel, equipment, and materials);
5. Estimated repair time.

Rapid assessment will assist in identifying resources required to restore the system immediately. If a list of needs is to be submitted to the donor community, it should be compiled quickly. Donor response is generally high in the days following a disaster, but soon subsides.

Human Resources

The unavailability of environmental health specialists will be a limiting factor when managing an emergency situation. Experts unfamiliar with local conditions and local environmental health services might misjudge priorities. First consideration should therefore be given to using locally available manpower. The local population should be actively encouraged to assist in providing needed resources and services. It should be clear that all immediate or short-term activities are directed to restoring pre-disaster services and not to making improvements beyond the pre-existing level. Nevertheless, the rehabilitation phase of the emergency provides an excellent opportunity to assess vulnerability of the water supply and sanitation system, and to carry out measures that will mitigate the effects of future events on water supply.

WATER SUPPLY

A survey of all public water supplies will have to be made, beginning with the distribution system and advancing to the water source. It is essential to determine physical integrity of system components, the remaining capacities, and bacteriological and chemical quality of the water supplied.

The main public safety aspect of water quality is microbial contamination. The first priority for ensuring water quality in emergency situations is chlorination; it is the best means for disinfection and emergency treatment of water because of its effectiveness, cost, and availability.

It is advisable to increase residual chlorine levels and raise water pressure as part of the relief operations. Low water pressure will increase the likelihood of infiltration of pollutants into water mains. Repaired mains, reservoirs, and other units require cleaning and disinfection.

A minimum free residual chlorine level of 0.7 mg/l is recommended in emergency situations. Routine testing of residual chlorine should start immediately with simple residual chlorine test kits and should continue well into the rehabilitation phase. In the absence of test kits, check if water has a distinct chlorine smell. Microbial contamination is likely if tests indicate the absence of residual chlorine in drinking water, unless bacteriological analyses prove otherwise. However, such analysis requires long periods of incubation (at least 8–24 hours), while residual chlorine levels can be measured in the field in a few minutes.

Chemical contamination and toxicity are a second concern in water quality and potential chemical contaminants have to be identified and analyzed. If there is justified concern that the water source is contaminated with toxic substances from a spill or heavy metals from volcanic activity, alternative water sources should be sought.

Alternative Water Sources

In general order of preference, consideration should be given to the following alternative water sources:

1. Deep groundwater;
2. Shallow groundwater and spring water;
3. Rain water;
4. Surface water.

Private water supply sources belonging to dairies, breweries, food and beverage plants, tourist resorts, and other industrial and agricultural developments often exist in the vicinity of a disaster stricken community. Pre-emergency arrangements with the owners of these systems will facilitate the use of the source in case of emergency.

Sources located near and/or downstream from sewage outfalls, chemical plants, abandoned or operational solid waste disposal sites, abandoned or operating mines, and any other hazardous sites should be considered suspect until an environmental health specialist familiar with the local conditions recommends otherwise.

Existing and new water sources require the following protection measures:

1. Restrict access by people and animals. If necessary, erect a fence and appoint a guard;
2. Ensure adequate excreta disposal at a safe distance from the water source;
3. Prohibit bathing, washing, and animal husbandry upstream of intake points in rivers and streams;
4. Upgrade wells to ensure they are protected from contamination. Include proper drainage of spilled water into a soak pit at a safe distance from the well opening;
5. Estimate the maximum yield of wells; over-extraction might bring about saline intrusion (in coastal areas) or cause the well to dry up. If necessary, ration the water supply.

In many emergency situations, water has to be trucked to disaster stricken areas or camps. Water tankers may be obtained locally from commercial water delivery companies, dairies, breweries, bottling plants, etc. All trucks should be inspected to determine fitness, and cleaned and disinfected before transporting water. As a rule, gasoline, chemical, and sewage trucks should not be used.

One of the reasons for recommending a higher residual chlorine level in disaster situations is to provide extra disinfection capacity to control contamination in temporary open storage tanks (primarily inflatable rubber). Risk of contamination of these tanks can be significantly reduced by providing a tap (if possible) or siphon to allow direct withdrawal of the water from near the bottom of the reservoir rather than "dipping" and possibly contaminating the tank. When such a tap or siphon is installed the reservoir can also be covered (e.g., with plastic sheeting). Closed water bladders should be given priority when ordering water reservoirs for emergency situations to circumvent the risk of outside contamination.

If *locally available,* mobile water purification equipment may be used in emergencies. However, such plants require skilled operators, auxiliary power, and maintenance and repair facilities, and they only produce limited amounts of drinking water. Extreme caution should be taken before requesting mobile equipment as part of emergency supplies. Experience shows many failures because imported equipment was not suited for the conditions at the disaster site. Shipment of mobile treatment plants always has low priority because they are expensive, bulky, and occupy valuable space.

Mass Distribution of Disinfectants

The mass distribution of tablets, powder, or liquid disinfectants should only be considered in these conditions:

1. Affected persons have experience in their use;
2. Affected persons can receive training in their use immediately after the event through a vigorous education campaign;
3. Appropriate water storage containers are distributed;
4. Public health or community health workers assist in ensuring the appropriate and continued use of the tablets;

5. A distribution network is in place to ensure a proper and continuous supply as needed throughout the emergency phase and in the early rehabilitation phase.

In general, individuals in small and controlled groups may be given such disinfectants to purify small amounts of drinking water for one or two weeks. Every effort should be made to restore normal chlorination, and to protect individual wells and storage reservoirs. This can be accomplished by sealing cracks in well casings and reservoir roofs, providing adequate drainage around wells, and roofing reservoirs.

FOOD SAFETY

Poor hygiene is the major cause of food-borne illness in disaster situations. Where feeding programs are used, as in shelters or camps, kitchen sanitation is of utmost importance. Utensils must be washed in boiled or treated water, and personal hygiene should be monitored in individuals involved in food preparation.

Food supplies should be stored in containers that will prevent contamination by rodents or insects. Refrigeration may have to be improvised.

BASIC SANITATION AND PERSONAL HYGIENE

Many communicable diseases are spread through fecal contamination of drinking water and food. Therefore, every effort should be made to ensure the sanitary disposal of excreta. Emergency latrines should be made available to the displaced, refugees, relief workers, and residents in areas where toilet facilities have been destroyed. Even if toilets are physically intact, they cannot be flushed without a water supply. Lime should be used in communal trench latrines to reduce the development of methane gas and odors. If no sanitation facilities are available, people should bury their excreta.

Personal hygiene tends to decline after natural disasters, especially in densely populated areas and where there are water shortages. The following measures are recommended:

1. Provide basic hand washing facilities (shelters, temporary settlements and camps);
2. Provide washing, cleaning, and bathing facilities (camps for refugees and displaced persons);
3. Make adequate amounts of water available (disaster stricken areas and camps for refugees and displaced persons);
4. Avoid overcrowding in sleeping quarters;
5. Launch education campaigns on personal hygiene, basic sanitation, and waste management.

Wastewater from camps for refugees and displaced persons, field hospitals, feeding centers, washing facilities, etc., requires proper disposal. The most common means is through a soak away, seepage pit, or absorption trench.

SOLID WASTE MANAGEMENT

Solid waste management often poses a special problem in emergency situations. In the aftermath of disasters authorities not only have to deal with refuse and garbage, but also with debris from buildings, utilities, trees, plants, and dead animals. The rapid commencement of debris removal is very important for the rehabilitation efforts. Clearing roads, for example, not only re-establishes access routes, but has a positive psychological impact on the population.

Sanitary disposal of refuse and other waste is also the most effective way to control vector-borne diseases. Garbage collection should be re-established as soon as possible in stricken areas. Burying or burning organic solid waste is recommended and open dumping should be avoided. Carcasses awaiting burial should be sprinkled with kerosene to protect them from predatory animals. Burning large carcasses is difficult unless special incinerators are built, which require huge amounts of fuel.

Heavy equipment will be necessary for debris removal, solid waste collection, and operation of the disposal site. Pre-emergency arrangements with private equipment owners may facilitate their services. The general public should be advised on sanitary waste handling where no services can be provided (such as burning or burying refuse in yards).

Established disposal sites might be inaccessible or unusable for a prolonged period, and new sites may have to be established. Great care must be taken in selecting these sites, since once disposal commences in an area, it often becomes a permanent dump site. Building debris can be used to improve access roads or in other areas where in-fill is needed. Other bulky materials should be flattened using bulldozers, if available.

Special care must be taken when disposing of hazardous materials (e.g., damaged high voltage transformers containing PCBs). Potentially hazardous waste must be safely stored in a place where it can be retrieved later for proper identification, recovery, treatment, and/or disposal.

VECTOR CONTROL

Control programs for vector-borne diseases should be intensified in the emergency and rehabilitation period, especially in areas where such diseases are known to be endemic. Of special concern in emergency situations are: leptospirosis and rat bite fever (rats), dengue fever and malaria (mosquitoes), typhus (lice, fleas), and plague (fleas). In flooded areas rats will escape their burrows in search for dry hiding places, often in dwellings. Flood waters provide ample breeding opportunities for mosquitoes. Dead animals and other organic waste provide food for rats and other vectors.

The following are essential emergency vector control measures:

1. Resume collection and sanitary disposal of refuse as soon as possible;
2. Conduct public education campaigns to eliminate vector breeding sites in and near the home and on measures to prevent infection, including personal hygiene;

3. Survey camps and densely populated areas to identify potential mosquito, rodent, and other vector breeding sites;
4. Eliminate vector breeding sites permanently by draining and/or filling in pools, ponds, and swamps; overturning or removing receptacles; covering water reservoirs; and carrying out sanitary disposal of refuse;
5. Resume indoor spraying if used earlier as a routine control method in flooded areas;
6. In areas where typhus is known to exist, apply residual insecticide powder to louse-infested persons, their clothing, and bedding in camps and temporary settlements (use DDT or Lindane, or alternatively, Malathion or Carbaryl, depending on local resistant strains);
7. Store food in enclosed and protected areas.

Well-organized control of mosquito breeding sites greatly reduces the need for outdoor spraying, but if surveys show it is needed, local resources should be employed. Consideration should be given to the high cost of outdoor spraying and its limited benefits.

Vector control measures should be associated with other health measures, such as malaria chemoprophylaxis, to reduce or eliminate the risk of infection.

Successfully controlling houseflies and rodents is nearly impossible in the early aftermath of a natural disaster. The only acceptable measures against such pests are environmental sanitation and personal hygiene.

BURIAL OF THE DEAD

The health hazards associated with cadavers are minimal. Especially if death resulted from trauma, corpses are quite unlikely to cause outbreaks of disease such as typhoid fever, cholera, or plague. If human bodies contaminate streams, wells, or other water sources, they may transmit gastroenteritis or food poisoning syndrome to survivors.

Despite the negligible health risks, dead bodies represent a delicate social problem. The normal local method of burial or cremation should be used whenever possible. Burial is simplest and the best method if it is ritually acceptable and physically possible. Cremation is not justified on health grounds and mass cremation requires large amounts of fuel.

Before burial or cremation, bodies must be identified and the identification recorded. In many countries, certification of death or an autopsy must precede the disposal of the body. Incorporating a waiver paragraph into legislation governing disaster situations should be considered.

PUBLIC INFORMATION AND THE MEDIA

Besides specific measures already mentioned, public information should be disseminated about available environmental health services and resources, their location, and which authorities should be notified of specific problems. This helps the public to understand the extent of the emergency, reduces confusion, and improves the effectiveness of emergency environmental health activities.

The media will play an important role in providing such information to the public. It is essential that authorities and media practitioners have a common understanding of the objectives of information distribution as well as their respective roles in the disaster. Pre-emergency meetings or seminars to clarify these roles and responsibilities are strongly recommended.