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NAVY ENVIRONMENTAL HEALTH CENTER

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PUBLIC HEALTH ASPECTS OF DISASTER MANAGEMENT

The Navy Environmental Health Center Guide To

Public Health Aspects of Disaster Management

Background

Disasters can be characterized as sudden, catastrophic events which disrupt the social structure, threaten the health of the population and outweigh the ability of the affected community to provide essential services. Disasters include tornadoes, fires, hurricanes, floods, volcanic eruptions, blizzards, avalanches, earthquakes, landslides, severe air pollution, epidemics, toxicological, nuclear and transportation accidents, explosions, war, civil disturbances, water contamination, and food shortages.

Each year disasters kill and injure thousands of people and leave many more homeless and without food. Throughout history, disasters have been responsible for a significant amount of death and human misery. A pandemic of plague known as the "Black Death" swept Europe in the fourteenth century killing well over half the population. In 1815 a volcanic eruption in Java killed thousands and lead to worldwide climatic changes and widespread famine. At the turn of this century, nearly 1,000 Sunday school excursionists were severely burned or drowned when the steamer General Slocum caught fire and sank off the shore of New York City. During the past century more than 10 million people have died in floods, earthquakes and tropical storms. It is now estimated that disasters requiring international assistance occur on the average once a week.

Today, the military is frequently identified as a possible provider of services to disaster stricken populations. This has not always been a military role. In the first half of the nineteenth century, most Americans considered health care, social welfare, and other aspects of disaster relief to be activities best left to individuals or private charity. Local, and in some instances state governments, were the only government agencies with the authority to provide relief if outside aid was needed after a disaster.

One of the first large scale humanitarian disaster relief operations carried out by the U.S. military was in 1847 when Congress approved the loan of naval vessels to transport privately raised supplies overseas to the sufferers of the Irish potato famine. In the years after the Civil War, Congress came to depend on the Army to administer aid, primarily because there was no other organization capable of rendering rapid relief. This small postwar Army was present throughout the nation and maintained stockpiles of food, clothing and tents. The purchasing and transportation system of the military thus allowed for the acquisition and movement of relief supplies which were made available to victims through government grants .

After the Civil War, military personnel served as relief administrators: they estimated needs, purchased supplies, delivered them in bulk, but left to local authorities the actual distribution to the needy. By the turn of this century, U.S. military disaster relief had been integrated into specific programs to improve sanitation and vaccinate local overseas populations during outbreaks of smallpox, cholera, plague, and yellow fever in Puerto Rico, Cuba and the Philippines.

Quick response facilitated by the military chain of command and skills in operational medicine are the major reasons that the armed forces have been identified as a prospective provider of disaster relief. The ability to deploy rapidly to remote areas and render aid allows the Uniformed medical departments to act as an effective arm of State Department policy. Today, better communications and increased media attention have stimulated public pressure for more effective aid. Although providing disaster relief is only a secondary function of the U.S. Navy Preventive Medicine Mobile Medical Augmentation Response Team (MMART), this type of mission must be viewed as a potential and likely use of medical department skills.

Management of Disaster Relief

The basic personal needs of affected populations are virtually the same in every disaster: medical care. food, clothing, sanitation, and shelter. In addition, the community needs immediate resumption of the normal local, state and national government responsibilities, including the maintenance of law and order, the removal of debris, the restoration of electricity, water supply, sanitation, transportation and communications. Military disaster relief workers must be prepared to help the local government provide any, or all, of the basic needs of the population.

The primary preventive medicine objective is to protect the health of individuals who live in or near disaster-stricken areas by minimizing the deterioration of environmental health conditions. Emergency measures should be designed to restore environmental health conditions and services to whatever levels existed before the disaster occurred, regardless of judgments about pre-disaster quality. The advice of local experts should be sought because they are familiar with the pre-disaster socioeconomic conditions and have had experience working under conditions common in the disaster area.

Mismanagement on the part of both relief workers and public officials has significantly added to the chaos and destruction after disasters. A most difficult problem is the "convergence reaction" when relatives, friends, volunteers, and other people converge on the affected area, increasing the confusion. Often physicians and nurses have been sent into an area in excessive numbers without adequate supplies. In some disasters, the supplies are either sent too late or have not been inventoried and thus were not appropriate for the situation. Frequently, no provision has been made for the transportation of personnel and supplies.

Historically, mismanagement of disaster relief has been caused by a variety of inadequacies. Damages have not been appraised realistically and problems have not been ranked appropriately. This was compounded by poor identification and utilization of resources, especially transportation. Inadequate communication and cooperation between relief agencies is another frequent problem. Commonly, international relief activities begin too late. All post-disaster measures, except for long term reconstruction activities, should be completed within three weeks of the occurrence of a disaster. During this time minimum levels of necessary public health services that must be provided including:

1. Emergency medical care
2. Shelter and clothing against adverse climactic conditions
3. Accessible drinking water
4. Environmental sanitation including disposal of human and animal bodies, excreta and other wastes
5. Protection of food supplies against contamination
6. Protection of individuals against infectious and vector borne diseases

An active, comprehensive surveillance system needs to be implemented quickly to assist in the provision of the above six services. This system requires the following actions:

1. Make an initial survey to determine the extent of damage to public water supply, waste disposal, and food production, storage, and distribution systems.
2. Inventory available resources such as undamaged food stocks, manpower, and readily available materials, equipment, and supplies.
3. Obtain information on population movements in or near the area such as refugee camps, partially or totally evacuated areas, and relief worker settlements. Densely populated areas where preexisting services have been seriously disrupted should be designated as priority areas for relief intervention.
4. Determine the stricken population's immediate needs for water, basic sanitation facilities and housing.
5. Meet the needs of essential users as quickly as possible after basic human needs are satisfied. Hospitals and other medical facilities, for example, may need much more water because of the large number of casualties to be treated, as will any remaining power plants for their operation.
6. Ensure that refugees are properly housed and refugee centers have basic necessities such as safe water and food supplies, latrines, and facilities for solid waste (garbage) disposal.
7. Supply high risk areas, such as those with dense population, with safe water supplies and emergency sanitation facilities quickly.

8. Apprise officials within the country of your findings and actions. Daily summaries with any necessary interpretation should be forwarded to the national emergency committee or civil defense authorities. Daily news releases are also recommended.

This epidemiological approach to disaster relief can greatly aid in establishing priorities for assistance efforts. It also allows for effective organization of communicable disease surveillance and control programs.

It is essential that a clear chain of command be established both within the military relief team and among all agencies within the disaster area. The U.S. Navy Preventive Medicine MMART team sent to Somalia during the 1985 cholera epidemic was one of over forty relief activities that acted independently, without coordination through any central agency. The resulting confusion drastically reduced the amount of effective relief that could be provided. Whenever military assistance is given, the senior military officer present should be identified as coordinator for all military efforts and should act as liaison with his U.S. civilian counterpart. A senior official, military or civilian, must be directed to be in charge as the disaster coordinator by the government agency directly responsible for the relief effort. This coordinator must see to it that a comprehensive initial survey is done, priorities are established, appropriate supplies, manpower, and equipment are requested, and volunteers work in a coordinated and effective manner. In addition, the coordinator must develop an active, ongoing surveillance system as described above. Assistants should be assigned to head four relief units (communications, medical, technical assistance, logistics). These units have the following responsibilities:

<u>Communications unit</u>: must establish a network of radio links for handling a disaster situation. Central headquarters of this system might be the emergency room in the main regional hospital. A messenger/courier system should be established in the event that two-way radio links fail.

<u>Medical unit</u>: must establish field clearing stations providing basic life support. Provides care for hospitalized patients as needed. The medical unit must also provide epidemiologic surveillance to measure the severity of the problem, plan for subsequent action, monitor ongoing public health programs and assess the successfulness of the programs.

<u>Technical Assistance unit</u>: must provide for organization and coordination of immediate rescue operations, clearing of roads, and provision of basic living facilities/services.

<u>Logistic unit</u>: must provide and direct transportation activities, including transportation of relief personnel, the sick/injured, food, water, and supplies. Extensive cooperation between the logistics and the communications units is emphasized.

Public Health Programs

Emergency Medical Care

Morbidity and mortality which result from a disaster situation can be classified into four types: injuries, emotional stress, epidemics of disease, and increase in endemic diseases. The relative numbers of deaths and injuries differ depending on the type of disaster. Injuries usually exceed deaths in explosions, typhoons, and epidemics. Deaths frequently exceed injuries in landslides, avalanches, volcanic eruptions, tidal waves, floods, and earthquakes. Substantial international assistance with the treatment of the injured after a natural disaster is likely to be required only after earthquakes. Man-made disasters such as toxicological emergencies, nuclear accidents or explosions, however, may require extensive relief.

The need for emergency care is most critical during the first 48 to 72 hours following the disaster. Unfortunately, personnel and supplies often arrive long after the critically ill have either been treated or died. Not surprisingly, military hospitals with self-supporting teams from neighboring countries are often the only relief facilities which have provided meaningful care. Within 14 hours after the 1972 earthquake in Managua, Nicaragua, a U.S. medical team was operating outside one of the damaged hospitals in the city. Within 40 hours, a mobile Air Force hospital was operating.

Triage is the most important principle involved in providing care whenever time, personnel and resources are grossly insufficient to meet immediate needs. Unfortunately, triage is often neglected in the climate of emotion and confusion, but it is the only approach that can provide maximum benefit to a majority of the injured. Triage consists of classifying the injured rapidly on the basis of benefit they can expect from medical care and not according to the severity of the injuries.

The majority of the trained medical personnel should stay at the local receiving hospitals where they are more effective. They must not be permitted to rush to the site of the disaster, thus contributing to the harmful "convergence reaction".

Transportation between clearing stations and receiving hospitals must be promptly and easily available. For that purpose, clearing stations should be established in locations easily accessible both by motor vehicles and helicopters. Ambulances should only be used when absolutely necessary (spinal cord injuries, burns, and probable cardiopulmonary resuscitation during transport, etc.). Many casualties can safely be transported in trucks, vans, buses, and even private cars.

The death rate caused by a disaster is a good indicator of its severity but is a surprisingly poor measure of the need for urgent medical or surgical care. What is needed is an initial assessment in which an objective estimate of the number and type of injuries is made (Appendix I). After the initial assessment, a precise and objective compilation of requests for emergency drugs and equipment can be made. Lists should be restricted to essential items and should not include miscellaneous drugs such as nasal sprays, multivitamins, etc. The precise requests, using generic names, should be supported with qualified data: expected number of injured, refugees, deaths, type of injuries, and extent of damage.

Equipment needed in addition to medical equipment includes: transportation (four-wheel drive vehicles, boats, helicopters, ambulances, aircraft), heavy equipment (bulldozers, cranes), communication equipment, pest control equipment (including pesticides and rodenticides), generators, fire-fighting/rescue equipment, means of water purification, and tanks for transporting drinking water. When compiling a "needs list" it must be remembered that food, water, shelter and sanitation will be needed for relief workers and for unprepared "convergers".

The psychological response to disaster can have immediate medical ramifications. Stress reactions have long been recognized in soldiers exposed to the disaster of war. It has been learned that there is a normal recovery process most people go through whenever exposed to extreme stress. During the recovery period, victims may exhibit a variety of symptoms, including severe anxiety reactions and psychotic disorders. Psychological symptoms common during the immediate post-disaster period include intrusive thoughts, emotional numbness, fears of a similar event recurring, difficulty concentrating, and startle reactions. Physical responses may include diarrhea, incontinence and palpitations. Symptoms caused by stress will be responsible for a portion of visits to medical facilities.

As a result of modern communications, the outside world usually learns of a disaster within minutes or hours after it has occurred. The initial reaction may be that urgent and massive aid is required if lives are to be saved. In fact, little or no reliable information may actually be available as to the immediate needs of the survivors or the resources already in the area. The unorganized rush of surgeons, blood, drugs, and mobile hospitals contributes to the "convergence reaction" chaos and drains or obstructs what few facilities remain in terms of accommodation, transportation, and communication. If appropriate chains of command and lines of communication within and between agencies are not established quickly, then a "second disaster" is created on top of the first.

Once the emergency phase is over, priority shifts from emergency medical care to the following environmental measures.

Clothing & Shelter

Although death from environmental exposure may follow disasters on land, there are few reports in the literature of deaths secondary to exposure following such disasters. This is probably due to the fact that the majority of disasters occur in tropical or subtropical areas. A notable exception has been significant exposure mortality during wars, most notably Napoleon's Russian Campaign. In the absence of suitable clothing and shelter in warm climates, the major impact of exposure may be an increased food requirement by the population to maintain body temperature in the face of environmental extremes.

Exposure to even modest environmental extremes can result in increased energy demand. In more severe climates, death from hypothermia is a possibility. In general, children and the sick are less able to tolerate environmental extremes. Both these groups are heavily represented in disaster-affected populations in developing countries. Fortunately, homeless populations will quickly find alternative shelter or windbreaks and reestablish a basic "micro-climate" necessary for survival. Even in tropical countries, however, the risk of hypothermia in displaced populations can be substantial especially when clothing has been washed away or buried under debris.

Areas proposed for accommodating displaced persons must be surveyed in order to determine whether basic environmental health services can be provided. Buildings used to accommodate victims during relief operations should provide at least 3.5 m^2/person of floor area; 10 m^2/person air space; and 30 cubic meters of air circulation /person/hour. There should be separate washing blocks for men and women. Washing facilities to be provided are: 1 hand basin/ 10 people or a wash bench of 4-5 meters/100 persons. One shower head should be available for each 50 persons in temperate climates and one shower head per 30 persons in hot climates. There should be one toilet seat per 25 women and one seat plus one urinal per 35 men.

Accommodating displaced persons in tent camps should be considered only as a measure of last resort. Existing, undamaged structures usually provide the best facilities for temporary shelter. The sudden creation of high population density in camps for displaced persons will likely precipitate numerous preventive medicine problems. Thus, displaced persons must be housed under conditions that will not lead to the deterioration of public health and the environment. Once individuals have been located and established on a site, it is difficult to ask them to move again. Therefore, it is important that relocation sites are well thought out.

Most communities have many more buildings than are required for the basic shelter of the population. Existing buildings such as schools, meeting halls, churches and hotels can serve as dormitories and are especially useful if they have a water supply, waste disposal, washing, bathing and feeding facilities. Even automobiles, railway cars and barns can act as temporary shelters. People should be encouragec to move in with friends and relatives. Fortunately, this usually takes place without any outside intervention.

As soon as possible, displaced persons should be encouraged to return to their own homes. If adequate resources exist, they should be provided with materials for constructing temporary shelter on their own property. Homeless individuals are often more concerned about maintaining family integrity and guarding personal propert then finding alternative shelter. Wherever they locate, however, they must have access to water, food, and a sanitary means of waste disposal.

Water

Drinking water is the most essential item provided to disaster-stricken populations. At the same time, water can prove a major medium of disease transmission. Fecal contamination of the water supply is typical after most natural disasters, as well as in refugee camps set up because of drought or war. Even if the water supply has not been seriously affected, the drinking water in many developing countries is often contaminated and can be a significant source of morbidity among relief workers. Therefore, an adequate supply of potable water must be ensured. A means of purifying and transporting drinking water must be identified immediately.

Mobile water purification plants should be used if available locally. However, they should not be shipped into the area if they will require space better used for drugs, medical supplies, food, and clothing. Tanks available locally from commercial water companies, dairies, and breweries can be cleaned and used to transport water. The adaptation of gasoline, chemical, or sewage trucks should be avoided as a means of transporting water.

Drinking water should be obtained from operational water distribution systems. Contamination of partially damaged systems can be controlled by increasing water pressure to compensate for pressure loss due to breaks in mains. Bulk supplies can also be sought from undamaged private sources (such as power plants, breweries and other small establishments); from undamaged springs, wells, or rain water cisterns; and from newly constructed water structures such as bore-holed wells. Water should be made accessible to victims, relief workers, and essential locations, such as hospitals and treatment centers first.

Drinking water water should be tested for the presence of Escherichia coli as an indicator of fecal contamination. When chlorine is available, damaged water systems should be repaired and then superchlorinated to 100 ppm chlorine with 50 ppm chlorine remaining at the end of a four hour contact period. The chlorine residual should then be maintained at pre-disaster levels.

Water supplies must be disinfected if it is derived from flooded structures (wells, rivers, reservoirs, and rain water cisterns). Bulk water can be treated with calcium hypochlorite (HTH) to achieve a free available chlorine (FAC) level of 2-5 ppm which should be maintained at all times (Appendix III). The systematic disinfection of unaffected water is not necessary, however. Routine disinfection of all water supplies is of limited value and not necessarily an effective use of scarce resources.

Environmental Sanitation

Environmental sanitation measures protect the environment from human wastes that may contaminate food and water. Latrines should be appropriately constructed and maintained in relocation camps, relief worker settlements, and areas of dense population where permanent facilities have been destroyed. Health education in latrine usage and upkeep must be provided to the users. Frequent on-site visits by environmental health technicians may be needed to enforce latrine upkeep. Other measures should be taken to provide for sanitary solid waste disposal including waste receptacles, means of transportation, and incineration or burial.

Proper waste disposal plays a significant role in communicable disease control. Fecal contamination of the water supply is a common cause of diarrheal disease outbreaks. Conjunctivitis, shigella dysentery, enterovirus infections, and some parasitic diseases may be transmitted by domestic flies; these will increase in numbers in warm climates as a result of available breeding places in feces and garbage.

Handling of hazardous substances or toxic gases may be a significant public health problem in certain types of disasters. Volcanic eruptions can release a variety of toxic gases as well as hot ash which can kill crops and grazing livestock. Chemical and radiological spills may require rapid assessment of the potential for short and long term contamination. Protective measures, including evacuation in some circumstances, may need to be implemented immediatley. Occupational physicians and either industrial hygienists or radiation health personnel should be actively involved in all such emergencies. The industrial hygienist should be able to estimate possible levels of exposure to specific gases and provide information regarding the decomposition products of burning materials. Industrial hygiene input is also valuable in determining what personal protective equipment should be used during disasters. Radiation health personnel serve a similar role in nuclear disasters.

A morgue will be needed in most disasters. An easily accessible central location which is large enough to allow relatives to identify the stored corpses is necessary. Health hazards associated with unburied bodies are minimal, especially if death resulted from trauma and the corpses are not contaminating the water supply. Therefore, the immediate mass burial or cremation of bodies is not necessarily a high priority concern. Bodies that cannot be disposed of quickly, however, should be treated with insecticide to eliminate vector breeding sites and mechanical transmission of pathogens. Of course, dead bodies represent a delicate social problem that public health authorities often must address. The normal local method of burial or cremation should be used whenever possible. Burial is the simplest and best method if it is ritually acceptable and physically possible. Cremation may be used, but it is not required as a public health measure.

Food

Although widespread famine can follow in the months after a disaster because of crop damage and loss of land, there is not always a fall in per capita food availability within an affected area in the short term. Nonetheless, severe shortages of food will immediately affect portions of the population after disasters because of loss or destruction of household stocks and the disruption of local transportation and marketing systems.

A major disaster [illegible] [temp]orarily disrupt short-[term] food distribution within an [illegible] physically blocking [illegible] and [illegible] retail and wholesale outlets. Food can become contaminated by polluted flood waters, insects, rodents, and by unsanitary handling, especially in mass feeding centers. Food degradation and spoilage may result from long periods of power outages that disrupt refrigeration, contact with flood water, fraudulent adulteration, and the use of outdated supplies. In addition, political factions may try to manipulate existing food stocks to meet their own needs.

All food should be inspected, especially in areas where contamination is likely or where there have been prolonged power outages. Routine microbiological analysis of food is a low priority unless a suspected source of a disease outbreak has been identified. When mass feeding programs are instituted, food should be inspected at distribution points and mass feeding facilities should be supervised by an environmental health specialist (Environmental Health Officer or Preventive Medicine Technician). To avert health problems, the public should be educated about food storage, preparation, and which foods are the most likely to be safe to consume. When arranging for food supplies, it should be kept in mind that even starving populations often do not readily accept unfamiliar food and therefore priority should be given to obtaining local foodstuffs whenever possible.

Nutrition, preventive and curative medicine must be integrated. Preventive treatment for specific deficiencies should replace the tendency to distribute multivitamins. Children under five years and pregnant or lactating women are the most vulnerable groups and should be fed first if long-term shortages are anticipated. Height and weight measurements may be necessary to define those individuals who are in most critical need of assistance. Even arm circumference alone can give a good indication of nutritional status. For a period of less than one month, a ration of 1200-1500 calories per day is considered sufficient to ensure the survival of a population of low activity in a tropical climate. For longer periods the caloric ration per day should be 1500-1700 to avoid protein-calorie malnutrition.

Disease Prevention and Control

With the exception of famines, disasters are <u>not</u> generally followed by major epidemics. The potential for the epidemic spread of disease exists, however, particularly in developing countries. Deterioration of the physical environment, overpopulation and poor sanitation in refugee camps, and disruption of routine disease control programs are the precursors of disease outbreaks. The physical damage done by the disaster can lead to contamination of the water supply and multiplication of disease vector breeding places. Overcrowding facilitates outbreaks of diarrheal diseases. Serious outbreaks of disease are likely to occur in areas where population density has increased without a commensurate increase in the provision of water supply, sanitation, and other basic services.

Disease control after disasters should be directed in two areas: The first is reducing the disease hazard by appropriate public health interventions, including emergency repair of water supplies, the provision of potable water and emergency sanitation systems, and vector control operations. The second is establishing a surveillance system so that outbreaks of disease which do occur can be promptly identified and controlled.

The risk of epidemic disease after a disaster is related to the presence of endemic diseases in the population. There can be disease outbreaks when disaster victims are more susceptible to endemic agents because of lack of food and environmental exposure. In addition, normal control programs are frequently interrupted and transmission is intensified because a deteriorating environment thrusts people into direct contact with pathogens. In general, if a disease agent did not exist in a population before a disaster, there is no risk of an outbreak occurring. However, disasters cause mass migrations which can lead to the import and export of new diseases.

The diseases common after a disaster are those usually seen throughout the developing world. These include diarrheal diseases, measles, pertussis, tuberculosis, and in many areas, malaria. In addition, outbreaks of leptospirosis have been reported following floods and hurricanes.

Debris and solid wastes accumulate in empty receptacles and on soil along with rain and flood water, allowing insects and rodents to proliferate. This allows for potential disease transmission as well as food contamination and infestation. To make matters worse, routine pest control programs are frequently disrupted and residual pesticides may have been washed away.

Vector-borne disease, particularly malaria and dengue, may increase as a result of a rise in the number of mosquito breeding sites and the increased exposure of the population to the vector because of loss of housing. This problem is greatly magnified by the fact that routine control and eradication programs are usually interrupted. The population should be educated about eliminating breeding sites and protecting themselves from vector-borne diseases. Disruption of natural habitats may cause increased contact between rats and humans, increasing the likelihood of plague. The breakdown in living conditions following disasters in some urban areas may increase the hazard of pneumonic (man-to-man) plague transmission. Other epidemics, such as the spread of louse-borne typhus depends upon the existence of a heavy infestation of a population with head or body lice, crowded living conditions and an endemic focus of the disease. Persons in settlement camps should be dusted with a pediculocide to control typhus in endemic areas. Bathing and washing facilities should be provided in all relocation settlements.

Vaccines against typhoid and cholera offer low and short-term individual protection with little effect in preventing epidemics. When appropriate environmental sanitation is provided, the risk of typhoid fever and cholera may be very small in comparison to other diseases. Emergency mass immunization is not a good method of disease control. Political realities, however, may require institution of some type of immunization program. Donated vaccines are often available in large quantities and immunization clinics are a highly visible activity. Immunization can meet the substantial pressure to "do something" and thereby raise the collective public morale. Certain routine immunization programs should be continued and immunizations against measles and pertussis in camps and temporary settlements can be effective. Tetanus toxoid must be available for trauma victims. Relief workers in endemic countries should be immunized against yellow fever. The emergency may provide the opportunity of extending routine immunization programs to those who would otherwise never seek them.

An increased incidence of animal bites, especially dog bites, have been reported following some disasters as neglected strays come into close contact with persons living in temporary shelters. Rabies is endemic in many areas, especially in the developing world. Therefore, a program for the elimination of stray dogs should be considered.

The establishment of an epidemiologic surveillance system is essential in order to obtain adequate and timely information on morbidity and mortality in the disaster area. Diseases which are under routine surveillance by local public officials require enhanced surveillance in times of disaster, especially those diseases with potential for epidemic spread. Depending on conditions, attempts should be made to have daily reporting of age, sex, locality, symptoms or general diagnosis of patients seen, as well as the number of injured or dead. Data regarding hospital admissions, beds available, and number of injured and deaths at each hospital and health center should also be obtained. In addition, it is also wise to monitor the local press for reports of disease and to take into account other independent reports including rumors of disease. A special public health team should investigate any rumor of epidemic outbreaks. The collection of data involves both denominator and numerator data; morbidity and mortality information has no meaning unless the actual number of people at risk of disease, injury and death is known. The return to the pre-disaster surveillance system should be gradual and planned in advance. Most emergencies are fairly short-lived and special operations should give way to the regular programs as soon as possible. It must be understood that there may well be an increased incidence of infectious diseases for several months after the event.

Appendix I

Assessment of Needs

Relief decisions must be based on reliable information derived from a systematic method of collecting data. Within the first few days of a disaster, estimates will be required of the geographical extent of the disaster. The disaster stricken area should be divided into "blocks" to be surveyed simultaneously so that the geographic extent of the affected area is defined by streets or other clear boundaries. The survey should include:

* Size of the affected population
* The number of persons known to be dead
* Estimated number of persons severely injured and/or requiring medical attention
* Needs for evacuation
* Estimated number of homes destroyed, homes uninhabitable, and homes which are still habitable
* Availability of clothing and construction materials
* Condition of schools, churches, public buildings, etc.
* Condition and extent of the water supply
* Needs for food and the condition and extent of the food supply
* Condition of roads, bridges, communications facilities, and public utilities
* Location and condition of health care facilities
* Estimates of medical personnel, equipment, and supplies available
* Description of relief activities already in progress
* Availability of local pest control equipment

Ideally, these estimates should be made using helicopter overflights of the area. However, limited personnel or transportation resources may necessitate conducting surveys on foot. This may require ingenuity and adaptation of technique. Care should be taken so that only information items that are truly needed are requested.

As soon as communications permit, the initial estimates should be supplemented by regular reports from medical facilities and other relief centers. The information obtained should include the number of injured and other diagnostic categories of patients seen, the number of admissions, bed occupancy and the requirements for drugs and other supplies. This reporting system will subsequently form the basis of the disease surveillance system.

Appendix II

Specific Concerns in Natural Disasters

Earthquakes

Earthquakes may result in more injuries than deaths. After major earthquakes, the bulk of serious injuries will be made up of fractures with a proportion of soft tissue and internal injuries and burns. Most of the trauma is due to the collapse of buildings. Older, traditional construction such as adobe or stacked fieldstone are at greatest risk during these disasters. Earthquakes often trigger landslides which bury houses, vehicles and people below unstable cliffs. In addition to destruction and damage to structures, there is frequently disruption of power and heat, thereby leaving many individuals without protection from the elements.

Substantial international assistance with the treatment of the injured is likely after earthquakes. This is especially true when earthquakes happen at night and without warning. Most people are indoors at this time and therefore vulnerable to trauma from falling building materials.

The usual consequences of earthquakes are destructive vibration, power outages, and fires. There can be significant water, soil and air pollution as a result of the disaster as well as near total disruption of solid waste disposal systems from shortages of equipment and transportation. Broken water mains, power outages, equipment/parts/supply shortages, damage to civil engineering structures, and personnel shortages lead to rapid deterioration of environmental sanitation. Damage to food preparation facilities as well as transportation failure and power outages can severely effect the quality and availability of food. Secondary disasters such as radiation leaks and floods are a possible result of damage to nuclear power plants and dams.

It is possible that there will be an increase in vector borne diseases due to proliferation of vector breeding sites, increased human-vector contacts and disruption of disease vector control programs.

Typhoons, Hurricanes & Tornados

The usual consequences of these storms are destructive winds, flooding, heavy rains, landslides, and power outages. Houses of light frame construction or mud walls with timber roofs can be completely destroyed and disruption of power and heat for long periods of time is common. Generally, the extent of property damage is much more dramatic than the number of deaths. A significant number of the total deaths are due to drowning because of flooding

Significant water, soil and air pollution occur as a result of the disaster. Chemical and biological contamination as well as power outages can drastically effect the water supply. Shortages of equipment, supplies, and parts may hinder the repair of environmental sanitaition systems stressed by shifts in population.

There may be contamination or degradation of stockpiled relief supplies and food as a result of power outages and flood waters. There can also be substantial problems with food supplies because of flood and wind damage to preparation and storage facilities, as well as food degradation because of power outages.

Tornados leave a relatively small and well defined area of near total destruction. Most structures directly in the path of a tornado are destroyed. Injuries are generally due to falling building materials or flying debris. The very high winds result in a large amount of flying debris, including soil, tar, manure, and water. Therefore, contamination of wounds with subsequent infection is a common and significant problem for tornado victims.

It is possible that there will be an increase in vector borne diseases due to proliferation of vector breeding sites, increased human-vector contacts and disruption of disease vector control programs.

Storm Surge, Tsunami and Other Floods

Floods are the commonest of all natural disasters and cause the most mortality. They account for approximately 50% of all disasters and a similar percentage of death. Unlike earthquakes, cyclones and tornadoes, floods cause very few injuries among survivors.

Most deaths are due to drowning, but water damage and power outages can severely effect environmental health. Residential buildings are frequently damaged with disruption of power and heat. As with floods that can accompany wind storms, there can be significant water, soil and air pollution as a result of the disaster. Flooding of facilities with degradation of supplies, as well as transportation failures can lead to food shortages. There can be deterioration of waste d sposal systems due to flooding as well as due to system overload as a result of shifts in population.

Volcanic Eruptions

Significant volcanic eruptions are rare and therefore there are relatively few deaths and injuries from this type of disaster. Nonetheless, volcanos pose a substantial disaster threat because many volcanos are surrounded by densely populated areas. This was recently seen in the volcanic eruption in Columbia.

Earthquake, tsunamis, fires, and volcanic debris are frequent consequences of volcanic activity. Pyroclastic material (tepha) thrown from the volcano can range in size from dust to hugh blocks. Large pieces can cause cause trauma directly or start fires. Ash can cause irritation and obstruction of lungs and corneal abrasions. Volcanic mudflow (lahars) are a major cause of volcanic destruction and loss of life. They range in temperature from very cold to boiling and can move with considerable speed.

Volcanic gases include: water vapor, carbon dioxide, carbon monoxide, sulphur dioxide, sulphur trioxide, hydrogen sulphide, hydrogen chloride, hydrogen fluoride, methane and more complex hydrocarbons as well as nitrogen, argon and other inert gases. Some of these gases are a threat to humans, primarily from asphyxiation when the gases pool in low-lying areas and displace oxygen. Crops can be destroyed by lava, ash, and volcanic gases. Grazing livestock may be killed by eating plants contaminated by poisonous ash.

Massive population movements can accompany eruptions, or the threat of an eruption. Therefore, even if the volcano has not caused any direct effects, the usual problems of refugee populations will exist. Relief efforts to provide adequate food, water, and shelter as well as environmental sanitation and communicable disease control will be needed.

Appendix III

Preventive Medicine in the Field

Field Water Supply Sanitation

Selection of Water Source

All water in the field should be regarded as unsafe until proven otherwise. The possible sources of water are public water systems, surface water, ground water, rain collected from roofs or other catchment surfaces, ice or snow, and distilled sea water. The cleanest source available should be chosen. As a general planning figure, 30-40 liters/man/day will be needed including bathing, food preparation, waste and evaporation. Field hospitals will require 40-60 liters/man/day.

Surface water should be drawn upstream from any possible contamination source. When surface water is used, care should be taken to avoid gettng mud from the bottom or picking up floating sticks, leaves or other debris. Ground water sources should be at least 30 meters from all possible sources of contamination such as latrines. Wells can be protected by keeping the bottoms of cesspools and latrines 1.5 to 3 meters above the water table and with impervious casing 30 centimeters above and 3 meters below the ground surface; concrete platforms around well of 1 meter radius and: and a fenced area of 50 meters radius.

Water Treatment

Preliminary treatment consists of removing floating debris and large suspended particles from the water. After primary treatment, coagulation and floculation gathers small particles into large particles which can be removed in a sedimentation basin or by a filter after settling. Coagulation is achieved by adding a chemical coagulant (usually ferric chloride and limestone or a polymer). Rapid mixing is important in order to speed the coagulant to all particles and create maximum particle-to-particle contact. Flocculation follows coagulation and occurs during gentle mixing as small particles are physically enmeshed to form a floc which settles rapidly or can be filtered out. Sedimentation of floculated material occurs most effectively in a stilling basin with reduced water velocity. Clear water can then be removed from the surface. Concentrated solids are periodically removed from the bottom of the basin.

Filtration can then remove any residual suspended material including algae, bacteria and some viruses. There are several types of filters including diatomite, multi-media, and reverse osmosis. Diatomite filters consist of a thin layer of diatomaceous earth which can remove 90% of the soilds suspended in the water passed through it. A multi-media fliter is composed of several different types and sizes of media (garnet, anthracite, sand, and gravel) which are arranged so that it becomes less porous as water passes through the filter. Reverse osmosis is a process in which raw water on one side of a membrane is pressurized above its osmotic pressure, causing pure water to pass through to the other side. A Reverse Osmosis Water Purification Unit (ROWPU) can provide potable water from any fresh, brackish, or seawater source. Coagulation, filtration, reverse osmosis and chlorination all take place within the unit.

Water Transportation

During the process of water transportation, it is essential that potable water does not become re-contaminated. Water trailers, tank trucks, and water cans must be clean and clearl, labeled upon arrival at a water point. New trailers and tanks, or those that have been used previously for other purposes and have been thoroughly cleaned, must be superchlorinated prior to use. Superchlorination is the process of adding a sufficient amount of chlorine to a quantity of water to bring the chlorine level up to 100 ppm initially, with 50 ppm free available chlorine (FAC) remaining at the end of a four hour contact period. If the chlorine residual falls below 50 ppm at any time during the 4 hour contact period, chlorine must be added to bring the residual back up to 100 ppm, and the 4 hour contact period must start again.

The form of chlorine normally used to treat water in the field environment is calcium hypochlorite, 65-70% (HTH), which can be obtained in bulk units. For batch chlorination of drinking water, a measured amount of HTH granules sufficient to produce the desired residual should be dissolved in a container of water and allowed to settle. Only the resulting clear supernatant liquid should be poured into the container to be disinfected. Add sufficent supernatant solution to the water storage container to provide 5 ppm free available chlorine (FAC). After a 30 minute contact time, test for FAC residual. Repeat chlorination procedure until 5 ppm FAC residual is obtained after a 30 minute contact period.

Fresh iodine water purification tablets can also be used. Any tablets which have been damaged or have turned completely yellow (canary yellow) or brown should be discarded. Using the clearest water available, add one iodine tablet per liter of water, two tablets if the water is cloudy. Then tighten the cap and allow a twenty minute waiting time.

Food Service in the Field

Inspection, Transportation and Storage of Food

The conditions under which food is transported, stored, prepared, and served can have a direct bearing on the success or failure of a mission. Storage in the field is particularly difficult. Although there are field reefers and freezers, their availability may be limited due to electrical and space requirements. In addition, temperature control may not always be adequate. Because of inconsistent electrical power supplies and various weather conditions, refergerated units must be checked at least three times daily and temperature readings logged.

Chopping and grinding of food in the field should be avoided and meat and chicken salads should be prohibited. Frozen foods should be thawed under refrigeration in the original, unbroken wrapping and cooked as soon as possible. Serving lines in field messes usually are unable to maintain proper holding temperatures and refrigerated space is always at a premium. Therefore, leftovers should be disposed of as garbage.

Care must be exercised with fruits and vegtables obtained from the local economy, particularly in areas where "night-soil" is used as fertilizer. All locally obtained fruits and vegetables must be properly washed and sanitized.

Messing Facilities and Equipment

When possible, messing facilities should use paper plates and cups, and plastic eating utensils. The advantages of disposable mess gear are: reduced water and fuel requirements, reduced requirements for gray water disposal, and reduced probability of disease transmission via contaminated eating utensils. The only real disadvantage is the resultant increase in solid waste storage and disposal.

A field dishwashing unit can be set up utilizing five metal GI cans (approximately 32 gallon size) and immersion heaters. If paper mess gear is not available, one or more GI cans of rapidly boiling water should be available at the entrance to the mess line for sanitizing mess gear.

The dishwashing battery should be set up as follows: First GI can is for collecting garbage; Second GI can is for prewash using warm detergent solution; Third GI can is for hot detergent solution; Fourth GI can is for clean, activley boiling water and; Fifth GI can is for the final sanitizing rinse-- water should be at a rolling boil. Mess gear should be air dried only. The galley and serving line should be physically separated due to the potential explosive hazard of immersion heaters.

Galley Waste Disposal

Soakage pits should be provided to contain waste water from the wash cans. Grease must be contained and not allowed to enter drainage ditches, evaporating beds, leaching fields or soakage pits. Grease will clog the soil, preventing absorption of water as well as acting as an insect or rodent attractant and giving off an offensive odor.

Solid wastes such as garbage, metal cans, and cardboard should be collected and compacted for burial or burning. Solid wastes must not be burned in close proximity to the galley or messing areas.

Waste Disposal in the Field

Large amounts of all types of wastes are generated daily under field conditions. If wastes are not removed promptly and thoroughly, the camp will quickly become an ideal breeding area for flies, rats and other vermin.

Disposal of Human Wastes

The devices for disposing of human wastes in the field vary with the situation, soil conditions, water table, weather conditions, availability of materials and local regulations. In temporary bivouacs of 1 to 3 days, the straddle trench is most likely to be used unless more permanent facilities are available. Trenches should be as narrow as possible, 2 meters deep and 3 to 3.5 meters long/100 persons. Boards may be placed along both sides of the trench to provide better footing. The removed earth is placed at the end of the trench and a shovel is provided so that excreta can be covered after each use.

In temporary camps, deep pit latrines and urine soakage pits can be constructed. One four seat deep pit latrine is needed per 50 people. The latrine pit should be 5-6 meters deep topped with a 8 x 1 meter box with four seats. A metal deflector should be placed inside the front of the box to prevent urine from soaking into the wood. Any cracks should be fly-proofed by nailing strips of wood or metal over the openings, by sandbagging or by using oil soaked burlap. In many developing countries, a squat latrine may be more acceptable. It can be constructed by placing wood or corrigated metal with holes cut out over the pit.

If fuel is available, burn barrel latrines have several advantages over deep pit latrines. They can be constructed quickly, are more sanitary, and can be used regardless of soil conditions. The barrels consist of 1/3 or 1/2 of a 55 gallon fuel drum over which a seating box is built. The seat of the hole should have a fly tight covering that can be secured in the closed position. Two barrels per seat are recommended to ensure that a barrel is always present while the other is being burned out.

Burn barrels should have 5-10 cm of fuel oil poured into each barrel before it is placed under the seating box. Do not use highly volatile fuels such as gasoline or aviation fuels. When full, the barrels should be stacked into a pyramid and sufficient diesel fuel added to cover the contents. The wastes are then stirred and the pyramid ignited. After burning, let the barrels cool and pour the contents of all barrels into one. Pyramid the barrels again with the full barrel on top and repeat the burning process. The second burning will render the fecal wastes to a fine ash which can be buried or scattered.

Urine soakage pits should be constructed so that men do not have to use the latrines to urinate, thus keeping the latrines cleaner and cutting down on the volume of traffic. Soakage pits are most effectively used in sandy soil. They are dug 2 meters square by 2 meters deep. The hole is filled to within 15 centimeters of the top with large rocks, flattened tin cans, broken bottles, rubble, bricks, etc. Oil soaked burlap is then spread over the stones and filled to ground level with compacted earth. A ventilation shaft which protrudes above the surface of the ground should be constructed to extend close to the bottom of the pit.

The urine soakage pit should have a urine pipe at each corner. These pipes should be approximately one meter long with one end inserted 20 cm into the pit before the compacted earth layer is added. A funnel made of tar paper, sheet metal, aluminum foil, etc. is then attached to the top of the pipe.

When the ground water is less than one meter below the surface, a urinoil should be constucted. The urinoil is a 55 gallon drum designed to receive and trap urine and to dispose of it into the soakage pit. Within the drum are interlocking pipes which reach below an oil seal. This system provides for slow leeching of urine into the ground and controls odors very effectively.

Maintenance of Latrines

A canvas or brush screen can be placed around the latrine. In cold climates, a heated tent is preferable. Simple, easily operated hand washing devices should be outside each latrine with special care taken to see that they are always full of water. To prevent surface water from flowing into the latrine, a drainage ditch should be dug around them. Latrine seats and boxes should be scrubed daily with detergent and water and disinfected with a mild (5%) chlorine solution.

When the latrine pit is filled to 1/2 meter of the surface, it should be closed by removing the box and spraying the pit contents, side walls, and ground surface around the pit with an approved residual insecticide. The pit is then filled in with earth and mounded above ground level. The mound is then sprayed with insecticide to prevent fly pupa which may hatch in the closed latrine from getting out.

Disposal of Gray Water

Used washing and bathing water, as well as liquid kitchen wastes are disposed of in the soil, usually by means of either soakage pits or soakage trenches. In order for the soil to absorb these liquid wastes, grease and any residual solids must be removed. Therefore a trap must be constructed to collect solids and grease before it enters the pit. The trap can be as simple as pouring gray water through grass or straw first. The straw can then be removed and burned daily. Traps can also be constructed using barrels where greasy water is allowed to settle until the grease can be skimmed off the top.

Gray water soakage pits are constructed as are urine soakage pits except for eliminating the urine pipes. One two meter square pit is adequate for a kitchen serving 250 people. If the camp will be used for more that two weeks, two soakage pits should be constructed and used on alternating days. The area under showers, washing facitities and at water points should also have soakage pits.

Evaporation beds are used when clay soil prevents the use of a soakage pit and where the climate is sufficently hot and dry. These beds are constructed by scraping topsoil to form dikes enclosing flat, level areas of earth where liquids will distribute in a thin, uniform layer. Beds are constructed to allow one square meter per person per day for kitchen wastes and slightly less per person per day for wash and bath wastes.

Garbage Disposal

Garbage is the solid or semi-solid wastes resulting from the preparation and serving of food. In temporary camps, garbage can be buried away from sources of drinking water. For camps that will be inhabited longer than one week, incineration is the disposal method most often used. Rubbish can be disposed of in a similar manner.

Prevention of Cold Exposure Injuries

Immersion Foot

Immersion foot or "trench foot" occurs when there is prolonged exposure to wet cold foot gear or outright immersion of the feet at temperatures usually below 50°F. At the upper range of temperatures, exposure of 12 hours or more will cause injury. Shorter durations at or near 32°F will cause the same injury. When exposed to these conditions, it is essential that boots are allowed to dry and socks are changed frequently.

Frostbite

Frostbite can occur whenever the ambient or windchill temperature is below freezing. It is an injury in which freezing of the tissue occurs. The first symptom of frostbite is usually a sharp, pricking sensation with a yellow-white, numb area or hardened skin. If exposure continues, the injury will proceed to blistering and eventually necrosis. In cold climates, all persons must wear the proper amount of clean, dry, properly fitting clothes. Clothing should be layered so that it can be taken off or put on depending on temperature and level of exercise.

Carbon Monoxide Poisoning

Carbon monoxide (CO) is a colorless, odorless gas given off as a by-product of internal combustion engines and fuel fired space heaters. Inexperienced troops operating in a cold climate may tend to congregate in closed spaces where CO may accumulate. Ensure proper ventilation when operating generators, fuel fired heaters, etc.

Dehydration

Dehydration results from the excessive loss of water from the body without replacement. Even in cold climates, personnel exercising can produce a large amount of perspiration which is quickly absorbed by clothing. The problem is exacerbated by the fact that drinking water may be difficult to obtain; therefore, personnel often do not drink adequate amounts of fluid. Urine color should be monitored to ensure adequate hydration. Dehydration is avoided by drinking at least two liters of water daily.

Hygiene in the Field

When water is in short supply and in very cold climates, keeping the body clean is difficult, but necessary to protect the individual's health and maintain morale. The entire body should be washed at least weekly. If bathing facilities are not available, the entire body can be washed with the equivalent of two canteen cups of water, using half for soap and washing, and half for rinsing. If circumstances prevent use of water, a rubdown with a dry cloth will help. Care should be taken not to abrade the skin. The feet, crotch and armpits should be cleaned daily.

Sleeping bags should be kept clean. Minimal clothing should be worn in the sleeping bag. Dry underwear and socks should be put on before going to sleep and the other set hung up to dry. The sleeping bag should be aired out daily.

Clothing must be worn in layers and must not be constricting. Loose clothing creates air pockets which provide insulation. Clean clothing provides maximal insulation. Underwear and shirts should be changed at least twice a week; however, if it is not possible to wash clothing this often, the clothing should be crumpled, shaken out, and aired for about two hours.

Mittens should be available during cold weather operations. Gloves can be used for tasks requiring dexterity, but they present more surface area for heat loss and are therefore less efficient than mittens in keeping hands warm.

Sunglasses should always be worn on bright days when the ground is covered with snow. They will protect the eyes against blowing snow and sun glare. If not used, snow blindness may result.

Care of the Feet

The feet should be washed daily and thoroughly dried, especially between the toes. During rest periods, the feet should be inspected and preventive measures applied before serious trouble develops. If socks become damp from perspiration or wet from surface water, they should be changed. Whenever possible, socks should be thoroughly washed with soap and water, stretched to facilitate drying, and hung up to dry.

Cold attacks the feet most often because they get wet easily (both externally and from perspiration) and because circulation is easily restricted. Socks must be chanaged whenever they get the slightest bit wet. The rule of wearing clothing loose and in layers also applies to footgear. Socks should be layered, but never worn too tightly.

Prevention of Heat Injuries

Heat injuries are preventable in most instances through education, acclimatization, and liberal water intake. Acclimatization occurs after working in hot environments for limited periods of time (at least 1 hour), on a daily basis, for several weeks. Once acclimatized, personnel tolerate heat stress much more easily as long as prudent precautions are taken.

Wet Bulb Globe Temperature (WBGT) Index

The WBGT index is the most practical heat stress index for assessing the effect of heat stress on the individual. The index is a single number by which the air temperature, air movement, relative humidity and radiant heat can be expressed as either favorable or unfavorable for certain types of activities. WBGT readings lower that 88° require some limitations in exercise. When the WBGT index is greater that 88°F, all strenuous exercise should be curtailed for personnel with less that 12 weeks training in hot weather. An index of greater that 90°F indicates that all strenuous exercise should be suspended.

Water Intake

A liberal water intake policy is essential in hot weather operations. Without adequate water intake, the body's cooling system will fail, with morbidity and even mortality following. An individual subjected to high heat stress may lose in excess of one liter of water per hour by sweating. This loss must be replaced. Personnel exposed to heat should consume water frequently, preferably at 10 to 20 minute intervals. The myth that-personnel can be taught to adjust to decreased water intake has been repeatedly disproven.

Thirst is not an adequate stimulus for water intake. Personnel should be trained to drink liberal quantities of water, even though they are not thirsty. Supervised, mandatory water consumption should be a command priority during periods of extreme heat exposure. When water is in short supply, water savings can be made only by reducing physical activity, or by limiting activity to the early morning, evening, and night hours.

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