SPECIAL REPORT

MEDICAL PROBLEMS OF SURVIVORS OF NUCLEAR WAR

Infection and the Spread of Communicable Disease

THE nature of the medical problems confronting survivors of a nuclear war has not been widely conveyed or fully understood Perhaps the most logical approach is to view this matter in sequence, from the moment of attack through the periods that follow The characteristic elements of each period can be delineated, with the reservation that the duration cannot be precisely stated The type and severity of the initial injury will clearly affect the response to new medical problems as they arise Each problem may be expected to extend beyond the period in which it is initially encountered (Table 1)

The effects of burn, blast, and radiation have dominated the discussions of the post-attack period But in the intermediate term, infection and the spread of communicable disease may represent the most important threat to survivors

The United States that we will view will have undergone a 6559-megaton attack. The magnitude of such an attack — the so-called CRP-2B model[1] used by the Federal Emergency Management Agency in civil-defense planning[1] reflects the world of the 1980s In terms of yield, it represents 524,720 Hiroshima bombs The targets of attack, in order of priority, will have included the following: military installations; military-supporting industrial, transport, and logistic facilities; other basic industries and facilities that contribute to the maintenance of the economy; and population concentrations of 50,000 or greater (Some 4000 megatons will have been detonated on urban areas and population centers)

Moments after the attack, 86 million people — nearly 40 per cent of the population — will be dead An additional 34 million — 27 per cent of the survivors — will be severely injured Fifty million additional fatalities are anticipated during the shelter period, for a total of 133 million deaths Many of the millions of surviving injured will have received moderate to high radiation doses Approximately 60 million may survive and emerge from the shelter period without serious injury and with relatively limited radiation exposure

The periods under consideration are as follows:

Barrage period. The explosions almost instantaneously inflict millions of lethal and nonlethal blast, thermal, and immediate radiation injuries on those caught in and around the blast areas

Shelter period For days or weeks after the attack, survivors of the initial explosions attempt to sustain themselves in fallout shelters amid intense radiation, fires, and deprivation

Post-shelter survival period Fallout has reached an "acceptable" level that allows survivors to emerge for variable times Food and shelter must be found. The injured must be nursed, the dead buried, debris cleared, the harvest reaped, and the next harvest sown In a primitive and hazardous environment, survival is the only coherent goal

"Recovery" period Survival has been accomplished, and some kind of recovery initiated A societal structure is emerging; food supplies have been secured, shelter obtained, and communities established A primitive social system, with potentially intense regional and intraregional competition for food supplies, faces all the problems of underdeveloped countries Long-term effects of the attack become apparent During the early years, the first cases of radiation-induced leukemia appear; later, the solid cancers will develop in the lungs, thyroid, breast, and colon

The problem of infection and communicable disease must be addressed during the shelter period and more particularly during the post-shelter survival period [2,3] The potential impact of this problem on the recovery process is clear It can only be examined realistically in the context of survival conditions: food, water, antibiotics, burn and blast residua, and radiation and its effects First, however, the nature of the threat itself must be clarified Why is the likelihood of infection so much greater in the post-attack world?

BASIS FOR INCREASED RISK AND SEVERITY OF INFECTION

Most survivors will have increased susceptibility to infection for two reasons: the pervasive direct effects of nuclear weapons and the subsequent pressures and hardships confronted Several factors will be of special importance

Radiation

Radiation affects the immune system in a number of different ways, not the least of which is its capacity to injure the bone marrow and the lymph nodes Hematologic effects may occur with doses as low as 50 rems The following changes must be anticipated in varying degrees: decreased antibody response,[4-6] decreased effectiveness of cellular defense mechanisms,[7] decreased effectiveness of immunizing agents,[3] and increased susceptibility to some toxins [3] Thus, vaccination will be less effective

Radiation also has a major effect on the mucosa of the intestine "Ulceration spreads through the entire gastrointestinal tract . . The multiplication of bacteria, made possible by the decrease in the white blood cells of the blood and injury to other im-

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Table 1. Medical Problems During the Attack and Post-attack Periods

Medical Problem *	Barrage Period	Shelter Period		Survival Period	Recovery Period	
	First hour	First day	First 0–4 wk		Long-term effects	Future generations
Flash burns	+	—	—	—	—	—
Trauma and blast injury	+	—	—	—	—	—
Flame burns and smoke inhalation	+	+	—	—	—	—
Acute radiation	+	—	—	—	—	—
Fallout radiation	+	+	+	+	—	—
Suffocation and heat prostration	—	+	+	—	—	—
General lack of medical care	—	+	+	+	—	—
Dehydration	—	—	+	—	—	—
Communicable diseases	—	—	+	+	—	—
Exposure and hardship	—	—	+	+	—	—
Malnutrition	—	—	+	+	—	—
Cancer	—	—	—	—	+	—
Genetic damage	—	—	—	—	—	+

*Listed in the approximate chronologic order in which they appear

mune mechanisms of the body, allows an overwhelming infection to develop."[8] The ulcerated mucosa provides a portal into the bloodstream for gram-negative organisms, with bacteremia as a certain result. These organisms are frequently difficult to control with antibiotics

Federal estimates indicate that 23 million survivors of a large-scale nuclear war will suffer from radiation sickness,[9] implying a mean dose of 200 rems or more. But the number of persons receiving doses between 100 and 200 rems will probably equal that number, so that 50 per cent of the population may have lowered resistance to disease from radiation exposure alone.[10]

Trauma and Burn Casualties

Among the millions with trauma or burns or both, over a third will also have radiation sickness[9] Aside from the risk of infection related to open wounds, there is a known synergy between burns and radiation that profoundly increases the mortality rate.

The organisms that will infect the burn sites include pseudomonas and serratia. Both may be troublesome — even in patients with normal immune mechanisms — and will be difficult to eradicate in a population with altered immunity.

Malnutrition and Starvation

During the shelter period, available quantities of food will vary. In some locales, fallout may prevent emergence from shelter to a point at which health would deteriorate. Previously healthy, well-nourished adults can maintain health for several weeks with only minimal amounts of nutrition,[11] but infants and young children may have severe malnutrition due to insufficient or inappropriate foods during an extended stay in the shelter.[12]

In the uncertain post-attack environment, food will take on an immense value, and persons or regions with food supplies may be reluctant to relinquish their holdings[13] When survivors emerge from their shelters, most of the food stores in urban areas will have been destroyed; other supplies will probably be consumed during, or soon after, the shelter period.[14]

One source that may remain available is grain stored on and off farms in small towns and rural areas. This will vary considerably in amount during the course of the year. It may support the surviving population from 200 to 500 days, with great dependence on the next harvest[14]

During the immediate post-shelter period, obtaining, transporting, and distributing grain to hungry survivors, wherever they are located, will be the most important survival activities These efforts will be hampered by the negative correlation between population and grain density in the United States.[15] Fuel shortages may pose another problem, since it has been estimated that as much as 99 per cent of the United States' refining capacity could be destroyed.[16] Farmers may be forced into bitter competition with grain transporters for the use of fuel; this would lead to an ironic choice between hunger today through a lack of grain shipments and hunger tomorrow through poor agricultural production. In many populated parts of the country, famine will be a reality.

A reasonable level of nutrition is essential to control infection Malnutrition lowers physiologic resistance to disease and heightens susceptibility to pathogenic organisms.[17]

Dehydration

It is estimated that a healthy person in the hot environment of a fallout shelter would need about 4 liters (1 gal) of water per day to prevent dehydration[12] Furthermore, the incidence of diarrhea and vomiting is expected to be high among survivors of a nuclear attack. No water is normally stored in public fallout shelters, and no means of transporting or storing water will necessarily be available. For the third of the population in areas in which the initial radiation level is over 3000 rems per hour, it will be at least five days before radiation levels allow them to leave the shelter for up to one hour per day.[18] Some may die of dehydration in the shelter; survivors will be profoundly weakened and far less able to resist infection. When water is available, there will be great difficulty in making certain that it remains uncontaminated

Exposure and Hardship

Widespread destruction of urban housing will occur, with major damage to rural housing as well. Heating fuel may be unavailable. General hardship will be accompanied by the need for intensive labor, with exhaustion, fatigue, and poor nutrition promoting great vulnerability to infection.

Lowered Natural Resistance to Disease

Surviving Americans will experience the underdeveloped world as their natural habitat for the first time. Unlike the inhabitants of impoverished lands, however, Americans, because of lack of exposure to many organisms, may not have the high natural immunity to a host of dangerous diseases that allows many in the Third World to survive. The normal production of antibodies to infectious agents among the developed nations has clearly been altered, perhaps partially because of the easy availability of antibiotics. With potential destruction of the pharmaceutical industry, as well as post-attack disorganization and chaos, antibiotics will be in short supply for countries that have depended on them

The successful campaigns to eliminate the lethal epidemics, such as cholera and typhoid fever, have been accompanied by a failure to develop resistance to these diseases. Even with our past vaccination policies, 74 per cent of the population was thought to be unprotected from smallpox.[19] This may be academic if smallpox has truly been eradicated, as some have claimed. But a store of smallpox virus remains at the Centers for Disease Control in Atlanta as a precaution in the event that vaccine should be required. If the Centers were to experience the blast of a nuclear weapon in the region, the virus might soon be out of control. Reintroduction of such "exotic" diseases might find the population incapable of handling them, as were American Indians who were exposed to diseases of Europeans.

Measles, whooping cough, and diphtheria may be rampant in nonimmunized infants, and beta-hemolytic streptococcal infections will be widespread

Factors Increasing the Spread of Disease

Shelter Conditions

Large public shelters may operate under severe space limitations, with thousands packed into inadequate areas. Under these circumstances, hepatitis and respiratory and gastrointestinal infections may spread rapidly. Most shelters will lack adequate or functioning forced ventilation.[12] Heat, humidity, and the absence of a continuous flow of fresh air will encourage the spread of infective microorganisms.

The length of time that fallout radiation necessitates basement and underground occupancy will be an important determinant of the spread of disease. This period may well be one week to several months.[20] Even after outside work is permissible, it may still be necessary to eat, sleep, and rest in the fallout shelters. "The spread of respiratory and other diseases . . . would be difficult to control in long-occupied shelters."[21]

Sanitation

Many familiar barriers to the spread of communicable disease — a sanitary water supply, properly prepared and refrigerated food, sewage treatment, and waste disposal — will be seriously compromised in the post-attack environment. In their absence, a host of enteric diseases not yet encountered by most Americans may be expected to spread widely. These include infectious hepatitis, *Escherichia coli* infection, salmonellosis, shigellosis, amebic dysentery, and possibly typhoid and paratyphoid.

Insects

Insects are generally more resistant to radiation than are human beings. This fact, along with the prevalence of corpses, waste, and untreated sewage, the depletion of birds, and the destruction of insecticide stocks and production, will engender a huge increase in insect growth. "Mosquitoes would multiply rapidly after an attack . . . The fly population would explode. . . . Most domestic animals and wild creatures would be killed. Trillions of flies would breed in the dead bodies."[21] Uncontrolled growth in the insect population, combined with a failure to provide adequate sanitation, may sharply limit the capacity to control such diseases as typhus, malaria, dengue fever, and encephalitis.[19]

Corpses

The millions of corpses left in the wake of a nuclear attack will pose a serious disease threat. In many areas, radiation levels will be so high that corpses will remain untouched for weeks. With transportation destroyed, survivors weakened, and a multiplicity of post-shelter reconstruction tasks to be performed, corpse disposal will be complicated

Animals

Like human beings, domestic animals such as cats and dogs will have altered immunity. Diseases of dogs such as brucellosis and leptospirosis may spread from animals to surviving persons. Cats and dogs injured or running wild will feed on carrion and be exposed to swarms of flies or other insects. Rabies may involve not only cats and dogs but also raccoons, foxes, and skunks. In some areas, wild rabid animals may become a major hazard

Factors Limiting the Response to Infection

Government Organization

The United States has developed an extraordinary ability to take effective countermeasures against communicable diseases. In 1947 a man infected with smallpox mingled with New York City crowds for several days. More than 6,350,000 persons were immediately vaccinated; as a result, only 12 additional cases appeared. More recently, the unfortunate "swine flu" episode illustrated how the hint of an epidemic can bring enormous medical resources to bear on the threat.

But coherent efforts to control and limit the spread of disease require a surviving government, organized geographic units, communication networks, and an environment in which physicians and health officials are able to perform their tasks.

All these conditions are dubious in the post-attack world. Most radio contact will be eliminated by nuclear weapons' effects.[22] Treating the wounded will require the full commitment of available medical resources. The huge number of injured, the tenuous food situation, massive industrial destruction, the enormous tasks of removing debris and disposing of bodies, and the disparity between "food-rich" and "food-poor" regions will seriously undermine interregional cooperation.[13]

Disease Detection and Diagnosis

Health measures against potential epidemics depend on the involvement of physicians. Casualties among physicians and other health personnel will approximate 80 per cent. This is higher than the casualty percentage of the population as a whole (73 per cent) because physicians are disproportionately represented in the large cities. Government estimates suggest that there may be 79,000 uninjured physicians surviving a large-scale attack. They will have 32 million injured to treat, of whom 18 million have radiation sickness and 14 million have trauma or burns or both. If only the trauma and burn victims are included, this represents a ratio of about 177 acutely injured patients for every uninjured physician.[9] If there is a serious epidemic, it will affect physicians as well. More physicians will become incapacitated as the number of sick people increases, further raising the injured-to-physician ratio.

Laboratories are essential for detection and diagnosis of communicable disease; however, they will be highly vulnerable to the effects of an attack. Of the 50 State Public Health Laboratories and six Federal Communicable Disease Centers, only 11 are in low-risk areas. None of the surviving laboratories will be able to provide tests for such diseases as amebiasis or plague.[23]

Inadequacy of Countermeasures

Control of enteric and vector-borne disease requires supplies of pure water and uncontaminated food, disposal of sewage and waste, and the removal of breeding areas for insects and rodents. Many of these countermeasures will be unavailable in the post-attack period. The spread of respiratory disease will be greatly enhanced by the crowded quarters and poor ventilation of fallout shelters. Antibiotics and immunization seem essential to stemming epidemics; but in this case, how effective will they be?

Antibiotics

Antibiotics are generally ineffective in combating viral disease and cannot limit the spread of such infections as smallpox or viral gastroenteritis. Several dangerous bacterial diseases such as diphtheria and tetanus respond poorly to antibiotics.[19] Furthermore, the demand for antibiotics will be large. If laboratory tests are not available, antibiotics will be prescribed for all undiagnosed ailments. Stores of antibiotics will be largely destroyed in urban centers, and those still intact may be inaccessible for days or weeks because of intense fallout radiation. Rural stocks may be more plentiful because of farmers' stockpiling for livestock. It is believed that a massive nuclear attack would virtually eliminate the pharmaceutical industry.[24,25] The strictest rationing of antibiotics will therefore be essential so that they can be available when they are most needed.

Immunization

For several hazardous diseases, such as tetanus, poliomyelitis, measles, and whooping cough, immunization is the only effective direct means of control. In post-attack conditions, however, the effectiveness of vaccination programs will be diminished by the impact of radiation on the immune system. Millions who will have had substantial radiation doses, and who will therefore need immunization most of all, will benefit least. Accurate diagnosis, although essential, may be impossible in the absence of adequate laboratory facilities. If an unfamiliar disease or a new strain emerges, existing supplies will be useless. Production of the specific vaccine in quantity will be difficult, if not impossible.

Potential Pathogens in the Post-Attack World

Studies performed in the late 1960s identified 23 diseases that might be important in the post-attack environment.[26] Many of these are encountered in endemic form throughout the country.[27] Among them, potential sources of epidemics may be divided into two categories (Table 2). The first includes the classic epidemic diseases, which fortunately are of low incidence; the second comprises diseases of higher incidence but low mortality.[28] Respiratory diseases, including viral pneumonias, influenza, pneumococcal and streptococcal infections, and tuberculosis, will particularly affect those living in crowded blast or fall-

Table 2. Potential Epidemic Diseases.

Group 1: Epidemic Diseases of Low Incidence	Group 2: Serious Existing Diseases
Cholera	Diarrhea
Malaria	Diphtheria
Plague	Hepatitis
Shigellosis	Influenza
Smallpox	Meningitis
Typhoid fever	Pneumonia
Typhus	Tuberculosis
Yellow fever	Whooping cough

out shelters, with an augmented impact on the young and the old. The diarrheal diseases, such as salmonellosis, shigellosis, campylobacter infection, and viral gastroenteritis, will be widely prevalent. Although their mortality rates are usually low, they will increase substantially owing to the presence of radiation injury to the gastrointestinal tract. Furthermore, these diseases, as well as infectious hepatitis, may spread rapidly in the absence of adequate sewage disposal, pasteurized milk, or appropriate sanitary precautions. The group of diseases endemic to rural sections — and thus dangerous to evacuated populations — includes rabies, plague, and tetanus. A number of other diseases such as cholera or influenza may spread rapidly in devastated areas.[19]

A more detailed look at two among the many diseases that are generally considered well controlled in Western society will indicate the roots of the concern for the role of communicable disease in the transformed post-nuclear world.

Tuberculosis

Tuberculosis, the "Great White Plague" of the 19th century, was a lethal infection for large segments of the population. Death rates ranged as high as 550 per 100,000 in New York City.[29] If the annual United States death rate of 184.7 per 100,000 from tuberculosis during the period 1900 to 1904 characterized our present population of 225 million, all the United States deaths from World Wars I and II, Korea, and Vietnam would be surpassed in one year and 10 days.

Should this concern us for the post-attack period, when we know that the mortality rate of tuberculosis has fallen below 1/200th of the 1900–1904 figures? In 1978 there were only 2830 deaths and 28,521 new active cases in the United States.[30] This change is largely attributable to improved socioeconomic circumstances; in the past, particularly in times of war, the incidence and mortality of tuberculosis have frequently been seen to rise and fall with altered societal conditions. In World War I, for example, mortality from tuberculosis increased 218 per cent in Warsaw, reaching a rate of 974 per 100,000 in 1917. During World War II, the death rate rose 268 per cent in Berlin, 222 per cent in Warsaw, and 134 per cent in Vienna. An analysis of 2267 chest roentgenograms at the Dachau concentration camp at the time of liberation showed that 28 per cent had evidence of tuberculosis, of which nearly 40 per cent was "far advanced."[31]

All the factors that would increase the susceptibility to and the spread of infection would be particularly applicable to tuberculosis. The destruction of housing, lack of fuel, shortages of food, medicine, and clothing, and a sustained period of labor and struggle would create precisely the setting in which tuberculosis has flourished in the past.

Crowding

Crowded living conditions are likely to become the norm for survivors. Crowding will begin in the shelter period and continue during the post-shelter phase because of the destruction of housing stock. Tuberculosis has been known to spread rapidly under such conditions. In 1959, for example, an outbreak occurred aboard a United States Navy destroyer. Despite vigorous efforts at control, 26 per cent of the ship's 236-man crew became infected during an 18-month period.[32]

Exposure and Stress

Stress, fatigue, exposure, and hardship will produce an infirm and weakened work force in whom relapse of latent cases and susceptibility to new infection will be widespread.

Undernourishment

Poor nutritional status has traditionally been associated with increased incidence and mortality from tuberculosis.[33] This relation is perhaps most striking during wartime.[34] The post-attack diet will consist mainly of grains and beans[35] and will be deficient in animal protein.

Lack of Previous Exposure

Fewer Americans have been exposed to tuberculosis today than ever before. There are numerous examples of catastrophic epidemics of tuberculosis among largely unexposed populations. South African troops in World War I had a mortality rate of 1745 per 100,000 from tuberculosis, whereas British troops had a rate of only 11 per 100,000.[31] In the post-attack period, the disease may be particularly virulent among Americans because of the lack of immunity.

Radiation

Studies in Hiroshima showed no increase in tuberculosis a few years after the bombing,[36] but the data on the immediate and intermediate post-bombing periods are unclear. It is known that immunosuppressive therapy is an important risk factor for converting latent tuberculosis to active tuberculosis, and many survivors of a massive nuclear war will have received substantial doses of radiation, with important effects on their immune systems. In the post-nuclear world, radiation — together with crowding, cold, stress, malnutrition, and lack of prior exposure — may predispose survivors to serious tuberculosis problems.

Plague

Plague has been a source of epidemics for the past 3500 years In the 20th century alone, over 12 million deaths have been attributed to it.

Plague is endemic among wild rodents in the 11 westernmost states,[37] and human contact with wild rodents is almost exclusively the source of plague in this country.[38]

A nuclear attack will create almost ideal conditions for breaching the "thin protective wall" against plague.[39] Western territories now relatively devoid of inhabitants may receive an influx of refugees from threatened or devastated urban areas. (Relocation plans call for enormous increases in the population of many remote regions.[40] Humboldt County, California, for example, will have a fivefold or greater increase in population.) Without existing dwellings, these urban refugees are likely to build earth-covered, "expedient" shelters in undeveloped areas. Such shelters might provide good fallout protection, but they would surely create ideal conditions for transmission of plague from rodents

Rodents are relatively resistant to plague They harbor chronic infections and may act as a reservoir for the disease. Radiation will increase their susceptibility, as well as that of human beings. High mortality among wild rodents will then help spread the disease to nearby persons. The more resistant fleas will leave the dying animals and search for another, perhaps human, host. At the same time, conditions in the damaged cities will continue to be favorable for the spread and propagation of plague, while the available harborage and food will ensure an increase in the rat population. (A growth rate of 3 to 11 per cent would be expected in the commensal rat population.[20]) Domestic rats, should they become infected, would further spread the disease among human populations.

A major danger comes not only from bubonic plague transmitted by rats but also from person-to-person pneumonic plague.[39] Under post-attack conditions, radiation and stress may raise the conversion rate of bubonic to pneumonic plague to 25 per cent.[37] This highly contagious disease may be especially dangerous among the survivors of a nuclear attack.[41]

The complexity of the control process in the post-attack environment may be readily understood from a consideration of the measures required, as noted by Mitchell[28]: maintenance of external quarantine, maintenance of plague surveillance, maintenance of central regional diagnostic laboratory facilities, maintenance of production of antimicrobial drugs, maintenance of production of immunologic agents, capacity for water and sewage control, maintenance of food quality control, capacity for insect-vector control, and capacity for rodent control.

Quantitative Estimates of Infection in the Post-Attack Period

Assuming a uniform risk across the country, it is possible that 12 per cent of the survivors may contract plague; in half, it would be fatal Some believe that plague may spread more widely and that it probably represents "the major national threat among the set of vectorborne diseases."[37]

In the aggregate, deaths from acute communicable diseases among the survivors may approach 20 to 25 per cent.[42] Estimates of both the incidence and the mortality of infection in the post-attack world vary widely for different diseases (Fig 1). Enteric[43] and respiratory[44] diseases represent major threats to survival.

In a computer simulation of the effects of a single nuclear explosion 14 km (9 miles) south of New Orleans, it was calculated that, in the absence of medical countermeasures, 35 per cent of the survivors would die from infectious diseases in the first year after the attack.[40] For purposes of comparison, the expected number of deaths from noncommunicable diseases, such as heart disease or diabetes, is estimated to be between 2.5 and 3 per cent of the survivors,[42] whereas cancer mortality is expected to involve a few per cent or less.[45]

Conclusions

Several factors point to an increased risk of serious infection and communicable disease in the post-attack environment These include the effects on susceptibility of irradiation, malnutrition, and exposure; the effects on disease transmittal of unsanitary conditions, lengthy stays in shelters, and the growth of insect populations; and the effects on attempted countermeasures of depleted antibiotic stocks, shortages of physicians, the destruction of laboratories, and the general disorganization sure to follow an attack.

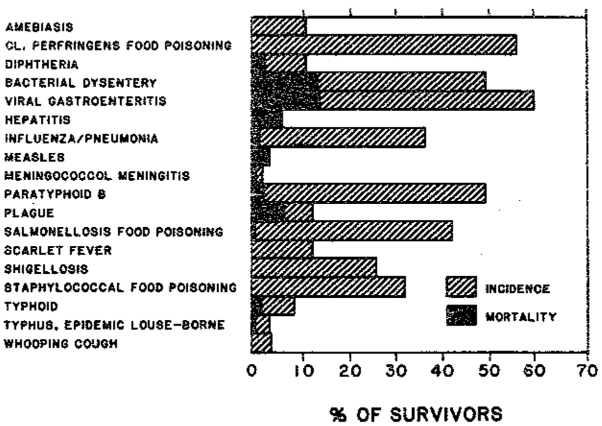

Figure 1 Estimated Incidence and Mortality of Acute Epidemic Diseases among United States Population Exposed to the Effects of Nuclear Weapons.

These composite figures show (in black) the anticipated mortality and (in the hatched areas) the incidence of the disease The figures assume no medical countermeasures and are based on the best available estimates from a variety of sources.[3,19,27,28,42-44] These estimates are subject to error due to variations in the magnitude, timing, and locale of the attack. In a conflict of lessened intensity, in which medical resources could be exploited, mortality figures would be reduced correspondingly.

Although this threat has been considered small in comparison to the direct effects of nuclear weapons, its potential impact both on survivors and on the recovery process itself requires careful consideration. Previous studies may have been overly optimistic in their assumptions and analyses First of all, the synergistic effects of increased susceptibility, easier disease transmittal, and less effective countermeasures are uncertain. Secondly, some studies have assumed the post-attack survival situation to be favorable, with plentiful food, and functioning governmental and health organizations. Thirdly, the profound effects of epidemics on post-attack recovery — leading to further famine and disease — have not been adequately calculated Fourthly, lethal, highly infectious, and largely uncontrollable diseases of low incidence in the United States have been assumed to stay at low incidence in the post-attack period. A breakout of one or more could greatly increase the number of deaths.

Although no existing data prove that catastrophic epidemics will occur in the post-attack period, the matter is one of overwhelming importance and uncertainty. What is certain is that infection will pose a substantial threat to health and recovery for all those injured by blast, heat, and radiation, and that the resources to grapple with this threat will be inadequate

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