

EFFECTS OF BIOLOGICAL WARFARE AGENTS

INTRODUCTION. The information herein has been compiled from official publications of the Department of the Army, Office Of Civil and Defense Mobilization, Department of Health, Education and Welfare, and from other sources. No classified material is included. This is not a substitute for the technical details in other official and more voluminous publications, but has been prepared as a guide to officials engaged in mobilization planning and in the programming of readiness measures. For those who wish to study these weapons effects in greater detail, attention is invited to the bibliography at the end of the text. A glossary of terms will also be found there.

The objectives of this publication, intended for planners and operating officials who will have emergency functions in the Department, are threefold: (1) to give a realistic recognition of the potentials and limitations of biological attack on population, animals and plants; (2) to develop an understanding of the conditions and hazards under which emergency functions may have to be executed; and (3) to identify the principal factors in this area which must be considered in planning emergency functions and indicate their current status.

1. GENERAL. Biological warfare (BW) is the intentional use of living organisms or their toxic products, to cause death, disability or damage in man, animals, or plants. The target is man, either by causing his sickness or death, or through limitation of his food supplies or other agricultural resources. Man must wage a continuous fight to maintain and defend himself, his animals, and his plants in competition with insects and microorganisms. The object of BW is to overcome these efforts by deliberately distributing large numbers of organisms of native or foreign origin, or their toxic products, taking full advantage of the ability to utilize more effective methods of dissemination and unusual portals of entry. BW has been aptly described as public health in reverse.

2. FEASIBILITY OF BIOLOGICAL WARFARE. Extreme statements have been made about the effectiveness of BW and available defenses. Because history records and emphasizes the devastating action of epidemics and pandemics during wars, predictions have been made that following a successful BW attack, entire populations would become infected and disabled with a resultant high mortality.

On the other hand, it has been asserted that the danger would be small, since man, his animals, and his crops have survived centuries of natural exposure to infectious pathogens. In light of present knowledge, a more reasonable assessment of the hazard places it somewhere between these two extremes. This is the basis for the following assumptions:

(1) The enemy can produce a variety of effective BW agents and can deliver them against population, agricultural and water resources of the United States by a number of means, overt and covert.

(2) BW agents may be used against humans to produce illness and/or death, impede defensive actions, impair morale, reduce the will to resist and minimize production capability either for the conduct of war or for recovery and rehabilitation.

(3) BW agents may be employed against food, drugs, animals and crops, since long-term recuperative ability may be a decisive factor.

(4) BW attacks may accompany an initial nuclear attack, follow in subsequent attacks or precede a nuclear attack sufficiently in advance to impair retaliatory and defensive capability.

(5) The effects of BW agent attacks on humans may not immediately be recognized or differentiated from naturally occurring epidemics or from illness produced by radioactive fallout.

(6) Adequate preparation in terms of preventive and protective measures, education and training, and provision of treatment measures can greatly minimize the effects of such attacks.

2.1 The estimations of BW potentials are speculative and controversial because evidence required for a rational appraisal will not be available until this weapon has been used. However, this lack should not prevent development of a practical defense program. Present knowledge of the epidemiology and epidemic control methods for human, animal, and plant organisms, vectors and other parasites accumulated over many years by workers in preventive medicine, public health, and agriculture is believed sufficient for a reasonable and acceptable approach to BW defense planning.

2.2 Sensational statements and magazine articles have given rise to some misconceptions which should be dispelled. The following points should be kept clearly in mind:

2.21 "Biological warfare will not destroy entire populations". Biological warfare is a special weapon for use against special targets or areas. It has limitations just as do other forms of attack.

2.22 "Talk of poisons that can kill millions is nonsense". Toxins, which are special kinds of biological poisons, can be deadly, but there are definitely practical limits to distributing them. Stories of one ounce killing millions of people are irresponsible. One might as well talk of dividing one aspirin tablet evenly among eleven million people in the greater New York area.

2.23 "Epidemics are not likely". Epidemics are not likely to be caused by biological warfare. Casualties would be confined essentially to the individuals directly exposed to the agent in the air, contaminated water, food, or on surfaces. Only rarely would secondary cases constitute a problem because:

(1) organisms meeting most of the BW requirements do not spread readily from person to person; (2) natural exposure would occur, hence normal body defenses will operate; and (3) preventive countermeasures can be set in motion with considerable prospect of success.

3. CHARACTERISTICS ESSENTIAL TO BIOLOGICAL WARFARE AGENTS.

In order for microorganisms or their products to be effective biological warfare agents, it is necessary that they meet certain requirements, and desirable that they possess other properties which will increase their value under conditions of use. An enemy would select them, keeping in mind not only the effect he hoped to produce, but also the environmental conditions existing in a given situation where he might use them. He would consider the following characteristics essential:

Coccidioidomycosis Nocardiosis

Histoplasmosis

TOXINS

Botulism Staphylococcus enterotoxin

Inclusion or omission of specific diseases is not based on either friendly or enemy military information or intelligence.

3.1 PATHOGENICITY OR DESTRUCTIVENESS. The first requirement is that the substance be lethal or incapacitating to man and animals or result in destruction or reduction of crops. The effects of the historical epidemics are well known, and the occurrence of food poisoning, diarrhea, measles, and tuberculosis make it evident that certain biological agents are capable of disabling or killing people. Those familiar with agriculture know that we spend large sums of money annually to prevent the destruction of livestock and food crops by disease and insect pests. There is no doubt about their effect, if left free to operate.

3.2 AVAILABILITY. The second requirement involves availability. Any material chosen should be economically obtainable in large quantities. Most of the bacteria, rickettsiae, and viruses can be grown by ordinary laboratory techniques, and by following the general production methods employed by the brewing, antibiotic, and vaccine industries.

3.3 STABILITY. The third requisite is stability. An agent must be stable under the necessary conditions of production, storage, transport, and dissemination, or it will never reach the target in usable condition. Stability in production would include maintaining its virulence. Many pathogenic bacteria lose their disease-producing ability when cultivated by repeated transfer on artificial media. There are several methods of maintaining virulence. Sometimes adding blood or other body fluids to the medium will do it; other organisms must be maintained in living laboratory animals or occasionally inoculated into a series of susceptible animals to accomplish this.

3.31 Maintenance of ability to produce infection during storage and transport is another matter. Most infective agents are living things, and when they are subjected to conditions under which they cannot lead a normal existence, they begin to die -- some more rapidly than others. The organism causing anthrax lives for years in the spore stage, while that of syphilis dies in a few minutes when exposed to air.

3.32 The most resistant form of life known to man is the bacterial spore. It is a dormant form of life, characterized by concentration of essential cell substance and a highly resistant cell wall. Spores are more resistant than vegetative cells of the same organism to such adverse conditions as exposure to high temperatures and chemicals. Spores may even survive prolonged boiling and can be held in the dry state for long periods without significant loss of numbers.

3.33 Another natural feature protecting some of the bacteria is the capsule enveloping such organisms. Whether or not the capsular substance is an alteration of the cell wall is uncertain, but its chemical nature is different in different species and it is simply a slimy layer surrounding the

cell. Microbiologists have made use of selected imbedding proteins such as milk, blood, and serum to simulate this capsule protection. By using this technique and with subsequent lyophilization, they have largely solved the problems of stability involved in storage, transport, and dissemination. Lyophilization is simply a process by which one rapidly freezes a mixture, e.g., microbes in a suitable organic material, and dries the frozen mixture under a high vacuum (2 or 3 microns of mercury). The resulting product is a dry material which may be powdered, and when held in airtight vials, is stable in some instances for years.

3.4 DISPERSAL. Even if all these criteria are met, an enemy would find an agent of little value unless the virulent form could be readily disseminated in such a manner as to be effective. Methods of dispersal are most easily considered under two headings: (1) covert contamination or sabotage of air, food, or water, and (2) overt attack or production of a cloud of pathogenic organisms or toxins in areas, possibly in conjunction with an atomic attack.

3.41 First, consider the covert attack, meaning the attack of a saboteur, and the advantages an enemy might gain by such an attack. Here biological weapons have some eminent distinctions: (1) Delayed action; (2) the small quantity needed; (3) the difficulty of detection. They would act slowly and would be hard to detect, and an intelligent person, working perhaps in a basement laboratory, could produce sufficient quantities for a covert act. With a pump sufficiently strong to overcome the water pressure, he could force his substances back into the water system. He could also introduce the pathogens into ventilating systems.

3.42 Another possible area for sabotage is the drug industry.

The enemy might sabotage our medical supplies if he intended to make a large-scale overt or airborne attack later. A shrewd, calculating organization could work saboteurs into critical positions in drug manufacturing establishments, where they might contaminate substantial portions of the drugs being manufactured, thereby converting drugs intended to control disease into agents that actually spread disease.

3.43 The food industry could also be attacked. The Civil Defense Foods Advisory Committee of the National Academy of Sciences--National Research Council reports that carefully placed saboteurs in food-producing establishments might introduce pathogens or large numbers of heat-resistant spoilage microorganisms into food, intending to produce disease or to reduce the supply; and since commercial processing practices are determined by the process necessary to preserve food contaminated with a natural load of microorganisms, a significant increase in the numbers or a change in the type of microorganisms present would make processing less effective. A manufacturer not knowing that he had an abnormal product and giving his goods the normal process would thereby fail to achieve proper sterilization and his food would spoil.

3.44 Another fertile field for the saboteur is our air-conditioning systems, which are built to provide fresh air in closed areas and prevent accumulation of "stale" air. A foreign agent might introduce a biological aerosol into the ventilating systems of factories, or of strategic buildings such as city halls, government offices, and manufacturing establishments, thereby infecting enough people to cause serious disruption of the function of the facility. In addition to the disruption, there would remain the problem of cleaning the area to make it safe for rehabilitation. Our chief defense lies in anticipation and early detection of these acts.

3.45 However, covert methods have serious limitations also. Any single attack could affect only a limited number of people. Multiple simultaneous attacks, as in preparation for a nuclear attack, would increase the likelihood of detection and consequent loss of the element of surprise.

3.46 Next, consider the overt attack. In such an attack, the enemy would probably try to create and disperse large clouds of pathogenic organisms. Several known natural phenomena indicate that this is possible. In an incident in Donora, Pennsylvania, fumes from chemical plants accumulated in the atmosphere in sufficient concentration to cause several deaths. The smog situation in Southern California is serious, and there are reports of similar situations from the industrial areas of Europe. These occur when a peculiar atmospheric condition called a "temperature inversion" causes a layer of cool air to be trapped below a layer of warm air, and we fail to get the normal vertical currents that cause smoke and fumes to dissipate. According to data accumulated on smogs, it appears that particles up to about 10 microns in size will float around in such an area indefinitely. These studies also show that the air is capable of holding approximately 500,000 such particles per milliliter of air. An enemy could prepare an aerosol with similar-sized BW agents, and such an aerosol would be stable in effective concentrations.

3.47 That such aerosols are physiologically effective has been shown by investigators who have demonstrated and confirmed data showing that although particles from 5 to 10 microns in size are largely removed in the upper respiratory tract, where they may be discharged through the nasal passage, spit out, or swallowed, articles from 0.25 to 5 microns are largely held in the alveoli of the lungs, with 90 to 100 percent of the 1-micron particles inhaled being retained. Aerosols have been reported capable of producing infections such as influenza, Q-fever, tuberculosis, anthrax, glanders, undulant fever, tularemia, psittacosis, and others.

3.5 PROTECTION AVAILABLE TO USERS. The fifth requirement for a suitable agent imposes on the user the ability to protect himself from his own weapon. Unless the user has developed immunizing or therapeutic agents, he must rely for this protection on distance and, in special instances where he cannot avoid contact with the BW agent, on masks and protective clothing. Since the user would know the precise time, place, agent, and dispersal method, he could easily protect himself.

3.6 IMMUNITY. The sixth requirement for a BW agent brings us to a consideration of immunity. A high immunity to an agent can preclude its use against us. The body's ability to combat infection is called resistance or immunity and is due to a combination of factors. Immunity is divided into two principal types: "natural immunity", that with which we were born, and "acquired immunity", at gained since birth.

3.61 The skin and mucous membranes provide the first defensive mechanism of immunity. The second line of defense is the "cellular system", where special cells or phagocytes of the connective tissue appear at the site of invasion and attempt to engulf and digest the foreign body. If the infective agent penetrates past these cells, it encounters larger lymph cells in the lymphatic tissue, which constitute the third barrier. The fourth line of defense, the blood, contains leucocytes, or wandering phagocytes, and antibodies. Leucocytes engulf the bacteria and eliminate the products through the kidneys, etc. These barriers constitute our natural immunity.

3.62 There are two types of acquired immunity -- "actively acquired immunity" and "passively acquired immunity". Actively acquired immunity results from direct contact with a microorganism or its toxin, either through natural infection or through vaccination. Smallpox and tetanus toxoid vaccinations are the most common examples. Immunity following infections or vaccinations is called active immunity. It is built up slowly, but it will last for years. Large numbers of microorganisms such as would be found during BW attack Ly overwhelm our natural immunity.

3.63 "Passively acquired immunity" is gained by using antibodies produced by another and offers immediate, but temporary, protection. The widespread use of serum globulin for preventing measles and polio is one practical application of this phenomenon. The serum must be administered before the disease manifests itself the body.

4. CHARACTERISTICS DESIRABLE IN BIOLOGICAL WARFARE AGENTS. Having considered what might be called basic requirements let us look at a few features an enemy would regard as particularly desirable.

4.1 DIFFICULTY OF DETECTION. BW agents are difficult to detect because when present they are usually in such small quantities that they are not recognized until they have produced a biological reaction of some sort. Even then we may have to resort to slow isolation and biochemical techniques to identify them. Detection and identification will be discussed in more detail later.

4.2 PREDICTABLE PERSISTENCE. The second desirable feature is that the user should be able to predict the persistence of an agent in a contaminated area. For example, he could not use a spore-bearing agent in an area that he intended to occupy within a few days. Light, moisture, and temperature, with oxygen playing secondary role, all have an effect on persistence. Microorganisms have no regular digestive tract as we know it, and must have a moist environment in which to grow. Drying, salting, and freezing are effective methods of withholding this moisture, and we have long made use of them in preserving food. Lyophilization, mentioned in paragraph 3.33, above, is a combination of two of these that has come into recent use. None of these operations kills all bacteria when properly handled, but the agent receives a considerable shock in being dried and, once it is moistened again, it must rapidly be given a desirable environment, or it dies. The enemy would want to use an agent that would be successful under the moisture conditions existing at the place of attack, and to be able to predict its persistence under those circumstances.

4.21 Ultraviolet light in the range of 2,000 to 2,800 Angstrom units (especially that of 2,600 to 2,700° A) is effective in killing microorganisms. Sunlight gives off rays within this range; and if BW agents were spread over large areas, the most effective decontaminants would be time and sunlight. Again, the enemy would want to know how long this required.

4.22 If properly prepared microorganisms are maintained in a frozen condition, they survive for long periods of time. As the temperature goes above freezing, they die at increasing rates unless they find themselves in favorable surroundings and begin to multiply. The enemy would want to know how long those of his agents that did not encounter favorable temperatures would survive.

4.3 MULTIPLE CHANNELS OF INFECTION. The third desirable property of a BW agent is its capacity to infect through more than one portal of entry. Ordinarily, organisms of a given group enter their host by only one channel of infection. Any that gain entry in more than one way, either by reason of their natural properties or as a result of special circumstances brought about by the enemy, would be especially valuable to him. At this point let us run briefly over the ways in which microorganisms or their products can reach those they attack.

4.31 NATURAL PORTALS OF INFECTION. Diseases are usually contracted through the digestive tract, through breaks in the skin, or through the respiratory tract.

4.32 The food- and water-borne diseases, such as cholera and typhoid fever, are often the first diseases thought of when BW is mentioned, but the infectivity of the agents of these diseases is not always predictable. Moderately effective vaccination is also widely employed against them. The toxins of *Clostridium botulinum* or *Staphylococcus* might be much more effective by the oral route.

4.33 The vectorborne infections are those transmitted by arthropods such as lice, fleas, mosquitoes, ticks, etc., and are usually introduced through the skin. This group is of particular interest because infected arthropods could be used to transmit organisms too delicate to be dispersed as an aerosol. This group includes diseases caused by bacteria and viruses, the rickettsial diseases, and many of the protozoan infections. These are of potential importance.

4.34 The airborne group is the largest group and probably the most dangerous. Clinical studies on epidemiology of infections occurring in hospitals with hemolytic streptococci, pneumococci, and diphtheria bacilli suggest the great practical importance of the airborne route of infection.

4.35 Certain of the organisms that normally belong in one of the above groups can under some circumstances operate in more than one way to cause infection. This may be especially true when they are dispersed as aerosols. Experiments have shown that viable microorganisms so dispersed can be recovered many hours later. Quite conceivably, organisms that are usually foodborne could cause infection when inhaled as aerosols and those we consider as airborne could settle on food in such numbers as to be dangerous.

4.4 AGENTS AGAINST ANIMALS AND PLANTS. Foreign pathogenic organisms appear as the agents most likely to be used as weapons in an attack on animals or plants. Unusual organisms which can be employed as biological weapons against man are fewer in number, and it is probable that the common species will be favored. However, all of the lower forms which will attack both man and animals have potential BW characteristics, since they have two possible targets, and a large number of secondary human cases might follow an epizootic (epidemic among animals). In the list of animal infections where man may be involved are such diseases as brucellosis, anthrax, glanders, Rocky Mountain spotted fever, tularemia, and plague. For many of them, eradication or control within the animal population is the only effective method of preventing human infection. Veterinarians and inspectors of meats and other animal food products may be the first to see the initial indication of antianimal BW.

4.41 Pathogens or pests suitable for BW attack against plants could be either of foreign origin or those confined to limited areas in this country. To be most effective, BW agents against plants should be capable of severely damaging important crops with no immediately available control

measures. They must also be capable of persisting, accumulating, and spreading under our prevailing climatic conditions, since serious losses would be expected only after several years of spread. A number of diseases and insects meeting these requirements can be used against each of our important field crops such as corn, wheat, oats, cotton, potatoes, and so forth. Losses caused by the introduction of several pathogens and pests might have serious attritional effects and might curtail the ability to export food and materials of plant origin. Partial crop failures might be brought about by a BW attack, but starvation or serious privation of any substantial part of our continental population would not be anticipated.

5. DISSEMINATION OF BIOLOGICAL WARFARE AGENTS. There are many methods easily adaptable for intentional dissemination of organisms pathogenic to man. Bombs or spray tanks could create clouds of the biological material over limited targets or to blanket wide areas. Aircraft, balloons, submarines, and surface vessels could launch similar attacks using a wide variety of devices. Saboteurs could directly contaminate air, water, and food supplies. If covert biological attacks are attempted, water, food, or air in ventilating systems would seem to be vehicles of choice. Overt attacks could probably be launched by dissemination of agents from aircraft or watercraft by aerosol spraying devices, generators, or bombs.

5.1 Animal diseases can be introduced and spread secretly, with little chance of detection, through feeds, biologics, raw garbage, and perhaps even by infected wearing apparel of man. While BW agents could probably be successfully spread among animals by aircraft, it is more probable that clandestine methods would be used. The ability of an enemy to utilize wild animals should not be overlooked.

5.2 Plants and crops can be attacked with exotic pathogenic spores used in overt methods of mass inoculation or in covert methods of establishing small foci of infection initially, with the expectations of producing serious disease or insect problems subsequently.

5.3 The probable priority of a given method of dissemination which would be assigned by an enemy is conjectural. It would depend upon the extent to which the engineering problems can be solved, and the suitability of the procedure for various agents and targets. The efficiency of each method and its practicability would have to be appraised by a potential enemy on the basis of the estimated effectiveness, the risks involved, and the cost as compared with more conventional weapons. The wide choice available to an aggressor prevents any accurate appraisal of the threat and forces the defense planning to consider every contingency.

5.4 Covert attacks appear to be the major threats for animals and plants. Overt actions, particularly in combination with other weapons, seem to be the most likely hazard for the general human population, although covert methods could be used very effectively against key groups or industries. The ability to utilize unusual portals of entry for the introduction of pathogenic organisms or their toxic products is an important element in planning attacks on man but is believed to have only limited value for animal and plant targets. Secondary spread after introduction of the agent, while not so important in BW directed at humans, is a prime essential for insuring the success of a BW attack on animals or plants. Widespread secondary transmission among animals would create serious problems, magnified by the shipment of stock to and from market centers. In the plant field, large geographic areas might be infected by airborne spores from scattered foci. In

the latter instance, timing would be very important since weather conditions have a direct and critical effect on the success of the operation.

6. RECOGNITION OF A BIOLOGICAL WARFARE ATTACK. To withstand BW attack, it is essential to know quickly when, where, and what agent was used. These will be difficult questions to answer in time to initiate countermeasures. Further complications may arise through the enemy's ability to attack in a great variety of ways, either covertly or in combination with other weapons.

6.1 The problem is made more difficult by the fact that BW agents are invisible, odorless, tasteless, and produce no immediate physiological effects, requiring incubation periods of two to fourteen or more days. This is in contrast to chemical warfare agents which produce immediate physiological effects and can be identified by chemical reactions.

6.2 An ideal solution would be a relatively simple apparatus, for routine automatic or semi-automatic operation, which would immediately detect unusual amounts of biological organisms in the air. Intensive research is being conducted in this field, and two or three promising avenues of development have been indicated. However, there is no satisfactory device presently available.

6.3 After an overt attack has occurred, it might be inferred by noting any of the following suspicious items or circumstances:

- (1) Enemy aircraft dropping unidentified material or spraying unidentified substances.
- (2) New and unusual types of bombs, particularly those which burst with little or no blast.
- (3) Smokes and mists of unknown source or nature.
- (4) Unusual substances on the ground or on vegetation and any unexplained containers, such as glass bottles or other breakable containers, lying around.
- (5) An increased occurrence of sick or dead animals, such as dogs or livestock.
- (6) Unusual or unexplained increase in the number of insects, such as mosquitoes, ticks, or fleas.
- (7) Any weapon not seeming to have any immediate casualty effect.

6.4 Water, food, or surfaces may be contaminated by the BW agent, either by saboteurs or incidental to a cloud attack, but the detection, and particularly the identification of specific organisms, can only be accomplished by laboratory procedures. Such identifications are especially

important in determining proper treatment and care measures as well as possible immunization programs. Normal laboratory procedures are time-consuming, requiring days or even weeks in some cases. New developments in techniques utilizing fluorescent antibodies have shortened the time from days down to hours for some agents. Continued research is extending these techniques to additional diseases, but the problem is complicated by the number of possible agents and the necessity for providing equipment and developing the technical capabilities in a large number of public health laboratories.

6.5 Until satisfactory physical or biological methods for environmental sampling have been developed, man himself remains the most reliable detector of agents aimed at him. The occurrence of an unusual disease or of an epidemic, therefore, may be expected as the first indication that a BW attack has been made. Prompt reporting, followed by epidemiological investigations, is the only practicable approach to this problem.

6.51 No new pattern is required. Individual physicians must rely upon the local health department and other laboratories for diagnostic assistance. State health departments will support the local efforts and can call upon the Public Health Service for assistance. The Epidemiological Intelligence Service of the Public Health Service, with its cooperating elements with the State and local health departments, provides an existing framework around which this program can be built, but the network must be expanded and strengthened at all levels. Development of qualified diagnostic laboratories through the country is an important part of any such program.

6.52 Similarly, the reporting system for outbreaks of infectious diseases headed by the Public Health Service's National Office of Vital Statistics must be further strengthened. The system must insure prompt and accurate reporting of diseases by states and municipalities and circulation of significant information as widely as possible, even under the handicaps of unorganized communications during a nuclear attack situation.

7. PHYSICAL PROTECTION. The problem of protecting humans against airborne BW agents is principally one of air filtration, since the organisms are carried in particles -- either liquid or solid.

7.1 Ideal protection for the individual is a suitable filtering mask. Offices of Civil and Defense Mobilization and some States have limited stocks of the CDV-800 Protective Mask. This is intended for use by civil defense operational personnel who must continue to perform their duties under attack. The mask was developed by the Army Chemical Corps and affords protection equivalent to the military mask, including protection against chemical agents.

7.2 For general civilian use, the Army Chemical Corps is completing development of a lighter mask for Office of Civil and Defense Mobilization. It affords the same protection as the CDV-800 but is less rugged and not as suitable for continued wearing under operational conditions. Office of Civil and Defense Mobilization plans contemplate development of production facilities and ultimate sale of masks to the general public through commercial channels.

7.3 In the absence of these masks, various types of dust respirators, such as those used for paint spraying or for wearing in dusty atmospheres, might be expected to give variable but limited protection. Also, experiments have shown that breathing through such expedients as a man's cotton

handkerchief (8 layers), bath towel (2 layers), or toilet paper (3 layers) would remove 85 to 90% of the organisms in an aerosol. It is evident that practical application would be limited.

7.4 Collective protection, that is, for people in groups, is feasible but expensive. Filter units which protect against BW and CW agents are available and have been incorporated in the ventilating systems of a number of facilities. This protection is especially important in emergency facilities such as operational headquarters, control centers, and agency relocation centers. In order to permit entrance and exit of personnel during an attack air-locks and personnel decontamination facilities must be provided. The current national shelter policy, which requires a provision of fallout shelters in all new Federal buildings, also prescribes that provision will be made for later installation of BW and CW filters. Such protection should also be considered in any program for the construction of mass shelters.

7.5 For the general population, ordinary unsealed rooms, structures, and buildings would afford some protection during the passage of an aerosol cloud or mist. However, if the concentration of the agent is high, there will probably be a later indoor buildup. For home shelter areas, a "diffusion" board developed by the Army Chemical Corps shows promise. Basically, it is a porous wall-board incorporating activated charcoal and thereby affording protection against CW agents as well. Relying on diffusion to permit the escape of carbon dioxide and moisture from the shelter area, it avoids the problem of forced ventilation which would require an uninterrupted power supply.

8. DECONTAMINATION. Decontamination of extensive areas is not considered practical. Rather, natural decay, assisted by sunlight, temperature and air movement must be relied on. Disinfection of enclosed spaces is feasible, using such materials as formaldehyde, carboxide or betapropiolactone. The process requires several hours, plus additional time for ventilation before the space can be reoccupied. This expedient would also be applicable to supplies in storage, including canned food but might be dangerous to food in other types of sealed containers, such as plastic or paper.

8.1 Personnel exposed to a suspected BW agent must wash their faces and hands as quickly as possible, and bathe completely using plenty of soap and water, as soon as the situation permits. Clothing should be washed, preferably with boiling plus a good soaping, before being worn again. Decontamination of bedding, towels and other items associated with the body is essential.

8.2 Unopened cans of food should be scrubbed with soap and water, or cleaned with a household disinfectant such as bleach before opening. All other food should be thoroughly cooked, avoiding contamination during preparation and serving. Drinking water must either be boiled or chlorinated.

9. SANITARY MEASURES. The sanitary measures employed to minimize the spread of naturally-occurring diseases under disaster conditions constitute important general countermeasures to BW.

These include:

(1) Provision of safe water supplies including the restoration of water systems.

(2) Maintenance of satisfactory milk, food, and drug supplies.

(3) Control of sewage and waste disposal facilities.

(4) Control of insects and rodents.

10. IMMUNIZATION: Commercially produced vaccines are not available for many potential BW diseases, such as the dysenteries, some encephalitides, brucellosis, glanders and fungal diseases. The potential role of vaccines in BW involving tuberculosis, rabies and gas gangrene is unknown. Experimental vaccines of incompletely proved value have been used in the equine and a few other encephalitides or viral diseases, and in psittacosis, but these need improvement. It is probable that the present plague vaccine, which protects against flea-borne infection, will not protect against infection by the respiratory route.

10.1 Animal experiments, and a current anthrax vaccination program in textile mills, strongly suggests the anthrax vaccine, developed by the Army Chemical Corps and in England, will afford significant protection; this vaccine has been successfully adapted to commercial methods of production, as have the botulinum toxoids.

10.2 The value of typhoid and cholera vaccines is questioned by some authorities. For the rickettsioses, of which typhus and Rocky Mountain Spotted Fever are typical, there either are vaccines or it seems likely that an effective vaccine can be made. The most clearly effective immunogens are the toxoids, and the vaccines for yellow fever and smallpox.

10.3 Combination of several vaccines into one fluid preparation has been demonstrated to be practical, by contract with a commercial pharmaceutical company. This is comparable to the progress being made in combined pediatric vaccines. More work along this line is desirable. A tularemia vaccine of living avirulent organisms, administered subcutaneously, has been shown to be more effective in protecting volunteers against respiratory challenge than a killed vaccine. The Office of Civil and Defense Mobilization stockpile includes limited supplies of serums and vaccines.

10.4 The possibility of BW attack accompanying or following a nuclear attack introduces another consideration. Whole body radiation in excess of 125 roentgens disrupts the body's immune responses, to the extent that immunization procedures begun after irradiation may be ineffective. The significance in planning for immunization in advance of the emergency is evident.

10.5 In general, there is an inadequate program for research, development and testing of vaccines in animals and man under conditions similar to those that might be encountered during BW.

11. MEDICAL TREATMENT. Medical treatment of people infected during biological warfare would be no different from treatment for those same diseases incurred during peacetime, except for complications induced by possible

(1) deliberate use of antibiotic-resistant strains (2) deliberate use of mixed agents (3) concomitant radioactive fallout (4) reduced bodily resistance to infection if disorganization of public services

occasioned degrees of hunger, cold, wetness and exhaustion (5) unfamiliarity of physicians and diagnostic laboratories with the diseases and microorganisms, and (6) unusually large numbers patients. Masked symptoms due to infections occurring through an unusual portal of entry. Little has been done in regard to determining the effect of such variables and stress-factors. Considering the above situation, it would seem that (1) chemoprophylaxis, that is, advance medication, would be inadvisable except in special situations where delay in onset of symptoms was essential to permit accomplishment of a specific mission of limited duration, (2) administration of antiserums would be impractical if for no other reason than that a completely inadequate supply for mass use exists, (3) treatment with broad spectrum antibiotic would be preferable.

11.1 Adequate stockpiles of broad spectrum antibiotics are attainable and would constitute the best single move that could be made to significantly reduce the impact of infectious diseases regardless of how the outbreaks may be initiated. Experience with laboratory infections, personal experience of physicians in hospital and private practice, and survey of the literature indicates considerable variation is possible, such as: (1) No available specific treatment for the viral encephalitides and fungal diseases, (2) poor results in pneumonic plague, pulmonary anthrax, and in the illness caused by specific toxins, (3) mediocre results in brucellosis and gastro-intestinal diseases, (4) excellent results with antibiotics for the rickettsioses such as Rocky Mountain Spotted Fever, typhus fever and Q fever, as far as reduction of mortality and number of days of incapacitation are concerned. The Office of Civil and Defense Mobilization stockpile also includes limited supplies of antibiotics and sulfa drugs; BW defense requirements for these, as well as serums and vaccines, are taken into account in reviews of the stockpile program.

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GLOSSARY OF TERMS

Definitions contained herein define words and terms as used in planning to meet biological warfare situations, and are not intended to define the words and terms for all usage.

ACQUIRED IMMUNITY:

Immunity acquired by the individual during his lifetime. It may be "actively acquired" from direct contact with a microorganism or a toxin either upon a natural infection or through vaccination. "Passively acquired" immunity is acquired by using antibodies produced by another, and offers only temporary protection.

AEROSOL:

A suspension of very small particles, either liquid or solid, in air. The particles are so small, less than 10 microns in diameter, that they remain suspended for considerable periods of time instead of settling out. Aerosols are an important form of dissemination for both BW and CW agents.

Common examples of aerosols are those produced by household atomizers, DDT bombs, and garden dusters.

ANTIBIOTIC:

Substances produced by and obtained from living cells, usually those of lower plants, such as bacteria and molds; they are antagonistic to other forms of life, including pathogenic organisms. Examples are penicillin and streptomycin. Some may also be produced synthetically.

ANTIBODY:

A specific substance produced by the body in reaction to a specific foreign body (antigen), such as bacteria and toxins; examples are antitoxins and agglutinins.

ANTIGEN:

Any substance which when introduced in the body stimulates the formation of an antibody. Antigens are usually protein in nature and react in an antagonistic manner with specific antibodies.

ANTISERUMS:

Serums containing an antibody or antibodies. It may be obtained from an animal subjected to an antigen either by injection or as the result of an infection.

ANTITOXINS:

A substance found in the blood serum or other body fluids which is specifically antagonistic to a toxin.

ATTACK:

Any act or series of acts by an enemy of the United States causing substantial damage or injury to property or persons in the United States in any manner by sabotage or by the use of bombs, shellfire, or atomic, radiological, chemical, or biological means or other weapons or processes. Overt attack is any open attack. Covert attack is an undercover attack, that is, sabotage.

AVIRULENT:

Not virulent.

BACTERIA:

Minute one-celled microorganisms which have no chlorophyll and multiply by dividing (fission).

BIOLOGICALS:

Pharmaceutical products of animal origin, capable of conferring an immunity by virtue of contained antibodies. A general term used to include vaccines, antiserums, toxoids, etc.

BIOLOGICAL WARFARE (BW):

The intentional employment of living organisms, toxic biological products and chemical plant growth regulators to produce death or casualties in man, animal, or plants.

BIOLOGICAL WARFARE DEFENSE:

Steps taken to prevent or minimize the effect of biological warfare attacks. These measures may include warning, detection, identification of agents, physical protection, decontamination, immunization, and treatment of casualties.

BROAD SPECTRUM ANTIBIOTICS:

Antibiotics which are effective against a number of infectious agents, rather than being specific to a few.

CASUALTY:

A person sick or injured and needing treatment, or one killed.

CHEMOPROPHYLAXIS:

Use of chemicals after exposure to a disease to prevent or minimize symptoms.

COLLECTIVE PROTECTORS:

Filtering devices for purifying all air entering an enclosed space. These include a filter for removing particles and beds of activated charcoal for removing gases. They may be fitted with self-contained blowers or incorporated in the ventilating system of the facility.

CONTAGIOUS DISEASE:

An infectious disease capable of being transmitted from one individual to another either directly or through an intermediate animal host, vector, or the environment. Synonymous with COMMUNICABLE. Many infectious diseases are not contagious but require some special method of transmission or inoculation.

CONTAMINATION:

The condition resulting from the deposit of radioactive material, biological warfare agents, other disease-producing agents, or chemical warfare agents in or upon structures, areas, bodies of water, personnel, and objects, or from failure of normal sanitary safeguards. Includes food, water and medical supplies which may be contaminated with disease-producing agents as a result of an attack.

OVERT:

Hidden, concealed. Covert attack refers to the stealthy employment either of accepted methods or of unusual or sabotage methods which might be used before or after the actual outbreak of hostilities. (See OVERT).

DECAY (OR BIOLOGICAL DECAY):

The rate at which infectious organisms become non-infectious or die under unfavorable conditions of light, temperature, or humidity. The decay rate is a major factor influencing stability and persistence of BW agents.

DECONTAMINATION:

The process of reducing the personnel hazard associated with an object or area by absorbing, destroying, neutralizing, making harmless, or removing chemical, biological, radiological or toxicological agents clinging to or around it.

DETECTION:

The determination that BW agents are present in the air, on surfaces, or in water or other materials.

DIFFUSION BOARD:

A wall-board like material capable of incorporation in home shelters. The material filters out particles and contains activated charcoal for removal of gases. It relies on diffusion for movement of air in and out, and for removal of carbon dioxide and water vapor from the enclosed space, avoiding the necessity for forced ventilation.

DISINFECTION:

To free from pathogenic organisms or to destroy them.

EPIDEMIC:

A regional outbreak of an infectious disease which attacks many persons and spreads rapidly.

EPIDEMIOLOGY:

The study of disease outbreaks in an attempt to identify the source, determine the extent, and the probable mode of transmission and control measures.

EPIZOOTIC:

Any disease of animals which spreads rapidly and is widely diffused.

FLUORESCENT ANTIBODIES:

Antibodies stained with a dye which causes them to fluoresce (glow) when viewed under ultra-violet light. Each fluorescent antibody is specific for a particular antigen. Use of fluorescent antibodies is one technique for rapid identification of certain microorganisms.

FUNGI:

A group of plants including the molds, mildews, rusts, smuts, and mushrooms; they do not contain chlorophyll and reproduce mainly by sporulation.

HEALTH SERVICES:

Medical and dental care in all of their specialties and adjunct therapeutic fields; and the planning, provision, and operation of first aid stations, hospitals, and clinics; preventive health services, including detection, identification and control of communicable diseases, their vectors, and other public health hazards; inspection and control of purity of food, drugs and biologicals; food and milk sanitation; public water supplies; sewage and other waste disposal; registration and disposal of the dead; prevention and alleviation of water pollution; vital statistics services; preventive and curative care related to human exposure to radiological, chemical, and biological warfare agents; and rehabilitation and related services for disabled survivors.

HOST:

Any animal or plant which harbors or nourishes another organism.

IDENTIFICATION:

Identifying the particular BW agent present after it had been detected.

IMMUNITY:

Ability of living individuals to resist or overcome infections.

IMMUNIZATION:

The process of conferring immunity on an individual.

IMMUNOGENS:

A proprietary bacterial antigen said to be free from bacterial cells and toxin, and containing only exotoxins (a toxin excreted by an organism into the surrounding medium).

INCAPACITATING:

Rendering an individual incapable of performing his usual duties or functions, as distinguished from lethal.

INFECTIOUS DISEASE:

One which is caused by a living agent, such as bacteria, protozoa, viruses, or fungi; may or may not be contagious.

INOCULATION:

To introduce a microorganism, vaccine, immunizing serum, or other antigenic substance for preventive, curative, or experimental purposes.

LEUCOCYTE:

A white or colorless corpuscle; an ameboid cell which is found in the blood, lymph, and body tissues and which forms the chief cellular element in pus. One of the body defenses in overcoming infection.

LYOPHILIZATION:

The process of drying from the frozen state under vacuum.

MICRON:

A unit of linear measurement used in connection with the size of particles. One micron is equal to 1-1/1000 of a millimeter, or approximately 1/25,000 of an inch.

MICROORGANISM:

A minute living organism, usually microscopic in size.

NATURAL IMMUNITY:

A type of immunity with which an individual is born, enabling him to resist infection without first having the disease.

OVERT:

Open; manifest. Overt attack implies the adaptation and use of principles and methods of attack and use of weapons and munitions previously developed, known, and commonly accepted in warfare. (See COVERT).

PANDEMICS:

Widely epidemic, affecting or attacking all or most of the population of a region.

PARASITES:

Plants or animals which live upon or within another living organism at whose expense it grows without giving anything in return.

PATHOGENS:

Disease-producing microorganisms.

PHAGOCYTE:

Any cell that is active in ingesting and destroying waste and harmful bodies in the blood or tissues.

PHYSICAL SECURITY:

Security against sabotage, espionage, and other hostile activities, destructive acts and omissions, but excluding security attributable to operations of military defense.

PROPHYLAXIS:

Preventive treatment.

PROTECTIVE CLOTHING:

Specialized clothing to prevent contact of BW or CW agents with the skin. There are two types: impermeable, which is air tight; and permeable, treated with a material which destroys or neutralizes the agent, but still allows the passage of air.

PROTECTIVE MASK:

A mask completely covering the face for protecting the respiratory system and eyes from BW and CW agents. It normally includes a filter for removing particles, and activated charcoal, either incorporated in the filter or in a canister, for removing CW agents from the air.

RESISTANCE:

The ability of the individual to ward off infection.

RICKETTSIAE:

One-celled parasitic microorganisms, probably intermediate in size between the bacteria and viruses.

SABOTAGE:

Any action taken deliberately by an agent or sympathizer of one country, coalition, or faction to impede, obstruct, or interrupt normal processes of production, or the regular work of employees, or the scheduled build-up of a war effort within an area controlled by another country, coalition, or faction. The damage resulting from such action.

SERUM GLOBULIN:

Antibodies concentrated by fractionation of human plasma, useful in the prophylaxis of measles and epidemic (infectious) jaundice.

SHELTER:

A specially constructed refuge for protecting people, records, or equipment from the effects of a nuclear attack. May also include protection against BW and CW agents.

SPORE:

Primitive reproductive bodies or resistant resting cells, produced by some plants and some microorganisms.

TEMPERATURE INVERSION:

Increase of temperature of the air with increase of height instead of the usual decrease. This causes a stagnant layer of cool air to be trapped below a layer of warm air, and eliminates the normal vertical currents which tend to dissipate clouds of BW or CW agents. Thus, it is a favorable condition for BW or CW attack.

TOXIN:

Generally any poisonous substance of microbic, vegetable, or animal origin. True toxins are of a proteinlike nature, more or less unstable, require a period of incubation or a latent period to produce symptoms, and induce in suitable animals the formation of specific antitoxins.

TOXOID:

Detoxified toxin, changed so that it is no longer poisonous, but still antigenic and produces active immunity when injected.

VACCINATION:

Protective inoculation with microorganisms, killed or attenuated; against smallpox by inoculation with vaccinia virus. Also any act of protective inoculation with a virus or bacteria.

VECTORS:

Carriers, especially an animal or host that carries a pathogen from one host to another, as the malaria-carrying mosquito.

VIRUS:

A minute infectious agent, smaller than bacteria, capable of passing through filters that will retain bacteria and of multiplying only within a living susceptible host cell.

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