Medical Problems of Atomic, Biological, And Chemical Warfare

Digested by the MILITARY REVIEW from an article by Brigadier A. Sachs in "The Journal of the Royal United Service Institution" (Great Britain) August 1952.

THROUGHOUT history, developments in weapons of destruction have continued to set new medical problems, and it seems likely that this may have occurred even in primitive times. Prior to the introduction of the spear, early man was acquainted only with contused injuries resulting from the blows from a club, and a new medical problem was to deal with the deep lacerated wounds caused by the spear. Later, with the advent of firearms, the removal of deep-seated bullets and shell splinters became, and even today may still be, a difficult problem. The result of the launching of gas warfare in World War I on the unsuspecting allies illustrates the consequences and chaos caused by the absence of adequate preparations for defense against new weapons and for treatment of the resulting casualties. The introduction to atomic warfare by the bursting of the atom bombs over Hiroshima and Nagasaki again serves as an example of the results of this unreadiness.

The weapons used in modern scientific warfare aim at mass destruction, and have created medical problems of a magnitude never previously visualized. It is problematical whether these weapons of mass destruction will in fact be used in the face of the many so-called humanitarian, ethical, and moral objections which have been raised, or, if used against a well-prepared nation, whether much success could be accomplished in the presence of adequate defensive methods.

The medical side of defense in a future war will affect the well being, morale, and possibly even the survival of a nation. If the medical resources of the country are to be effective, there must be full co-ordination between the medical services of both the civil defense organization and the armed forces.

This consideration forms an integral part of planning. It is of the greatest importance that a correct appreciation should be made of the many and various medical problems which are likely to arise when considering defense against special weapons, in order that there is no wastage of medical manpower or medical equipment and drugs.

Civil defense planning before the onset of hostilities must aim at minimizing the effects of modern warfare on the civil population. As a preliminary, arrangements should be made to reduce the number of individuals who may be potential casualties in target areas. One method is that used in the last war—the selective evacuation of mothers and children and others whose presence would not be essential to the national effort. By long-term planning for the dispersal of industries, a further reduction in population densities can be ensured. A firm policy regarding shelters and methods of warning will also help to reduce the number of casualties.

The medical problems arising in a future war will no doubt be influenced to a great extent by atomic, biological, and chemical warfare.

Atomic Warfare

The most obvious targets for an attack with atom bombs are key cities of strategic and industrial importance which are vital to the national effort. Much of the data available on the effects of atom bomb explosions have been derived from the attacks on Hiroshima and Nagasaki and various trials carried out by the United States in certain islands in the

Pacific. Owing to the difference in the structure of buildings, it is not possible to apply the Japanese experience directly to any European city.

It is well known that when an atom bomb explodes, energy liberated in the form of blast, heat, and radioactivity is capable of causing death or injury to the population, structural damage, and contamination of water and food supplies.

The problems facing the medical services after an atom bomb explosion are associated with the treatment of large numbers of injured and with the prevention of further casualties from residual radiation and contaminated food and water supplies. People in a city may be killed or injured by (1) the direct effects of blast, (2) secondary effects of blast resulting from flying debris and shattered glass, (3) flash burns, (4) secondary fires, and (5) radioactivity—either the penetrating gamma rays and neutrons liberated at the time of the explosion or the residual radiation remaining afterward on the ground and in any contaminated food and water supplies.

Blast and Burn Injuries

When British cities were attacked with high explosives and incendiary bombs during the last war, the medical services had to deal with injuries caused both by the direct and secondary effects of blast and burns resulting from fires. After an atom bomb explosion the actual injuries will present no new problems in treatment except when complicated by radiation effects; the new problem will be the magnitude of the numbers of casualties. Some idea of the size of the surgical task facing the medical services can be gathered from the fact that, during the last war, it was shown that it is humanly impossible for one surgical team to carry out more than 12 major operations in 24 hours. It would, therefore, require 84 teams to deal in 24 hours with a thousand serious casualties requiring urgent operations. This will necessitate the availability of teams fully equipped with instruments, dressings, splints, and drugs, which in itself creates a considerable planning problem.

Flash burns occurring at the time of the explosion are peculiar to atomic warfare and were extremely common in the exposed population in Japan. These burns are due to thermal radiation ranging from infrared to ultraviolet rays acting over an extremely brief period of time. If the entire population has taken cover in houses or in shelters before the bomb is released, they should be protected and flash burns should be rare. With an exposed population like that of Hiroshima and Nagasaki, or an army in the field, the circumstances will be different and flash burns are likely to predominate over other types of injury.

The effects of thermal radiation will depend on distances from the center of the explosion, protection afforded by shielding and clothing, and atmospheric conditions. In Japan, flash burns occurred within a radius of 4,000 yards. Those within a 1,000-yard radius of the center of the explosion were so severely burned that the majority died from their injuries. Beyond 3,000 yards, however, the effects of thermal radiation were mild, the injuries on the exposed parts resembling severe sunburn. Between these two distances burns of varying degrees of severity were encountered. Since flash burns occurred only on the surface facing the detonation, shielding and shading by structures afforded protection and reduced the number of casualties. At distances greater than 1,500 yards, loose fitting, light-colored clothing seemed to afford some protection. Mild cases can be prevented by wearing gloves and by covering the face and other exposed parts before the explosion. The minor traumatic injuries and mild burns will outnumber the serious casualties. Skilled medical attention is unlikely to be available for some time to treat these mild cases, since all medical personnel will be fully occupied in dealing with the more seriously injured. It is, therefore, evident that there must be some system of mutual help and first aid. This stresses the importance of the necessity for training the civil population in first aid or at least in its rudiments. A civil population so trained will do much to alleviate the pressure on what will be an overworked and harassed medical service.

Radiation Injuries

Radiation injuries are also peculiar to the atom bomb explosion. There has in the past been a tendency to emphasize unduly the importance of the casualties occurring from radiation injury. Although from the serious nature of the injury sustained, the group is undoubtedly important, numerically its importance is less than that of casualties from the mechanical and thermal effects of the explosion; the relative proportion being 20 percent from radiation and 80 percent from mechanical and thermal injuries combined.

Medical science has long been familiar with the effect of the localized use of radiation for the treatment of cancer, but not with the effects of radiation on the entire body. The clinical effects resulting from radiation depend on the dosage received at the time of the explosion. It is most important that an assessment should be made at the earliest opportunity as to whether individuals have been exposed to radiation and, if exposed, the probable dosage received, in order to separate radiation casualties from others. Attempts to separate the population into these categories may be based on (1) the distance from the explosion, (2) readings from personal monitoring instruments, and (3) symptoms. Each of these three methods has its disadvantage. The absence of knowledge of the amount of shielding, the size of the bomb, the height of the burst, and the effect of terrain and buildings will preclude an accurate assessment based on distance. The personal dosimeter may give a fallacious reading when part of the body is shielded or the dosimeter shielded and the body exposed. An assessment of symptoms is not perfect, as the susceptibility of individuals varies. It was found in the Japanese cases that an early onset of the characteristic symptoms was indicative of exposure to a high dose of radiation. Those whose symptoms developed late were generally assumed to have received a smaller dosage. Indeed, it came to be realized that the earlier the onset of symptoms the worse the chances of recovery.

Three Main Categories

For convenience patients have been grouped into three main categories, namely:

1. *Those receiving a lethal dose of radiation.*—In such cases, severe vomiting and diarrhea came on within 1 to 3 hours and fever and marked wasting developed within 1 week, by the end of which time the majority had died, though some survived for as long as 2 weeks.

2. *Those receiving a large, but not necessarily lethal, dose.*—The onset of symptoms was delayed until the end of the second week after exposure. These consisted of loss of appetite and malaise, diarrhea and some wasting, and loss of the hair. Recovery largely depended on good nursing.

3. *Those receiving a low dose.*—Symptoms of the foregoing type were present to a slight degree after the second week or were entirely absent.

An examination of the blood of casualties by counting the different types of blood cells gives a fair indication of the severity of the illness and a check on its progress. It is the best means of assessing whether a blood transfusion is necessary or not and, if necessary, the amount of blood required. The assessment of the degree of radiation injury and the giving of transfusions are among the major medical problems.

Blood and plasma are commodities even now in short supply and will be in great demand in warfare for the treatment of all the different types of injury, whether caused by the atom bomb or other weapons of destruction. Under ideal conditions, blood cannot be stored for longer than 21 to 28 days, mainly because of degenerative changes in the red blood cells, but the plasma will keep for several years. Plasma is particularly valuable in the treatment of burns, but blood is required for all types of injury where there has been severe blood loss and also for the treatment of cases of injury resulting from radiation. It seems most improbable that sufficient blood and plasma will be available in any country to deal with more than a limited number of atom bomb "incidents."

Research work is being carried out in many countries to discover an ideal substitute for blood and plasma. During World Wars I and II, a number of substitutes for blood were used both by the allies and by the enemy; but all had serious disadvantages. The Swedish product dextran has been used with success in England and the United States, but is still far from the ideal.

World War II demonstrated the size of the organization necessary for the maintenance of an adequate blood transfusion service to meet the needs of the civilian population and the oversea forces. This effort will have to be increased considerably in any future war and, even prior to the outbreak of hostilities, arrangements must be made to have stocks of plasma and blood substitutes available. Training will be essential to ensure that the necessary technicians are available to carry out transfusions, blood counts, and blood grouping.

Residual Radiation

An important task of the medical and health services will be the prevention of further casualties among rescue workers and others as a result of undue exposure to residual radiation or the ingestion of contaminated food and water supplies. The quantity of radiation an individual can stand either externally, or internally from ingestion or inhalation, without harmful effects (either immediate or after the passage of time) is known as the "tolerance dose." This amount is based on an absence of clinical effects to a single exposure or to multiple smaller doses spread over a period of time. Exposures to doses in excess of the tolerance dose are likely to be followed by casualties and consequently constitute a hazard. It is not unlikely that circumstances may arise when it will be necessary to send rescue squads, bodies of troops, or others into a radioactive area, and the amount of residual radiation present may be so high that working in these areas would result in casualties. The decision as to whether parties should be sent into such areas will be the responsibility of the controller or commander on the spot, who will have available tables to indicate the number of casualties which are likely to follow exposure to different doses of radiation. From these and the information available as to the quantity of residual radiation being emitted, he will be able to assess the advisability of exposing individuals to the risk.

Hazards from exposure to radiation are not a new experience. Several years ago the maximum dosage of radiation to which an X-ray worker could be exposed was laid down, and rules were drawn up for the conduct of X-ray rooms to minimize the chance of overexposure and for the regular examination of personnel to detect early physical changes which might result from such overexposure. Radioactive material may be absorbed into the body by inhalation or ingestion and through injured skin surfaces. The effects of radioactivity within the body have been long recognized as an industrial hazard. From 1920 onward, cases of radiation injury occurred in luminous dial painters who moistened with their saliva the tips of brushes which had been dipped in radioactive paint, and also in uranium miners in Czechoslovakia. Radiation injury may thus arise from an external source of penetrating radiation, and from absorption into the body through ingestion or inhalation.

The intensity of radiation given by the fission products resulting from an atom bomb explosion dies down very rapidly. The hazards resulting from residual radiation will vary with the different types of burst. After a high air burst the rising "ball of fire" carries the products of the explosion upward, and the powerful rising air currents produced by the blast and heat disperse this material so effectively into the surrounding atmosphere that only in exceptional circumstances will the radioactive particles falling to earth constitute a hazard. In the case of a low-level ground or underwater burst, however, residual radiation may constitute a very serious problem because of the "fall out" of radioactive material. In assessing the radiation hazards of an area, it is essential to differentiate between remaining in the contaminated area for prolonged periods, and entering it for rescue operations; in the former case the dosage received by an individual remaining in the area for 24 hours may result in serious injury or death, but in the latter that received by walking through the area or remaining there for a short period of, say, 15 to 30 minutes is unlikely to have any harmful effects.

The type of burst also requires consideration when assessing the risk of contamination of food and water supplies. After a high air burst, serious contamination of water supplies in reservoirs or other parts of the water purification system would be unlikely. As mentioned previously, radioactivity resulting from the "fall out" of fission products to the ground would be small, but an explosion at ground level or an underwater burst might produce very heavy contamination in open reservoirs, and might be so serious as temporarily to preclude the use of water for cooking and other domestic purposes. The length of time that the water would remain unusable will naturally depend on the degree of contamination. It will be an important duty of medical officers to evaluate the analysis of water supplies. It should be noted that chlorination and boiling will not destroy radioactivity. This may be removed, however, by the usual processes of sedimentation and filtration. The disposal of radioactive waste from the filtration plant will be difficult, and it may be necessary to bury this waste to avoid contamination of sewers. It should be noted, however, that the normal decay of radioactive particles will rapidly reduce contamination to safe levels in the course of time.

Food is likely to be contaminated after an atom bomb burst, but it can be assumed that tinned or canned food, if the tins are undamaged, and food in sealed packages or in refrigerators can be used provided care is taken to wash off any dust or moisture from the outside of the container. It will be one of the duties of medical officers to help to determine whether perishable or nonperishable foods from stores, markets, and restaurants within the zone of residual contamination are fit for human consumption. The cooking and boiling of food will not destroy radioactivity.

Casualty Estimations

A general survey has been given of the main problems which will face the medical services in atomic warfare, but the magnitude of their task will be better realized when estimations are made of the total number of casualties which are likely to occur after the explosion of an atom bomb of similar power to that used on Japan.

TOTAL CASUALTIES FROM ONE NAGASAKI-TYPE ATOM BOMB ASSUMING A POPULATION DENSITY OF 43 PERSONS FOR EACH ACRE		
TYPES OF CASUALTY	*EVERYONE IN HOUSES*	*EVERYONE IN REINFORCED BRICK SURFACE SHELTERS*
KILLED OUTRIGHT OR TRAPPED IN DEBRIS	30,000	10,400
DELAYED RADIATION DEATHS	1,100	3,900
TOTAL KILLED	31,100	14,300
INJURED NOT AFFECTED BY RADIATION	27,000	1,800
INJURED BY RADIATION	2,500	8,700
TOTAL INJURED	29,500	10,500

3-1602

A recent assessment of casualties for a British city is shown above.

For comparison, separate estimates were made on the hypothetical assumption that the entire population is placed in turn in (1) houses, and (2) reinforced brick surface shelters of the type used during the last war. The effect of shelter is to reduce the number of both killed and injured to less than half of that which would have occurred if all had been inside houses, and to about a quarter of the estimate for an exposed population caught unaware in the open.

The location of the population at the time of the explosion will determine the ratio of the different types of injuries. If the Japanese experience is used as a basis for determining the percentage of the different types of casualties for exposed populations, it may be assumed that, of the survivors, 60 percent will be suffering from burns, 50 percent from traumatic injuries, and 20 percent from radiation injuries (a number of the casualties will be suffering from more than one type of injury). Theoretically, if the entire population is in houses or shelters, there should be no casualties because of flash burns, and 80 percent of the injuries will be of the traumatic type resulting from the secondary effects of blast. The remaining 20 percent of the injuries will be due to radiation and burns resulting from secondary fires.

It is obviously impossible to predetermine the circumstances which may exist at the time of an atom bomb attack. Preparations are likely to prove inadequate if these are based only on the supposition that every one will be in reinforced brick shelters. Most likely there will be a combination of different circumstances. It does, however, appear that an estimate of casualties based on the assumption that the entire population will be in houses can provide a satisfactory basis for assessing the medical problem. The data available on the types of casualties produced during the bombing of cities in the last war are a valuable guide for calculating the possible proportion of the seriously injured who will require urgent surgical treatment.

Although this article has primarily assessed the medical problems from a civil defense point of view, the general principles are equally applicable to an army in the field where the question of sheltering will be of great importance.

Biological Warfare

Biological warfare is a weapon as yet untried in war, and one for which the most extravagant and unrealistic claims have been made. This type of warfare may be defined as the dissemination of living germs or their poisonous products (toxins) to cause death or disease in humans, animals, or plants. Assuming that man will be able to use biological warfare as a weapon—and there is by no means any certainty of this—it is theoretically possible that sickness can be spread deliberately among selected groups of a community and lead to disruption of industry, chaos in the everyday life of a nation, and disorganization of a force. If attacks were directed against animals and crops, they could lead to serious food shortages.

A number of statements have appeared in the press in recent years about the horrors of biological warfare and the terrible nature of this weapon. However, when the pros and cons are examined impartially, would the use of this weapon really be so inhuman? It is a weapon which is only effective against living things, and which does not cause structural damage. Therefore, its use is not attended by the destruction and devastation caused by *V* weapons and conventional incendiary and high explosive bombing, from the effects of which this country is still suffering.

Is a direct attack on man with a biological warfare agent, which still leaves him with the resources of modern medicine as a countermeasure, any less humane than an attack by explosive, fire, or bullets, let alone the atom bomb?

The concept of biological warfare is not new. Man in his age-long struggle has been continuously on the defensive against biological warfare waged by nature. He has had to develop a defense against insidious attacks which in the past have led to epidemics like the Black Death in the fourteenth century, when about a third of the population of Europe perished; the Plague in the seventeenth century, which disrupted the life of London; and, in more recent times, the influenza epidemic in 1918, which caused more deaths in a matter of months than did bullets and shells in the 4 years of war. In past centuries the louse, by spreading typhus; the rat and flea, plague; and the mosquito, malaria and yellow fever, had a greater bearing on the course of campaigns than generalship. Up to World War I, deaths from disease in war far outnumbered those from firearms.

To wage biological warfare successfully, man must adopt the mantle of nature. However, it is evident from the present-day spread of diseases, such as infantile paralysis, influenza, measles, and foot and mouth disease, which cannot be prevented, that scientists have much to learn before they can emulate nature. Bacteriological research must be intensified to ensure that defensive measures are so satisfactory that it would be impossible for biological warfare to be waged successfully. Such research must also be directed to a study of the mechanism of the spread of epidemics.

Defensive measures against biological warfare agents must be based on the fundamental principles of public health for preventing the spread of disease. It, therefore, follows that any country which has a well-organized public health service also has available the nucleus of a defense organization which can be adapted to meet unnatural outbreaks of disease; but planning must be integrated with any general defensive plan.

The first requisite in any scheme for defense is the provision of adequate facilities for the detection and identification of biological agents. The identification of germs is at present a highly skilled and laborious procedure. Specially fitted laboratories, staffed with trained bacteriologists and technicians, are necessary. It is obviously desirable that efforts should be made to speed up techniques so that possible biological warfare agents can be identified rapidly.

Humans and animals can only be infected by three routes, namely: *inhalation* from the air, for example, the common cold; *ingestion* of infected food or water, for example, typhoid and dysentery; and through *the skin surfaces and mucous membranes*, for example, tetanus by development of infection in a wound, or malaria from the bite of a mosquito.

The *first line of defense* is, as always, the prevention of the infecting agent from reaching the victim. The gas mask will afford physical protection not only against the inhalation of chemical but biological warfare agents as well. Clothing impregnated with certain repellant chemicals did much to minimize the number of casualties from scrub typhus in Burma and Malaya; this is another type of physical protection. Food and water supplies are always likely to be infected either accidently or deliberately. These vehicles of infection are those obviously likely to be used by a saboteur. Water discipline as practiced in the Army and the consumption of well-cooked, hot food should do much to minimize the risks from these sources.

However, there is always a possibility that these barriers to infection may break down, and allow the infecting agent to find its way into the body of the victim. This necessitates a *second line of defense*, namely, preventing the development of disease once infection has taken place. This is done by increasing resistance and is generally referred to as immunization. This can only be carried out when sufficient time is available and the probable infecting agents known. It is a long-term policy, and the immunization of a large population (known as mass immunization) against a number of diseases is practiced in the services. Basically, every serviceman is protected against smallpox, typhoid fever, diphtheria, and tetanus. When at special risk he is also inoculated against cholera, plague, and typhus. A potential enemy naturally will not use an agent against which a community is likely to be protected. It is improbable, however, that the state of immunization in the civilian population can be as satisfactory as that in the services.

It is, therefore, necessary to have a short-term policy, available for use after an agent has been identified, when infection is likely to occur among nonimmunized persons. This is the practice adopted for the protection of contacts of infectious disease.

Finally, if these prophylactic measures fail and disease does develop, it is essential that the resources of modern medicine are available to reduce the time of disability to a minimum.

To summarize: medical problems in biological warfare will include the rapid detection and identification of agents used; the protection of individuals by immunization, when time permits and possible agents are known; the prevention of the development of disease once infection has occurred; and, finally, the treatment and cure of the stricken.

Chemical Warfare

Since World War I, developments in the field of chemistry have been overshadowed by those in physics, particularly nuclear physics. This has led to the development of an outlook in which the potentialities of chemical warfare have tended to be ignored or forgotten. Although chemical warfare was not used during the last war, it must not be assumed that this type of warfare will not be used in the future. After their defeat it was discovered that the Germans had available large stocks of the older-known types and of some new types of chemical warfare agents.

It is not known definitely why Hitler did not use chemical warfare against this country. A probable explanation is that the enemy was aware that, owing to the state of preparedness for defense against this type of warfare by the agents then available, any attack was likely to be unsuccessful or only partially successful. Further, he probably hoped to win the war without the use of chemical warfare and the odium which would follow. Later, however, when the new agents were available, he had lost air supremacy, and the opportunity for the use of chemical warfare had passed. It is, therefore, obvious that the potentialities for a successful attack with chemical agents must depend directly on the state of preparedness of the nation or services. These preparations must ensure that the medical profession has adequate knowledge and training for the prevention or early treatment of casualties.

The study of chemical agents, whether used for the destruction of man or to cure his ills, or whether to destroy plants or insects or to fertilize the ground, follows certain basic principles. Physical properties, such as stability, solubility in water or other fluids, and the effect of temperature, must be ascertained. The physiological and pharmacological action on man and animals must be determined, so that the requisite knowledge is available as to how the substance works. The effects of different doses, including those which have harmful or toxic effects, must be investigated and antidotes be prepared to combat them.

Most of us have heard of the important chemical agents used in World War I—chlorine, phosgene, mustard, and lewisite. A great deal of research into the action of these agents on man and animals, and the best means of treatment of casualties caused by them, was carried out during the inter-war years.

It is interesting to note that during the investigation into some derivatives of mustard gas, it was found that nitrogen mustards appeared to have a therapeutic action on certain types of blood disease, and further research is now being carried out into this beneficial use. Veritably a case of good coming out of evil!

It must not be assumed that merely because a good deal is known about the potentialities of the chemical agents used in World War I, and the appropriate countermeasures to minimize their effects, that at least some of them would not be used in a future war. However, the main interest of the medical profession is centered around the newer types of war gases which were discovered in Germany at the end of the last war. These are commonly referred to as the nerve gases, because they interfere with the transmission of impulses along the nerves by causing a block at the junction of the nerve ending with the muscle fiber. This may be compared with a break in an electric wire which prevents the flow of current.

The effect of poisoning by nerve gases leads to paralysis of the muscles carrying out respiration and a constriction or narrowing of the air passages in the lungs similar to that encountered in cases of asthma. Other symptoms are due to contraction of the pupil of the eye which interferes with vision. Casualties can be caused either by external liquid contamination or by the inhalation of vapor, and are likely to occur with extreme rapidity. In contrast with the nonirritant war gases, there is no lag period between the contamination or inhalation of vapor and the manifestation of symptoms.

In severe cases it is the interference with respiration that constitutes the gravest menace to life and requires the most urgent treatment. Physiologists and pharmacologists have been investigating these problems. It has been found that the early administration of atropine is the best line of treatment, but it is emphasized that this must be given early. Since atropine is the principal therapeutic agent, the correct dosage should be available in a readily usable form, such as in a syringe for self-injection. Artificial respiration may be required to restore natural breathing after severe poisoning.

One important task of the medical services in the field will be to decide when a man who is a nerve gas casualty can return to duty. At present, this decision can be based only on laboratory findings. The technique for these determinations is complicated and requires special apparatus.

Such is the nature of the problems confronting the medical profession in the prevention and treatment of casualties resulting from chemical agents. Ever since chemical warfare has been used the gas mask has been the first line of defense and must remain so. It is, therefore, of the greatest importance that gas masks fit properly and that both civilians and service personnel are familiar with gas-mask drill.

Commentary

Details have been given of the many and varied problems which the medical services will have to face should atomic, biological, or chemical warfare be used. Some of the problems will have been encountered previously either in dealing with casualties caused by conventional weapons used in the past, or during the routine treatment of disease; others will be new. It will be the number and variety of the problems which will strain the medical resources of a nation.

The scope of the responsibilities which the medical services will be called upon to undertake in the preservation of morale, the conservation of health, and the treatment of sick and wounded, both in civil defense and the services, makes it imperative that this should be fully realized in all stages of planning to ensure that medical manpower is not dissipated.

What of the future? Will the biological sciences make advances during the next decade similar to those made in the field of nuclear physics during the past decade? If so, will the knowledge be used for the benefit or the destruction of the human race? The future and even the ultimate survival of man may depend on the answer to this question.

In preventing war, the influence of modern technology—especially in the atomic field—can be a deterrent power. It has been up until now. But science and research are not weapons for us alone. They can easily be weapons for the aggressor also. When a potential enemy achieves relative strength in atomic and other untried weapons, the deterrent effect of our atomic capabilities diminishes.

General of the Army Omar N. Bradley