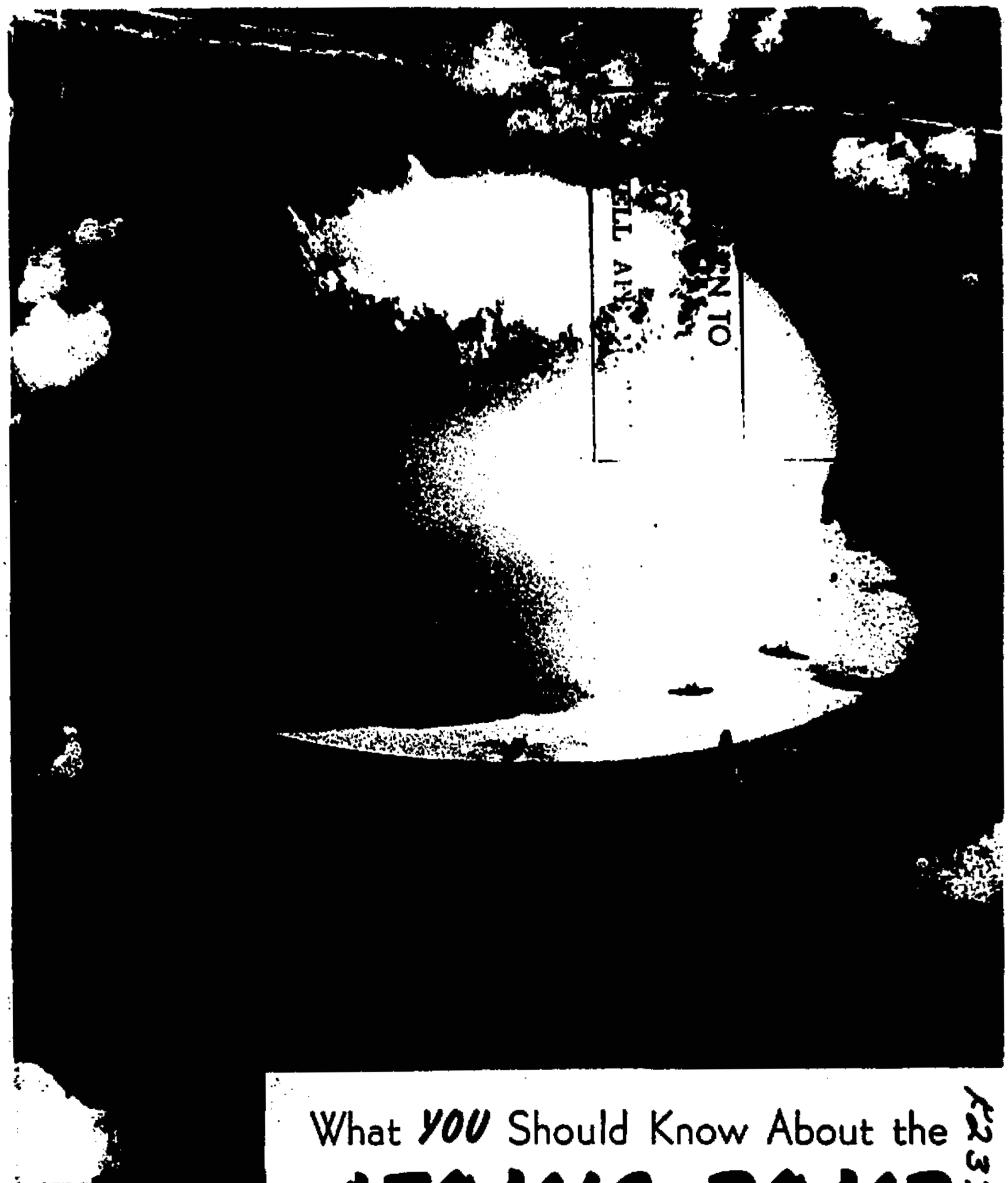

What *YOU* Should Know About the

ATOMIC BOMB

A MESSAGE FROM THE SURGEON GENERAL

ARMY MEDICAL DEPARTMENT

The Doctor and the Atomic War

Much has been said of the need for public understanding of the new Atomic Age. A citizenry ignorant of the vast opportunities and of the crushing responsibilities inherent in the release of nuclear forces, is courting annihilation. In the future, only the informed nation will be safe.

Yet, important as it is for the average man to measure his obligations toward the future, it is far more important for the medical man to understand his. The responsibility of the doctor for the safety, for the sheer survival of great masses of the population, if a new conflict comes, is gigantic. For nobody seriously doubts that the next war will be fought with atomic bombs many times more devastating than those dropped on Japan.

We of the United States Army Medical Department fully realize the gravity of the new situation that confronts the physician and the medical research man. Though we fervently hope that there will not be an atomic war, we cannot assume there will never be one; on the contrary, we must act as though one were certain. We cannot leave to chance, or to hurried last-minute action, the technological preparations which alone will cut down the enormous casualties if these new bombs are dropped upon our closely packed civilian centers.

We are doing everything in our power to anticipate such a catastrophe by study, by training, and by research; by planning and by special organization of our medical forces. Through these efforts we seek to acquaint all civilian physicians of the procedures that will be necessary in time of emergency.

Our beginnings, to date, have been modest, but our efforts are growing daily. They consist, in the main, of utilizing every item of data and experience gained in the manufacture of the bomb in its use at Hiroshima and Nagasaki, at Bikini, and recently Eniwetok. We can say, even at this early stage, that our population need not be defenseless. The trained combination of nuclear physicists, engineers, and medical men *can* operate to protect our Nation if it is ever attacked.

In this little booklet we have brought together a series of articles based on lectures delivered during our first course in atomic medicine, currently sponsored by the Armed Forces Special Weapons Project. They were originally published in the *Bulletin of the U. S. Army Medical Department* and are collected here to give an over-all picture of our present thinking on the subject. We hope that every doctor, in and out of the Army, will take this message to heart, and will cooperate with us in a steady improvement of the defenses which we know we must prepare.

R. W. Bliss
R. W. BLISS
MAJOR GENERAL, U. S. ARMY
THE SURGEON GENERAL

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IV. Evaluation of the Five Atomic Explosions

Employment of the bomb. The atomic bomb is primarily a strategic weapon, and the choice of target and method of employment require the evaluation of a number of factors. Thus far, five atomic bombs have been detonated, three of them under test conditions. The one factor that makes an atomic bomb detonation different from the detonation of any other type of weapon is the nuclear radiation produced. All high-explosive weapons produce high temperature and high blast pressure, and the only difference in these respects between atomic and conventional weapons is the increased magnitude of the blast and thermal effect produced by the atomic bomb. However, no other weapon devised to date is capable of releasing nuclear radiation.

The first bomb was set off under experimental conditions from a tower near Alamogordo, New Mexico, on 16 July 1945. The second bomb was dropped, 6 August 1945, on the city of Hiroshima from a B-29 bomber. Over 4 square miles of the city were instantly and completely devastated; 66,000 people were dead or missing and 69,000 were injured. On 9 August another B-29 dropped an atomic bomb on Nagasaki, totally destroying 1.5 square miles of the city. The number of persons dead and missing in Nagasaki was 39,000, and 25,000 more were injured. The fourth atomic bomb was dropped by a B-29 on target vessels assembled in Bikini lagoon on 1 July 1946, and the fifth was detonated underwater on 25 July 1946. Test animals placed in various locations on the target vessels yielded important data on the bomb effects. This work was under the supervision of the Naval Medical Research Center.

Action of the bomb. When a mass of fissionable material equal to or greater than a critical size is assembled, a violent detonation will occur. The subcritical masses of fissionable material must be brought together rapidly in such a manner that a chain reaction and detonation will occur. The bombardment of each fissionable nucleus by neutrons results in the formation of two fragments known as fission products. All nuclei do not split into the two types of fragment; therefore, many radioactive substances (fission products) are liberated. The sum of the masses of these fission products will not equal the original mass of the split nuclei. The difference between the fission products formed and the original mass represents the mass of the nuclei that has been converted into energy in the form of blast, heat, light, x-rays, gamma rays, and released nuclear particles.

The detonation of the atomic bomb generates a crushing wave of high pressure. The bomb also liberates an enormous quantity of electromagnetic radiations and neutrons. The electromagnetic radiations include infrared, visible light, ultraviolet, x-ray, and gamma radiation. Thereafter, the fission products formed emit gamma rays and beta particles. The unfissioned bomb residue emits alpha particles. Substances bombarded by neutrons released at detonation, which become radioactive by induced radioactivity, may also emit nuclear particles and gamma rays. A large fraction of the gamma rays is emitted in the first flash of the atomic explosion. Neutrons also accompany this reaction. The range of neutrons is negligible at 1,000 yd. because of their absorption in the air. In an underwater burst, greater absorption occurs, resulting in induced radioactivity of the sea water. Of the constituents of sea water, only sodium is of any significance, and even this element is hazardous for only a limited period because of its short half-life (14.8 hours).

At detonation, practically all of the lethal gamma radiation is released, and the remaining small fraction of the total dose is given off by the resultant fission products that rise rapidly in the bomb cloud. The column of radiating fission products and combustion material rapidly rises into the air and begins to mushroom out when the temperature of the column is equal to the temperature of the surrounding atmosphere. The climatic and meteorologic conditions will govern the diffusion, dispersion, and radiation activity of the cloud. The fissioned and unfissioned material in an airburst will be distributed in the atmosphere; while in a subsurface waterburst, the adjacent water, ships, and land facilities in proximity to the detonation will be seriously contaminated. Fission products in the cloud may be dispersed as fine particles of varying size, and, depending on many factors, a shower of the radioactive material will fall on nearby areas. The fission products, therefore, present a continuing health hazard for a considerable time as an aftermath of the explosion. In general, regardless of the technique of bomb detonation, radioactive materials emitting alpha and beta particles and gamma rays will be encountered. The radioactivity of these substances will range from a few seconds to years. Violent changes in temperature, strong magnetic or electric fields, and drastic chemical interactions have no effect on the rate of transformation or emission characteristics of the radioactive substance. If an element is radioactive, it will decay normally according to its inherent half-life.

In the underwater detonation of the bomb, thousands of tons of water rise in a column, a few thousand feet in the air, followed immediately by a rapidly moving mass of water, constituting the base surge. The turbulent waters contain a high percentage of the fission products and unfissioned residue. Immediately at detonation and for a short period thereafter an enormous amount of radiation is emitted. The falling column of water and mist, depending on wind conditions and depth of detonation, contains a high percentage of the fission products and unfissioned residue that can contaminate an area of several square miles for a considerable period.

The emission of infrared, visible, and ultraviolet light occurs a few milliseconds after the explosion. The ball of fire in the airburst grows rapidly in size. As it grows, its temperature and brightness decrease. Several milliseconds after the initiation of the explosion, the brightness of the ball of fire is several times the brightness of the sun. Most of the infrared and ultraviolet radiation is given off after the point of maximum intensity. The ball of fire rapidly expands from the size of the bomb to a radius of several hundred feet at one second after the explosion. Thus, the infrared and ultraviolet radiation comes in two bursts--an extremely intense one lasting a fraction of a millisecond and a less intense one of much longer duration lasting several seconds.

The heat from the flash in an airburst occurs in a short time, and, since there is no time for any cooling to take place, the temperature of a person's skin can be raised 50° C. by the flash of infrared and ultraviolet rays in the first millisecond at a distance of over 4,000 yards. People may be injured by flash burns at even greater distances. Gamma radiation danger does not extend nearly so far, and the neutron danger zone is still more limited. High skin temperatures result from the first flash of high intensity infrared and ultraviolet and are probably as significant for injuries as the total doses that come mainly from the second, more sustained, ball of fire.

Effectiveness against personnel. For personnel in the open, within one-half mile of zeropoint of the airburst detonation, death would occur almost instantaneously or within a few hours from the blast, heat, and radiation effects. Within a radius of one-half mile and one mile from zeropoint, some persons would die instantly, while a majority would receive varying degrees of injury. Ordinary houses and structures would suffer complete destruction or extensive damage and fires would be widespread. Outside a radius of one mile and within a radius of two miles from zeropoint, personnel would suffer injuries from flash burns and indirect blast effects. Outside a radius of two miles and within a radius of four miles, personnel would be injured by flying fragments and suffer superficial wounds. Structures would be half or partially destroyed within this radius. In an airburst explosion 70 percent of those exposed would suffer from trauma, 65 percent from burns, and over 35 percent from radiation.

Delayed gamma radiation from the base surge is similar to immediate gamma radiation, except in its nondirectional characteristics. The shielding requirements are similar to those in the previous situation, in that the same half-thicknesses are applicable. There are no delayed neutrons of significance; hence, special shielding is of no importance in this problem. In the delayed situation we also have important beta radiation. Immediate beta radiation occurs but does not travel a very great distance from the source, because of the efficient shielding furnished by air. Where the base surge is surrounding the location in question, beta radiation is important, because the half-thickness of air is about 4 yd. Normal clothing furnishes sufficient shielding to beta radiation. Similarly, thin walls and the glass in windows are adequate. It is, of course, nondirectional and comes from all sides. The extent of the external hazard furnished by beta radiation is not well understood. It is believed comparable to that of gamma radiation when a base surge has been created. Alpha radiation occurs from the nonfissioned plutonium and uranium. This radiation constitutes no external hazard, as the skin furnishes adequate shielding. All the alpha rays are absorbed in the epidermis with no resulting damage to living tissues.

Internal radiation gets into the body through inhalation, ingestion, or injection. This is a delayed hazard and is possible only where one is in the base surge, the mushroom cloud, or an area over which the base surge has previously passed. The internal hazard generally occurs only where there is also an external hazard. If one is exposed to the base surge or is in the mushroom cloud, the external radiation is often lethal without any consideration of an internal hazard. Particularly if one is working in a highly contaminated area after the detonation, there is a significant, but not necessarily lethal, degree of external hazard; but there is also a very great internal hazard. This is created by disturbing the dust and usually enters the body through inhalation. An additional hazard exists from eating with contaminated hands and thus getting the active material into the body through the mouth.

In the case of an atomic explosion, a small amount of this radioactive material is in the form of a true gas or vapor. Almost all of it exists on particles of dust or droplets of water. These contaminated particles have a size range from 0.1 to 10 microns. The filter in a modern gas mask such as the assault mask is believed to give adequate protection. This filter is extremely efficient. It is quite possible that new masks will be devised that will protect against atomic, biologic, and chemical warfare. Such a development is highly desirable. Protective clothing would be required for workers entering contaminated areas. It would probably be permeable clothing. Its main requirement is that it should be disposable. Its functions would be to keep contaminated material from the skin and possible later entry into the body. Disposability is desirable, as these materials cannot be rendered harmless by any physical or chemical means.

Collective protectors with filters or inclosed air-conditioning systems are probably indicated for vital installations and underground shelters in anticipation of atomic warfare. Such items would prevent the highly contaminated air of the base surge from entering installations that otherwise would furnish adequate protection against the effects of the atomic bomb. The development of decontamination techniques and facilities is indicated to reduce the long-term possibility of personnel becoming contaminated and later having active material enter the body through the respiratory and digestive tracts. Such techniques will probably consist of washing away, carrying away, or burying the active material.

Education. In an attack on a modern city it is believed that about 50,000 deaths would result from a single bomb. It is felt that, if the individual civilian and soldier in such a city were adequately trained as to what he could do for himself after the detonation occurs, perhaps 10,000 lives could be saved. The development of atomic defense for the individual will be the subject of much work in the future. The education of large numbers of persons, both civilian and military, for special jobs in atomic warfare is important and will probably be given to such people as radiologic safety personnel, medical officers, civilian doctors, and civil defense technicians. The method by which the individual indoctrination and the specialized training is given will determine to a large extent the psychological preparation that will be attained in a population. It is highly desirable that we impart the proper degree of knowledge to all so that each individual has a respect for the special hazards of atomic warfare, thereby avoiding the undesirable extremes of excessive fear or ignorance. This will be a difficult job and the Nation is far from attaining this goal at present.

A large amount of detailed defense planning will be required for the protection of the Nation. It will include large-scale training of such specialists as fire fighters, evacuation control personnel, first-aid personnel, and decontamination groups. Large stock piles of food supplies, medical supplies, and disaster equipment will be required in relatively invulnerable locations. Preparations will be required for mutual aid between cities and major installations. All civil and military groups must be equipped and trained in the detection and isolation of contaminated areas. This new hazard created by nuclear radiation is the one hazard that may not be detected by any of the physical senses. It requires special instruments and special consideration. With sufficient indoctrination and a few minutes' advance warning of an attack, it is quite possible that a 50 percent saving in casualties can be effected. This establishes the fact that development of advance detection techniques and warning signals is of the greatest importance to insure the continuation of our present existence.

ACTIVE DEFENSE

Of less direct importance to the medical profession but of the utmost importance to the Nation is active defense, which means the prevention of an atomic attack. Regardless of our degree of preparation and protection, large numbers of casualties and a more important amount of disorganization and dislocation will occur. The attempts of the United Nations Organization to set up machinery to insure peace in the future, if successful, will be the greatest protection we can have against the atomic bomb. The basic responsibilities of military organizations require that they assume that war will occur.

Regardless of the political situation, the military organizations must constantly maintain the highest level of preparedness. In the case of atomic warfare this will consist of extensive stock-piling of all weapons, including atomic bombs. It will require readiness of retaliation forces. Because of the nature of the atomic bomb, it will require extensive protection of our ability to retaliate and conduct an offensive war. As was seen above, advance warning is most important—thus an efficient foreign intelligence corps is vital. Some persons have raised the provoking thought that, because of the capabilities of the atomic bomb, we shall lose an atomic war unless we attack first, assuming the enemy has atomic bombs.

A vital part of active defense that is erroneously played down in articles in the press is the assumed futility of interception of an atomic bomb carrier. Within the last few weeks our authorities on guided missiles have stated openly that it is their belief that guided missiles cannot be used to carry an atomic bomb for at least ten years. The military authorities must concentrate on the intervening years in which it is anticipated that a manned aircraft is the most likely vehicle. We have had only a fair degree of success in the interception of aircraft on bombing missions. There is no scientific reason why our degree of interception cannot be raised to nearly 100 percent if sufficient money, time, and technical ability are put on the problem. Atomic warfare presents a truly horrible outlook. It is our duty to push to the utmost any procedure that could possibly reduce its effectiveness against us.

For the Record

It is no news that the war has fostered amazing advances in science, not the least of which are the forward steps of medicine. The Army Medical Department with its expanded research and development program is preparing to apply many of these scientific advancements to the postwar world. Thus the Medical Department is keeping pace with the changing conditions of global health needs by developing the practice of total medicine.

Doctors who are looking for outstanding training in any of the many specialties in medicine and surgery will find that the Army Medical Department offers some of the best training in the world. They receive instructions and experience under the guidance of top-flight Army and civilian teachers. They use the latest equipment—work in large general hospitals and laboratories. They learn new techniques which few civilian doctors have an opportunity to master.

For further complete information about the Graduate and Professional Training Program offered to medical officers write to:

The Surgeon General
Department of the Army
Room 2E526, The Pentagon
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