

59.1 The final challenge to preventive surgery

Thermonuclear annihilation is the ultimate in trauma, both in the severity of a single injury, and in the number of casualties. There are three dangers which are commonly confused: (1) Those associated with atomic power. (2) The release of a single atomic bomb by accident or design. (3) A multi-megaton exchange of intercontinental ballistic missiles. The consequences of the first are comparatively minor, those of the second are survivable by mankind as a whole, as indeed were the bombs at Nagasaki and Hiroshima. The last is truly terrifying. If we in the Third World do not actually perish, we will see our sources of drugs, equipment, and spares, and much of our tenuous hope of development, vanish instantly.

Firstly, some facts, many of them in the words of *The Lancet*. The arsenals of the world now contain the equivalent of a million bombs of the kind that fell on Hiroshima, and are equal to about 4 tons of TNT for everyone of us here on earth. More energy can now be released by one weapon in one microsecond than in all the conventional wars of history. In the nations directly attacked tens to hundreds of millions of people would be killed instantly. Hundreds of millions more might starve to death. Millions might die from cancer caused by nuclear radiation.

Radioactive contamination would spread to vast areas and pollute the biosphere. *The natural protective ozone layer round the earth might be damaged, with unpredictable consequences to all forms of life, and possibly even the extinction of the human species. Mankind might indeed destroy itself.* At the very least, the social, cultural, environmental, and medical damage in the aftermath of a nuclear war would persist for generations.

4 TONS OF TNT FOR EVERY ONE OF US ON EARTH

Among those who might survive the initial effects of blast, fire, and radiation, many would endure prolonged agony and a slow death. Untold numbers would die from injuries for which no adequate medical care could be provided. Widespread starvation, epidemics, and civil disorder would be inevitable. The people who would not be immediately vaporized would suffer from radiation, and from

THE ARMS RACE AND ONE OF ITS VICTIMS

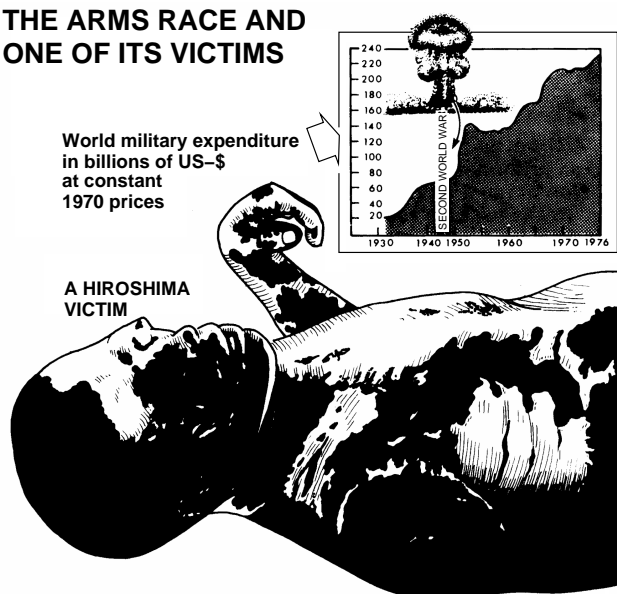


Fig. 59.1: ATOMIC CATASTROPHY The second world war ended with the atomic explosions at Hiroshima and Nagasaki. Here is one of the victims. The graph shows the world's military expenditure in \$-US billion at 1970 constant prices. Most of this expenditure is designed to produce death from the very injuries we describe here.

many of the injuries discussed elsewhere in this manual. A 'nuclear winter' might end all life on earth. Medically, the terms 'limited' and 'winning' have no meaning in the context of nuclear war.

Mounting military expenditures and the intensification of the arms race heighten the tension, and each new crisis worsens the threat. World military spending in real terms, corrected for inflation, has increased four fold since World War Two. In the 1970's it approached \$5 trillion, or about \$500 thousand million a year—a sum larger than that of the total goods and services created by mankind in one year. *Most of this expenditure is carefully designed to cause the very injuries we describe here, if not death itself.* It is also killing people now by diverting scarce resources from urgent health needs. Twenty times as much is spent on arms as on development aid. To provide everyone on earth with clean water and sanitation would cost less than the equivalent of seven months of the arms race. Smallpox was eradicated from the world for a cost equal to only five hours of it. One year of it would

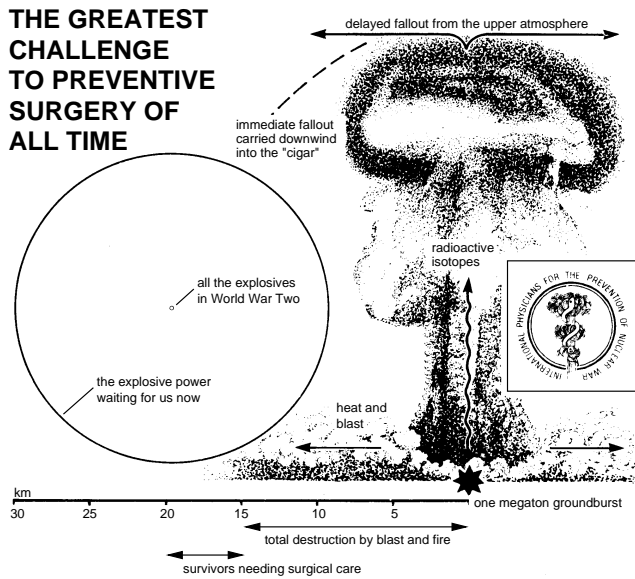


Fig. 59.2: NUCLEAR ARSENALS. The area of the small circle represents the power of all the explosives used in World War Two. The area of the larger circle represents the nuclear arsenals of the world now which are about 5,000 times greater. The scales at the bottom of the figure show zones of total destruction and of the survivors needing surgical care; they are those following a 1 megaton groundburst. The Hippocratic serpent symbolically surmounting the mushroom cloud is the emblem of International Physicians for the Prevention of Nuclear War (IPPNW).

more than abolish all the international debts of the Third World. One nuclear aircraft carrier, the Ohio, launched in 1979, cost \$6 billion—more than the total government budgets of Kenya, Tanzania and Uganda combined.

'Overkill' is now such that 1000 times more bombs are available than are required to kill everyone on the other side. The balance of terror becomes daily more frightening. It is sometimes argued that it has kept Europe free of war for nearly 40 years. This is not correct since there has never been a sufficient cause for war during this period. If war does break out it will only be by accident; if it does it will annihilate most of the industrial world and perhaps all mankind.

Not only is there a very real chance that all this will happen, but such is the unreliability of military computer systems that it is quite possible that it might even happen by mistake. The growth in sheer numbers of nuclear weapons and the increasing complexity and sophistication of their delivery systems increase the possibility that a nuclear conflict may be triggered by some tragic accident. Any technological system is liable to malfunction, and the people who direct them can easily make mistakes, or be sick, or mentally deranged, or tired, stressed, drunk, drugged, or senile. Until now their errors could kill only a few people. Now they can endanger the very existence of humanity.

The strategy of mutually assured destruction ('MAD') was bad enough. Even more terrifying are the attractions of a 'preemptive first strike' to overwhelm the command, control and intelligence systems of the other side. The risk now is that, at a time of international tension, a defensive response by one side might be taken as an offensive one by the other side in a series of escalating responses that would culminate in catastrophe. The system itself may indeed have been mistakenly designed so that it cannot operate safely. For example, the carrying out of necessary additional defensive

procedures during a high level alert may give the opposing side the mistaken impression that it is about to be attacked. Instead of escalation taking weeks as it did in the first world war, following the assassination of an obscure archduke in Sarajevo, it might only take minutes—a "nuclear Sarajevo".

Hitherto it has been assumed that the ultimate authority for pressing the button to release the holocaust would lie, in the West, with the President of the United States. There are however good grounds for believing that he has already given 'preauthorisation' to end life on this earth to his generals in their bunker. If the Strategic Defence Initiative ('Star wars') is implemented, they will have to be given this authority, and may in turn have to hand it on to a computer. In matters of military technology the East usually follows the West...

In the face of this unimaginable calamity, our response, as mere humans, is to deny reality and to try to forget it, and to hope that it won't happen. Most of us can just cope with the little tragedies of our daily lives, but a cataclysm of this kind is too much for us. We become apathetic, and our response is in no way appropriate to the magnitude of the threat that faces us.

Perhaps this is not surprising. We have slowly evolved over millennia, yet in the space of only one lifetime, we have found ourselves able to fly, to unravel the chemistry of our own genes, to reach for the moon, to probe the very limits of the universe—and to destroy ourselves. Unfortunately, with it we retain an attitude to war which is at best mediaeval. Many of us even enjoy some aspects of it. We need time, much time, in which to adapt to our new powers. Above all, we need to look into the future with a much longer time perspective. Instead of seeing it in terms of years, or tens of years, we must look at it, not in the span of our own lifetime, but of that of our children's children, far into the centuries ahead.

A HUMAN PERSPECTIVE OF MILLENNIA

Both East and West see themselves, almost certainly falsely, as being about to be overrun, but even if they were, they should take comfort from the fact that all previous dominations have ultimately come to an end, often surprisingly quickly. Against such a longer time perspective, what happens in the next decade or two will not matter very much. Both sides—and mankind—will ultimately survive. So will our beautiful green earth.

Henceforward, the greatest threat to man's life and health may not be the diseases with which medicine presently concerns itself, but his propensity to make war and destroy himself. If so, the greatest challenge to preventive medicine (and preventive surgery) in the closing years of this millennium and the next one (if we reach it), must be the prevention of war, both between East and West, and between the countries of the Third World. In some countries one person in 20 is a health worker, so if every health worker could become a 'peace worker', the massive challenge of 'global health education for a nuclear age' is not an impossible one. In the Third world it would allow money spent on arms to be spent on development.

Paradoxically, this is less a challenge to our intellects than to our courage, to our imagination, and to our willingness to face reality. We have yet to realize that the real courage

required of us now is not courage in battles as it used to be, but courage to stand against the opinions of our fellows, who have yet to see things as clearly as we think we do, and conceivably, when the time comes, to resist domination—not violently but with an even greater kind of courage. The weapons of today are not tritium and plutonium but vision, hope, courage, perseverance, and indomitableness, together with the solidarity and good humour which several nations are already showing to magnificent effect against just such domination. If an atomic holocaust is the ultimate challenge to preventive traumatology, then these are our vaccines against global trauma and insane suicide, the "new community medicine (and surgery)...".

**IT MIGHT ALL HAPPEN BY MISTAKE!
COURAGE, PERSEVERANCE, HOPE**

NEAR DISASTERS There have indeed been many mistakes: (1) to 1961 near Goldsboro, North Carolina a B-52 bomber broke up in flight, releasing two 24 megaton bombs. Airforce experts found that on one of the bombs five of the six interconnecting safety devices had been set off by the fall, leaving only one to prevent an explosion. (2) In September 1980 a technician working on a Titan II intercontinental ballistic missile dropped a socket wrench onto a fuel tank below. The tank lost fuel and some hours later exploded, blasting open the silo's 740 ton door and shooting the 9-megaton warhead 600 feet into the air. Frantic radio messages were overheard as the survivors tried to find the missing warhead. (3) In November 1979, a war game training tape was accidentally fed into a NORAD computer, and was accepted as real, initiating a low level nuclear war alert as personnel prepared launch procedures. (4) On another occasion the military systems of the USA were alerted, B-52s took to the air and readied to counter attack. Within six minutes of the time that this was to happen, the hostile missiles identified on the radar screens were seen to be only a flock of Canadian geese... East and West had come to within 6 minutes of destroying one another, and perhaps the Third World too. This happened when the superpowers faced one another over the poles, where missiles have a journey of half an hour. Now that they confront one another in Europe, where there are only three minutes in which to react, the possibilities of a mistake are ever more frightening. LESSONS "You may reasonably expect a man to walk along a tightrope safely for ten minutes, it would be unreasonable to expect him to do so without accident for two hundred years". The risks have grown greatly since Bertrand Russell wrote this.

Not only are all thinking people in the West frightened, but from many accounts those in the East are even more so. If it does happen by mistake, or intention, and you do have the fortune or misfortune to survive, here is an atomic ABC.

**THE GREATEST CHALLENGE TO MEDICINE IN THE
NEXT MILLENIUM
(and the rest of this one)
"EVERY HEALTH WORKER A PEACE WORKER"**

59.2 Trauma from heat, blast and radiation

Atomic bombs release energy in four forms. Like any chemical explosion, they cause: (1) heat and (2) blast, which produce the burns, fractures, and crush injuries described on other pages. (3) Radiation in the form of neutrons, X-rays, gamma rays, and alpha and beta particles. This radiation takes two forms: (a) the initial radiation, mostly neutrons and gamma rays, which ends within a minute of the explosion, and falls off with distance according to the inverse square law, and (b) the fall out radiation emitted by a mixture of radioactive isotopes, some with a half life of centuries. This fallout occurs in two forms, immediate and delayed, and is described below. (4) There is also an intense pulse of electromagnetic energy at the moment of the explosion capable of destroying communications and all electromagnetically stored data over a huge area.

The heat and blast from bombs of one megaton and larger kill almost everyone who might possibly have survived the initial radiation. As bombs get smaller, their radiation becomes more important than their blast. This is the principle of the small, neutron bomb, which kills by radiation without causing much heat or blast.

A 10 megaton bomb exploded at a height of 2000 metres (an airburst) produces an intensely hot luminous fireball, and a blast wave which travels at supersonic speed. It produces no crater, and therefore little fallout.

The same bomb exploded on the surface (a groundburst) makes a crater nearly a kilometre wide. In doing so it makes thousands of tons of earth radioactive by irradiating them with neutrons, and draws them up into the air as the 'mushroom cloud' in Fig. 59-2. This huge quantity of radioactive material then descends to the earth as fallout in two forms; (1) Immediate fall out which occurs in the first few days, and is comparatively localized, the larger particles falling nearby, and the finer ones progressively further downwind. The pattern of this fallout is determined by the speed and direction of the prevailing wind. The large particles are deposited close to the site of the explosion as a fine visible radioactive sand. (2) Delayed fallout in the form of much smaller particles. These reach the upper atmosphere and descend only slowly to be added to the natural background radiation of the biosphere.

Assuming that the ozone layer and the biosphere itself survive a major nuclear exchange (and there is good reason to think that they might not), it is the delayed fallout which matters to countries which are not directly attacked, and particularly to us in the Third World. This fallout is ultimately distributed round the earth, although fortunately for us, most of it falls in the hemisphere in which it is released.

The heat and blast from a one megaton bomb destroys everything within about 14 km. Within this area heat causes severe burns and ignites anything combustible. Innumerable fires are started, and if the weather conditions are right, these produce a firestorm, like that at Hiroshima which destroyed 12 sq km of the city. A powerful vertical updraft of hot air draws cool air in from the periphery until everything which can burn has burnt. In doing so it creates temperatures of 1,000°C, that melt glass and metal. The Dresden firestorm, caused by conventional incendiary bombs during the second world war, killed 100,000 helpless people, many of them women and children, in one night.

59.3 Radiation injury

Radiation imparts energy to the electrons of living tissues. This allows harmful chemical reactions to take place, particularly in DNA. Extreme radiation damage kills cells, particularly those in rapidly multiplying tissues, like the mucosa of the gut and the marrow. Lesser damage causes: (1) mutations, which can only express themselves when cells divide, and are responsible for cancer in the survivors, and (2) genetic deformities in their children.

The absorbed energy is measured in rads. In tissue at or near the surface of the body, an exposure of one roentgen of radiation energy results in the absorption of one rail (100 ergs/gram). Clinically, this absorbed energy expresses itself in the short term as the 'radiation sickness' described below. If irradiation is spread over weeks or months the body can tolerate more.

'RADIATION SICKNESS'

This is the response to whole-body radiation delivered over 48 hours or less.

0 to 100 rads. Men lose fertility at 20 to 50 rads

100 to 200 rads. After 3 to 6 hours there is nausea and vomiting which lasts for less than a day. After a latent period of up to 2 weeks, symptoms recur for 4 weeks. Leucopenia develops.

There are few deaths below 200 rails.

200 to 600 rads. Nausea and vomiting lasting 1 to 2 days are followed by the recurrence of symptoms for up to 8 weeks.

There is severe leucopenia, purpura, and haemorrhage, often with infection. Above 300 rads the hair is lost.

The death rate is 0 to 90% in 2 to 12 weeks from haemorrhage or infection.

600 to 1000 rads. Nausea and vomiting start within half an hour and last 2 days. There is a latent phase of 5 to 10

days, followed by the same symptoms as with 200 to 600 rads which last 1 to 4 weeks.

The death rate is 90 to 100% in 6 weeks from haemorrhage and infection.

1000 to 5000 rads. Nausea and vomiting start within half an hour and last one day. A latent phase of under 7 days is followed by fever and diarrhoea lasting 2 to 14 days. Everyone dies within 14 days from circulatory collapse.

More than 5000 rads. Almost immediate nausea and vomiting are followed by convulsions, tremor, ataxia, and lethargy. Everyone dies within 48 hours from respiratory failure or cerebral oedema.

Anyone within 1.5 km of a 1 megaton bomb could expect to receive a dose of the initial radiation with a 50% chance of killing him (about 500 rads)—should he survive the initial heat and blast.

The dose from fallout decays exponentially by a factor of 10 for every sevenfold increase in time. If it is 3000 roentgens per hour at one hour, it will be 300 at 7 hours; at 49 hours (7×7) it will be only 30 roentgens an hour. In practice, radiation from fallout is difficult to calculate, and has to be measured. Here is an example. After a one megaton ground burst with a uniform wind of 24 km an hour, the fallout plume that would expose an unprotected person to a fatal cumulative dose (about 500 rads) in the first week after the explosion would be 240 km long and 32 km wide.

The longer the fission products remain in the mushroom cloud, the less radioactive they will be when they fall to the ground. They are likely to arrive in dangerous concentrations for at least 24 hours. If you are in the path of the plume, there will be an interval before the fallout arrives, which will depend on your distance from ground zero and on the wind speed. When it first arrives, the dose rate is small. It then builds up over a day or two and decays.

Whereas there is little effective protection from the heat and blast, except perhaps in a deep bunker, some protection is possible from the fine radioactive dust of the fallout.

THE FALLOUT PATTERN

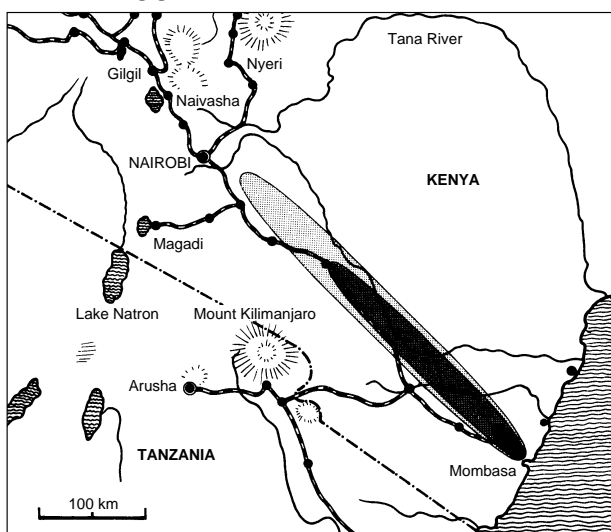


Fig. 59.3: THE EXPECTED FALL OUT PATTERN after a one-megaton surface burst on Mombasa, assuming a uniform southeasterly wind of 30 km/hr. The contours indicate seven day accumulated doses of 900, 300, and 90 rads to unprotected people. A dose of 500 rads will kill about half of those exposed to it.

SOME POSSIBLE MEASURES

These are the preventive measures you can take to protect yourself from the fallout.

PREVENTION Build a fallout shelter for yourself and your family, preferably in a basement. The further this is from any dust that might fall outside, the better. The more material of any kind you can put between yourself and the falling dust the better. Pile 50 cm of earth against the windows and any unexposed walls. Fit your shelter with a simple ventilation system that will keep dust out. Carefully seal it against dust, and provide it with a toilet. Furnish it with enough food and water for at least two weeks.

CAUTION! Get into your shelter before any fallout descends, and don't come out!

IF YOU ARE CAUGHT IN THE FALLOUT change your clothes and wash any dust from your skin and hair. Dust particles in contact with your skin will cause beta burns. Don't eat or drink anything contaminated with fallout.

HOW LONG TO STAY INSIDE? If you don't have a radiation monitor, there is no means of knowing. Stay for at least two weeks.

WHEN YOU COME OUT expect millions of your countrymen to be dead; power, communication, water, and

sewage to be disrupted, pestilence and famine to be widespread, the economy to be in ruins, and civil disorder rife.

Perhaps, when (and if) you do come out you will agree with Nikita Khrushchev that it might have been better not to have done so. Perhaps you will realize that you might have done more to prevent it? If so, read on.

59.4 A nuclear Hippocratic oath

As physicians (and surgeons), our calling is to prevent sickness where we can, to cure it when we cannot prevent it, and to comfort the sick whom we cannot cure. Our challenge now is to make the ultimate supreme effort in the history of our profession—to do our bit to prevent mankind, all 4.3 billion of us, from destroying ourselves in the ultimate catastrophic act of global suicide—with the obscene possibility that it might all happen by mistake. 'International Physicians for the Prevention of Nuclear War' (225 Longwood Avenue, Boston, MA 02115, USA) have suggested that we should adapt our Hippocratic Oath to the atomic age like this:

As a physician of the 20th century, I recognize that nuclear weapons have presented my profession with a challenge of unprecedented proportions, and that a nuclear war would be the final epidemic for mankind. I will do all in my power to work for the prevention of nuclear war.

Thompson James, 'Psychological aspects of nuclear war' (1985) Published by the British Psychological Society, and John Wiley and Sons, Ltd.