HEALTH AND ENVIRONMENTAL EFFECTS OF NUCLEAR WEAPONS

Report by the Director-General

Since 1981 WHO has been studying and reporting on the effects of nuclear war on health and health services. Although the likelihood of an all-out nuclear war with catastrophic consequences for humanity has greatly diminished, nuclear weapons are still present and being produced; therefore the potential danger of the consequences of their use has not yet been eliminated. Also, concern is widespread about health and environmental risks associated with accidental releases of radioactivity during nuclear weapons production, decommissioning of nuclear facilities and dismantling of nuclear warheads, in addition to the health and environmental hazards posed by nuclear tests.

At the request of some Member States the item, "Health and environmental effects of nuclear weapons" has been included on the provisional agenda of the Forty-sixth World Health Assembly. This report provides information on the subject and refers to earlier related work of WHO. The members of the management group appointed by the Director-General to follow up resolution WHA36.28 were consulted in the preparation of this report.

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I. INTRODUCTION

1. WHO and its Member States have for many years expressed deep concern over the disastrous consequences of nuclear conflict for health. From previous WHO reports on the effects of nuclear war on health and health services, published in 1984 (1) and 1987 (2), and from numerous other investigations, it is evident that besides the catastrophic effects in terms of deaths, casualties and material damage, the use of nuclear weapons will cause human suffering and environmental disturbance on an unprecedented scale.

2. The threat of a global catastrophe is now fortunately remote. The nuclear arms race among the main nuclear powers is over and a major nuclear conflict is unlikely in the foreseeable future. Nuclear weapons, however, still exist in large numbers and their spread among more countries remains a cause for concern. Continuing apprehension about harmful effects on health is thus not unfounded.

3. At the request of several Member States, the item "Health and environmental effects of nuclear weapons" has been included on the provisional agenda of the Forty-sixth World Health Assembly.

4. This report briefly reviews previous WHO work on the health consequences of nuclear war and concentrates on current information about the effects of nuclear weapons on health, and related environmental problems.

II. REVIEW OF WHO ACTIVITIES, 1981 TO 1991

5. In 1981 the Thirty-fourth World Health Assembly, by resolution WHA34.38, initiated a WHO project entitled "The effects of nuclear war on health and health services", with the aim of studying the contribution that WHO could make to the implementation of United Nations resolutions on strengthening peace, détente and disarmament and preventing thermonuclear conflict. In response to the Health Assembly resolution an International Committee of Experts in Medical Sciences and Public Health was established to carry out the project.

6. After extensive study and consultations the Committee prepared a report which was presented to the Health Assembly in 1983. It was endorsed and published in 1984 (1). This initial report reviewed the then available knowledge on the possible effects of a nuclear war. It concentrated strictly on the scientific aspects of the problem, such as the physical characteristics of nuclear explosions and their effect on health, management of casualties, and short- and long-term effects of a nuclear war on health and health services.

7. The Committee's main conclusion was that, in view of the disastrous consequences of a nuclear conflict on human health and welfare, "the only approach to the treatment of the health effects of nuclear explosions is primary prevention of such explosions, that is the prevention of atomic war" (1).

8. In 1983 the Health Assembly by resolution WHA36.28 endorsed the conclusions of the Committee, requested the Director-General to transmit the report to the Secretary-General of the United Nations, and recommended that WHO "in cooperation with other United Nations agencies, continue the work of collecting, analysing and regularly publishing accounts of activities and further studies on the effects of nuclear war on health and health services ...".

9. In implementation of this resolution, the Director-General established the WHO Management Group on the Follow-up of Resolution WHA36.28. The Group continued the work of the Committee. The findings of new research strengthened the original conclusions presented in 1983. They made clear the fact that health services could not alleviate the situation caused by the explosion of nuclear weapons and the only approach to treatment of health effects of nuclear warfare was the prevention of nuclear war.

10. The Group's report constituted WHO's major contribution to the International Year of Peace (1986). The Fortyeth Health Assembly endorsed the report by resolution WHA40.24 and decided that investigation of other health aspects of the effects of nuclear war that are not reflected in the report should be continued in

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1 See document EB91/1993/REC/2, pp. 247-249.
collaboration with interested United Nations bodies and other international organizations. The report was published in 1987 (2) and has been translated into many languages.

11. WHO, the United Nations and other interested organizations continued to review the situation and collate all new scientific findings. The Management Group noted in its meetings that the increased radiation risk per unit of dose resulted partly from a new system of dosimetry; a United Nations report reviewed, inter alia, the health aspects of nuclear war in the light of the changing political climate (3).

12. In 1991, the Management Group reported on its activities since 1981 (4). It noted that with the positive changes in the world situation it was the peacetime uses of atomic energy that had become the greater cause for concern. Nuclear weapons were, however, still being produced and stockpiled; therefore the potential danger of the consequences of their use had not yet been eliminated. Developments should be monitored.

III. CURRENT SITUATION

13. The nuclear arms race between major nuclear powers has subsided and a nuclear war between them has become unlikely. Remarkable progress has been achieved in arms limitation, including agreements by the two major nuclear powers to withdraw and destroy most of their tactical weapons and drastically to reduce their strategic nuclear arsenals. Also more countries have acceded to the Treaty on the Non-Proliferation of Nuclear Weapons.

14. On the other hand, some problems remain and new ones are arising. First, a large number of nuclear weapons are still in existence and their production worldwide has not ceased altogether. Secondly, nuclear weapons are now located on the territories of more countries than before. The possibility of clandestine production of nuclear weapons in certain countries has made proliferation of great concern to world security. Thirdly, there is the problem of the dismantling and disposal of nuclear weapons and their production facilities, both of which could pose risks to the health and safety of workers, the general population and the environment. The disposal of nuclear weapons and decommissioning of production plants undoubtedly increases the need for more radioactive-waste disposal facilities and better management. Fourthly, problems are exacerbated by the fact that the number of unemployed nuclear weaponry experts is growing, which may lead to undesirable dissemination of this expertise.

IV. HEALTH EFFECTS OF NUCLEAR WEAPONS

Effects of actual use

15. A single thermonuclear weapon can have the destructive power of a million times the largest conventional weapon. The detonation of a nuclear weapon produces a blast wave, a thermal wave, instantaneous radiation, radioactive fall-out and an electromagnetic pulse. If a number of powerful weapons are used at the same time, global environmental disturbance and climatic changes may take place (2).

16. Most of the information concerning the health and environmental impacts of nuclear weapons comes from the two bombings that took place in 1945, the consequences of which have been and are being continually studied. In addition, other investigations are under way, based on analysis of nuclear tests, mathematical models of various scenarios, and other scientific information.

17. Immediate effects. The detonation produces three major sources of death and injury: the blast, the heat wave and instantaneous radiation. In addition, an immediate source of destruction is the electromagnetic pulse which leads to the impairment of electronic devices, including those needed for health services. Initially, the release of radioactive substances and human exposure to them would play a secondary role in terms of the health effects produced.

18. Other immediate effects include death and injury caused by overpressure, the destruction and collapse of buildings and structures, and heat and fire. Exposure to instantaneous radiation (gamma rays and neutrons) produces radiation syndrome with sickness and, possibly, death. At relatively low doses, it impairs bone marrow. At higher doses, damage occurs to the gastrointestinal tract, and at very high doses injury to the brain (2).
19. The destruction and impairment of health services would greatly impede efforts to treat the victims. Among those killed and injured would be a large number of physicians, nurses and other health workers. Hospitals and other health facilities would be destroyed or greatly damaged. Power supplies which are important for operation of hospitals would be interrupted and would severely interfere with the treatment and care that could be provided (5).

20. **Intermediate and long-term effects.** These effects would range from after-effects of the injuries sustained from the explosion to long-term effects of radiation exposure and health problems caused by the disruption and destruction of health services. Those who survive the acute effects of nuclear explosion will still be confronted by protracted non-healing wounds, suppurating extensive burns, skin infestations, gastrointestinal infections and psychic trauma.

21. Suppression of the body's immune system is recognized as a consequence of radiation overexposure. Ionizing radiation reduces the helper T-lymphocytes and increases the suppressor T-lymphocytes, thus increasing the victims' vulnerability to infection and cancers. Other effects of the explosion, such as burns, trauma and psychic depression can also influence the immune response (2).

22. The drastic fall in available health services on account of the small number of remaining health personnel, health centres, supplies or functioning ambulances and the immense logistical difficulties will render care totally inadequate.

23. Long-term effects such as cancer induction and genetic damage will result from instantaneous radiation during the explosion and the longer-term radiation contamination of the environment. The survivors of the nuclear explosion and the populations of contaminated areas will be at risk of such effects. The risk from instantaneous radiation will vary depending on the dose received. For example, at an exposure of 1 Gray whole body irradiation, there will be an estimated lifetime risk of mortality from all forms of cancer in the range of 4% to 11% of survivors (6).

24. Although the studies in Japan do not reveal any increase of genetic defects among offspring of the survivors, there are theoretical and experimental indications of the possibility of such risks. This risk would not be limited to the immediate offspring of the exposed, but would extend over many generations. Recent studies have shown that exposure to plutonium alpha particles produces chromosomal instability which can be transmitted to the progeny, thus causing cancer in future generations (7). Other studies indicate that the effects of internal exposure from the inhalation or ingestion of radioactive materials is much greater than was originally thought (8).

25. Long-term psychological effects continue to be noted among the survivors of Hiroshima and Nagasaki. Behavioural and psychological disturbances are observed. After an initial tendency to profound apathy and disorientation, feelings of guilt seem to appear. In addition, survivors have a continuing fear of cancer and late effects of radiation, and an expectation of abnormalities in their offspring (9).

**Health risks of nuclear weapons production and disposal**

26. An account of the health effects of nuclear weapons must also include considerations of the production cycle of these weapons, from production of materials, development, manufacture, testing, stockpiling, repair, and maintenance, to transport, dismantling, and waste storage and disposal. Each of these stages may constitute direct risks to the health of the personnel involved and the general population.

27. At the reactor, reprocessing or production plant, hazards to personnel may include routine and accidental release of radionuclides and other harmful substances into plant life, air, water and soil; fires; inadequate worker protection; poor plant safety; accumulation of radioactive wastes at the plant and other sites; and unsafe movements and transport of highly hazardous materials (3). Such risks at work may be related to accidental exposure to or ingestion and inhalation of radioactive material, or to fires and explosions.

28. A number of accidents have occurred at nuclear weapons production and disposal facilities that have affected health through overexposure, radiation contamination with plutonium and other transuranic nuclides, poisoning with uranium hexafluoride, and so forth.
V. HEALTH-RELATED ENVIRONMENTAL EFFECTS OF NUCLEAR WEAPONS

Effects of actual use

29. Within the extensive destruction of the built environment, a nuclear explosion will destroy public health and sanitary facilities, thus opening the way for the spread of disease. Water supplies would be contaminated not only by radioactivity but also by pathogenic bacteria and viruses. Sewage treatment and waste disposal facilities would have almost completely disappeared.

30. Great numbers of putrefying human bodies and animal carcasses as well as untreated waste and sewage would provide easy breeding ground for flies and other insects. Diseases like salmonellosis, shigellosis, infectious hepatitis, amoebic dysentery, malaria, typhus, streptococcal and staphylococcal infections, respiratory infections and tuberculosis would occur in epidemic form over vast areas (2).

31. In addition to the acquired health risk for survivors from high-dose external radiation, the longer-lived radioisotopes, particularly strontium-90 with its 29-year half-life and caesium-137 with its 30-year half-life, would lead to a risk for the population over a large area and over long periods. An impaired immune system would contribute later to an increased incidence of cancer (10).

32. Among trees, evergreens are especially vulnerable to radiation; coniferous forests are liable to suffer most, whereas weeds are more resistant and will proliferate. Radiation is notably harmful to crops and the food chain; it is harmful to livestock and will contaminate milk and meat products. Plant pests are particularly resistant and would abound. The marine ecosystem would become contaminated and suffer similarly. For all practical intents there will be a severe shortage of edible and sustaining substances, at a time when the victims' needs are greatest (2).

33. In a major nuclear conflict climatic and global environmental changes would occur, with extensive health implications.

Risks of nuclear weapons production and disposal

34. Inherent health-related environmental risks linked to nuclear weapons production and disposal may stem from routine releases, industrial accidents, weapons testing, accumulated wastes, weapons disposal, or unforeseen events, including human errors.

35. Emission of radionuclides occurs during routine operations of a nuclear facility. Such releases are generally too small to constitute an appreciable risk to the environment and health.

36. There have, however, been serious accidents in weapons industrial complexes. For example, a chemical explosion at the waste storage facility in Kyshtym (former Soviet Union), in which about $10^{17}$ Bq of radioactive material were released, showered hundreds of square kilometres with radioactive substances causing, inter alia, the evacuation of 10 000 people (3). Two serious fires occurred in 1957 and 1969 at the nuclear weapons establishment in Rocky Flats (United States of America). The second accident, believed to be due to spontaneous ignition of plutonium scrap, released unknown quantities of plutonium into the environment (11).

37. Great amounts of radionuclides were discharged directly into the river Techa at the Chelyabinsk 55 complex (former Soviet Union). Thousands of inhabitants have received high doses of internal radiation. After 35 years water reserves in the region are still undrinkable. Excess levels of leukaemia and other radiation-induced disorders have been recorded among the population (12).

38. In April 1989 a nuclear-powered warship sank in the Barents Sea. Besides its nuclear reactor, the ship carried nuclear torpedoes. The risks of slow and continuous contamination of the waters or a sudden release of radioactivity after breakup cannot be taken lightly (13).

39. Plutonium is a harmful substance both to health and to ecosystems. Its main danger lies in its radioactivity. Huge quantities - some 250 tonnes - of military grade plutonium are held by several countries, whereas only three to seven kilograms are required to make a nuclear weapon (11). A man-made product,
rather than a resource, it has accumulated to the stage of becoming a dangerous, unwanted waste, although it has a use in breeder reactors. A safe method of plutonium disposal has not yet been found.

40. Testing is important in weaponry. At least 1950 nuclear weapons tests have been carried out since 1945 (14). Testing can be carried out in space, in the air, on the earth's surface or under water (all called "atmospheric"), or underground, the latter being the only method used at the present time. To date approximately 1420 underground tests have been conducted in different parts of the world.

41. Atmospheric nuclear tests posed hazards to both the personnel participating in the tests and, through environmental contamination, the general population. An enhanced risk of cancer is presumed among the military and other personnel who took part in atmospheric atomic tests. The whole population of the northern hemisphere has been subjected for many years to a risk of cancer due to earlier atmospheric tests, although this risk is very small compared with the risk of developing cancer from other causes. Fall-out from atmospheric testing has affected test areas, some of which have not been, after many years, restored to safe, habitable, arable conditions. Thyroid tumours in children of the Marshall Islands exposed to radioactive fall-out from tests have been documented (10).

42. Underwater testing contaminates vast areas of ocean and fish-bearing waters. A particular pathology is ciguatera, a highly toxic disease induced by eating fish that become poisoned by the disturbance of the ecological balance after coral reefs have been shattered by explosions. Epidemiological data for 1960-1984 showed a ten-fold increase in the disease in the Polynesian archipelago (10).

43. Underground tests in such islands as Novaya Zemlya in the Arctic and Mururoa in the Pacific cause particular concern. The latter is also used as a radioactive-waste storage site, and there are indications that plutonium-239 is accumulating in the food chain (10).

44. Decommissioning of nuclear facilities and dismantling of nuclear warheads involve complex sequences of related steps, including disablement, tagging, transport, storage and disposal of the highly enriched uranium and plutonium. The capacity of countries proceeding to dismantlement is reported to be insufficient, and under the best conditions it is expected to take many years. Interim storage arrangements would increase the risks of radiation accidents and environmental pollution.

VI. THE SOCIOECONOMIC EFFECTS OF NUCLEAR WEAPONS

45. The socioeconomic impact of the use of nuclear weapons is devastating. After nuclear war, even a scenario in which only military installations are assumed to be targeted gives a vivid idea of the terrifying conditions that would ensue. Besides the extensive breakdown of health facilities, attendant social structures, the economic system, communication lines and the very fabric of society would be severely disrupted.

46. Evacuation of large numbers of people to uncontaminated areas in the same country or mass exodus to neighbouring countries implies not only exacerbated health problems but also a series of social and economic difficulties for both the abandoned area and the receiving regions. Shortages of food, the possibility of intercommunal strife, disarray due to lack of work, societal disorganization, poverty, dependence and apathy, or revolts, all converge to create complicated social and economic problems that are likely to be of some duration.

47. Environmental degradation will create poverty and shortages of food, which in turn will exacerbate social friction, conflict and disorganization of authority, which may lead to violence and societal disintegration (15).

48. Studies on the perception of young people in industrialized countries of nuclear issues show that about a third to half of them feel concerned. The degree of anxiety about nuclear war does not seem to be associated with any specific psychopathological condition, neurosis or drug abuse. A realistic degree of anxiety has been interpreted as being a positive reaction and an expression of a developing sense of social responsibility (2).

49. Adults fear genetic defects and cancer, as noted among the survivors of Hiroshima and Nagasaki and the affected population of Chernobyl. Besides ionizing radiation, it is known that stress and anxiety also contribute to a fall in helper T-lymphocytes and immune response mechanisms.
50. A society that has suffered a major nuclear incident - in peacetime or in war - will be traumatized and, most likely, profoundly changed, as observed in the cities mentioned above.

VII. CONCLUSIONS

51. WHO has been concerned with the effects of use of nuclear weapons on health for many years. In 1984 and 1987 it presented detailed reports on the effects of nuclear war on health and the health services, concluding that in case of nuclear war no amount of help from the health profession would be adequate to meet the devastating health needs.

52. The threat of such a catastrophe is now remote and a nuclear war is unlikely. However, nuclear weapons still exist in great numbers and their production has not ceased altogether.

53. Health and environmental risks associated with accidental releases of radioactivity during nuclear weapons production, decommissioning of nuclear facilities, and dismantling of nuclear warheads, in addition to the health and environmental hazards posed by nuclear tests, are still widespread. These risks will continue as long as nuclear weapons are being produced, and the only remedy is their elimination.

54. WHO will continue its efforts to monitor and distribute further information on health and environmental risks and hazards, as well as on the health effects of radionuclides.

REFERENCES


