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. 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.

3. 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).

4. 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, tested and stockpiled; therefore the potential danger of the consequences of their use had not yet been eliminated. Developments should be monitored.

II. HEALTH EFFECTS OF NUCLEAR WEAPONS

5. 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.
6. The nuclear 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.

7. 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).

8. 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).

9. 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).

10. 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).

11. 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).

III. HEALTH RISKS OF NUCLEAR WEAPONS PRODUCTION, TESTING AND DISPOSAL

12. An account of the health effects of nuclear weapons must also include considerations of the production cycle of these weapons, from mining and production of materials, fuel enrichment, 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.
13. At the reactor, reprocessing or production plant, hazards to personnel may include routine and accidental release of radionuclides and other harmful substances into air, water and soil with subsequent detrimental consequences to flora and fauna. Poor plant safety, in particular inadequate worker protection, leaks and fire hazards, in another concern, because some of the top-secret plants have not undergone the same upgrading of safety procedures and equipment as commercial plants. Such risks at work may be related to accidental exposure to or ingestion and inhalation of radioactive material, or to fires and explosions. Accumulation of radioactive wastes at the plant and/or other designated sites, as well as movements and transport of highly hazardous materials, would pose an additional hazard (3).

14. A number of accidents have occurred at nuclear weapons production and disposal facilities that have affected health through explosion hazards, instantaneous or long-term overexposure to radiation, contamination with plutonium and other transuranic nuclides, poisoning with uranium hexafluoride, and so forth.

15. There have 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).

16. 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).

17. Plutonium is a toxic substance and harmful both to health and to ecosystems. Its main danger lies in its long-term radioactivity. This very hazard is also used for reliable long-term energy sources, such as in pacemakers. Large quantities - some 250 tonnes - of weapon 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 resource, it has accumulated to the stage of becoming a dangerous, unwanted waste. Plutonium is usually bred under neutron bombardment from natural uranium and can also be mixed with uranium or substitute it to become a nuclear reactor fuel. Such mixed fuels have been successfully used in current nuclear power plants; this type of fuel recycling could eventually be used to dispose of all stock piles of weapons grade plutonium and uranium.

18. 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.

19. 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 annual doses resulting from atmospheric nuclear testing have been estimated by UNSCEAR (16).
The dose was highest in 1963 (0.16 mSv) and has subsequently declined to less than 0.01 mSv in the 1990s. The short-lived radionuclides made important contributions to the annual doses at the time of the explosions. Doses from ingestion pathway peaked in 1964 and from external irradiation in 1965. The annual doses at present are due primarily to external irradiation (70%). The major contributors are Cs-137, C-14 and Sr-90. The dose from C-14 now exceeds that from ingestion of other radionuclides. 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).

20. 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).

21. Underground tests in such islands as Novaya Zemlya in the Arctic and Mururoa in the Pacific have been of particular concern. The latter is also used as a radioactive-waste storage site. Planned resumption of underground tests would not only entail the risk of instantaneous leaks of short-lived and long-lived radioisotopes to the ground, to water and air but also trigger potential long-term effects not immediately apparent. Geometrical changes, temperature and stress are likely to increase the number and size of crevices in the surrounding rock or ground. Such crevices would provide paths for long-term exchanges with the surroundings, in particular ground water, rivers and the oceans. Isotopes likely to dominate long-term radioactivity, notable Cs-137, C-14 and Sr-90, are known to be transported by water and stay in the food-chain. In addition radioisotopes from prior tests and/or radioactive waste depositories which had already settled or lodged in the rock are feared to be freed again by the new tests. There have also been insinuations that plutonium-239 has leaked or migrated and is accumulating in the food chain (10).

22. 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.

IV. EFFECTS OF ACTUAL USE

23. 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.
24. 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).

25. 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).

26. 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).

V. CONCLUSIONS

27. 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.

28. 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.

29. 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.

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

31. There are currently four main activities in this field: (1) International Programme on the Health Effects of the Chernobyl Accident (IPHECA), (2) Radiation Emergency Medical Preparedness and Assistance Network (REMPAN). Eight WHO Collaborating Centres within REMPAN have been established. They are located in Australia, Argentina, Brazil, France, Germany, Japan, Russia, USA. (3) Global Environmental Radiation monitoring network (GERMON). (4) In order to update knowledge about health effects of radiation, WHO has taken a decision to organize an International Conference on Health Effects of Chernobyl and other Radiological Accidents. The Conference will be held in Geneva from 20 to 23 November 1995. This Conference will discuss main results obtained within pilot phase of IPHECA and compare them with findings from other radiological accidents.
REFERENCES


