Nuclear weapons, a continuing threat to health

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32,000 nuclear weapons, with a destructive force equivalent to several thousand megatons of conventional explosive, are still deployed. The risk of nuclear war by accident may have increased and new threats include war between newly declared nuclear-weapon-states and the construction by terrorist groups of crude but effective devices. Health workers have drawn attention in the past to the likely major health consequences of the use of nuclear weapons. An opportunity for their global elimination under a nuclear weapons convention arises with the current review conference in New York of the nuclear Non-Proliferation Treaty—a crucial event for efforts to bring about a world free of nuclear weapons.

Nuclear weapons have been used in war only twice, over Hiroshima and Nagasaki, Japan, in August, 1945. The energy yields were equivalent to 12,500 tonnes and 20,000 tonnes of high explosive. Yields from thermonuclear weapons (H-bombs) range up to several megatons (Mt). Between 1945 and the signing of the Comprehensive Test Ban Treaty in 1996, over 2000 nuclear tests were carried out by the USA, USSR, Britain, France and China, plus one by India. More than 800 of these were above-ground tests; the largest, by the USSR, had a yield of over 50 Mt.

Concern about radioactive fallout led to the Partial Test Ban Treaty of 1963 which only drove testing underground. Stockpiles rose to over 69,000 in 1985, but have fallen to around 32,000 today.1 Nevertheless, there will still be over 20,000 in about 2007, with a combined yield of some 10,000 Mt.2 Many missiles can be launched within minutes of an alert, which could be an error—indeed accidental nuclear war remains a serious risk.3 The economic crisis facing the Russian military undermines the Russian system of command and control, with more danger of an unauthorised military strike. In January, 1996, a rocket was launched from Norway to explore the aurora borealis. Notification of the launch was given but the information was not passed on, and President Yeltsin’s aides opened the “football” containing Russia’s nuclear launch codes. If a single Russian submarine had been ordered to fire its missiles, nearly 7 million people in US cities might have died from the resulting firestorms.4

The Non-Proliferation Treaty of 1970 obligates nuclear weapon states to achieve nuclear disarmament by negotiation, though their commitment is questionable. April 24 saw the start, in New York, of a review of this treaty and many non-nuclear states and non-governmental organisations will be pressing for genuine progress. This is the best, and perhaps the final, chance to advance to a nuclear-weapon-free world. The review ends on May 15, 2000.

Effects of nuclear weapons

Although today’s weapons can be accurately aimed at military targets these targets are often close to major population centres (eg, Faslane and Glasgow in the UK), so that any use of nuclear weapons would result in civilian casualties.

Information on the effects of nuclear weapons5–7 has been obtained from Hiroshima and Nagasaki and from animal experiments during the atmospheric tests of the 1950s. Effects depend upon the size of the explosion and its distance from “ground zero”, and whether the detonation takes place at ground level (when aimed at hardened military targets) or 600–1000 m up to maximise blast and thermal damage. Immediately after detonation the temperature at the centre of the fireball is several million °C, producing a shock wave travelling at supersonic speeds, followed by hurricane-force afterwinds, and an intense flash of heat radiation.

Most deaths from blast would result from indirect effects such as the collapse of buildings or being blown into objects. The human body can withstand direct overpressures of more than 200 kPa (2 atmospheres) but nuclear explosions create transient overpressures of up to 35 kPa. A “lethal area” is defined as the area within which the number of survivors is equal to the number of blast fatalities outside it. For a 100 kt explosion this area, if circular, has a radius of 2.4 km; for 1 Mt the lethal area is 71 km2 (panel 1, figure). The heat flash from a 100 kt airburst would cause lethal burns out-of-doors over about 75 km2.8 Flash blindness would occur over many kilometres.

“Prompt” radiation (neutrons and γ-rays) contributed to the deaths in Hiroshima and Nagasaki but direct radiation from the fireball of a large nuclear explosion
One has been tested. The collapse of the Soviet Union has plutonium can be used to make an explosive device, and needed to make a nuclear weapon. Reactor-grade plutonium and 220 tonnes is reprocessed from civil stockpiles are sufficient for the possibility to remain. The end production could kill many more in its aftermath. The end between uranium mining and lung cancer has been well known for centuries in the areas in central Europe, where pitchblende has been mined since the fifteenth century. The death rate from lung cancer is five times higher in uranium miners than in the general population. Almost all the world’s plutonium, the key component of modern nuclear weapons, has been produced in nuclear reactors since 1945. The reactor produces plutonium-239 from uranium-238 in a controlled nuclear reaction and the reprocessing plant separates chemically plutonium from the irradiated reactor fuel. After separation from residual uranium and fission products (highly radioactive and needing special storage), the plutonium is processed and assembled into weapons which are deployed at military bases. The toxicity of plutonium arises mainly from its radiological effect. Plutonium delivers a negligible external radiation dose to the skin because it emits mainly alpha particles. Inhaled plutonium will irradiate the lung, ingested plutonium the walls of the gastrointestinal tract. Weight for weight, ingested plutonium is more toxic than inhaled plutonium plus external radiation doses. The end of the “cold war” makes this risk less likely but remaining stockpiles are sufficient for the possibility to remain.

**Nuclear terrorism**

There are currently about 500 tonnes of separated plutonium available, of which 250 tonnes is military plutonium (3220 tonnes is reprocessed from civil nuclear reactors. Up to 14 kg (35 kg of the dioxide) is needed to make a nuclear weapon. Reactor-grade plutonium can be used to make an explosive device, and one has been tested. The collapse of the Soviet Union has been followed by illicit trafficking of fissile material by people who often have no concept of the danger of the material they are handling. In Küste, Estonia in January, 1995, caesium-137 stolen from the Saku Nuclear Waste Facility was kept in a kitchen cupboard, the thief died from radiation sickness.

A terrorist organisation could explode a crude weapon made of stolen plutonium with a yield of 0·1–20 kt. The largest 1939–45 bombs were only 0·01 kt.

**Health hazards of nuclear cycle**

There is a risk to health due to exposure to ionising radiation at all stages of both nuclear weapon manufacture and deployment and the civil nuclear cycle. Uranium is mined mainly in the USA, Australia, and central Europe, but also in France and Argentina. The link between uranium mining and lung cancer has been well known for centuries in the areas in central Europe, where pitchblende has been mined since the fifteenth century. The death rate from lung cancer is five times higher in uranium miners than in the general population. Almost all the world’s plutonium, the key component of modern nuclear weapons, has been produced in nuclear reactors since 1945. The reactor produces plutonium-239 from uranium-238 in a controlled nuclear reaction and the reprocessing plant separates chemically plutonium from the irradiated reactor fuel. After separation from residual uranium and fission products (highly radioactive and needing special storage), the plutonium is processed and assembled into weapons which are deployed at military bases. The toxicity of plutonium arises mainly from its radiological effect. Plutonium delivers a negligible external radiation dose to the skin because it emits mainly alpha particles. Inhaled plutonium will irradiate the lung, ingested plutonium the walls of the gastrointestinal tract. Weight for weight, ingested plutonium is more toxic than inhaled plutonium plus external radiation doses. The end of the “cold war” makes this risk less likely but remaining stockpiles are sufficient for the possibility to remain.

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Radioactive materials have been released from some at least of these sites. Furthermore, information about releases has not always been reliable, and standards of handling waste have been ignored at Dounreay (where reprocessing has now ceased) and have been appalling at the Russian complex at Mayak, where Lake Karachai may be the most radioactively contaminated site on earth. Leaks of strontium-90 and caesium-137 are over five times the combined releases of these isotopes from atmospheric nuclear testing, Chernobyl, and Sellafield taken together. In the 1957 Kyshtym accident in this region of the Urals high-level waste was dispersed by a chemical explosion in a storage tank, and a later report will describe environmental and health effects around the Mayak site.

Epidemiological studies do not prove that the leukaemia clusters are due to release of radioactivity. On conventional models of radiation carcinogenesis the exposures seem too small to account for the effects observed. It has been suggested that preconceptual irradiation might be to blame, but other studies have failed to confirm this, and the finding is currently ascribed to chance. A large study of cancer in the children of radiation workers found increased cancer, but no correlation with parental radiation dosage. Radiation doses in such studies are generally expressed as effective whole-body dose, but recent research raises the possibility that inhaled or ingested radioisotopes, particularly alpha-emitters such as plutonium, may have a disproportionate effect. Irradiation of human bone marrow with a-particles (which have high linear-energy-transfer) causes "genomic instability" resulting in diverse aberrations in the progeny of some stem cells many cell divisions later. The UK's Committee on Medical Aspect of Radiation in the Environment remains unconvinced of the relevance of this work to the Sellafield cluster. If the relative biological effectiveness of absorbed a-emitters is high enough to explain the excess leukaemia around Sellafield, COMARE estimates that natural background sources would induce more cases of leukaemia and non-Hodgkin lymphoma than are actually observed, but accepts that further research is needed on effects in the offspring of irradiated male parents. Mice were treated with plutonium-239 and the offspring were given a carcinogen, methylmethanesulphonate. Significantly more of the offspring of irradiated male parents developed leukaemia and lymphoma, than those of untreated parents; there are many more cell divisions in spermatogenesis than ovogenesis. The pathological consequences of low-level internal radiation, particularly from a-emitters, and the concept of genomic instability are beginning to suggest that standard models of radiation effects need updating.

**Nuclear testing**

One source of release of radioactivity should have ended with the Comprehensive Test Ban Treaty but this treaty is still not in force, and the legacy of atmospheric tests in the 1940s and 1950s will remain for centuries. Meanwhile, two non-signatories to the treaty, India and Pakistan carried out underground tests in May, 1998 and in April, 1999, both countries test-fired nuclear capable missiles with ranges of over 2000 km. The relation between leukaemia in Utah, USA, and radioactive fallout from the Nevada test site was investigated in a case-control study of 1177 individuals who died of leukaemia and 5330 controls. The risk increased in subgroups defined by cell type, age, and time after exposure. As a result of atmospheric tests in Nevada, mainly between 1951 and 1958, American children were exposed to 15-79 times more radiation than previously admitted. Some children's thyroids received up to 1-1 Gy, and many millions more than 0·1 Gy. This will cause between 10 000 and 75 000 excess thyroid cancers, only a third of which will have been diagnosed to date.

Evidence of the effects of Pacific testing remains anecdotal because of the official secrecy of the Minsei of Defence of Britain and France, but armed forces personnel and the local population may well have been exposed to what are now considered to be unacceptably high levels of radiation. The US government has awarded compensation to US test veterans for certain cancers, but similar requests from British test veterans have been refused. Anecdotal reports document the concerns of the native population of the Pacific islands.

**Solutions**

The only solution is prevention—ie, the elimination of all nuclear weapons. This is a political issue but preventive medicine often has a political dimension. Physicians' groups such as International Physicians for the Prevention of Nuclear War have long been concerned with the threat of nuclear war. Indeed the former USSR's Mikhail Gorbachev was convinced by his contacts with IPPNW in the need to bring about nuclear disarmament, and he initiated the stepwise reduction in nuclear weapons stockpiles.

The end of the cold war has provided a window of opportunity for the elimination of nuclear weapons—indeed, according to 1996 advisory opinion of the International Court of Justice (the "World Court") this is an obligation. IPNW and its affiliates were active in persuading governments to vote in the UN General Assembly for the opinion to be obtained. The Court stated that any use of nuclear weapons must accord with international humanitarian law limiting attacks on civilians and neutrals and damage to the environment. The Court could not agree on whether use would or would not be legal "when the very survival of a state was at stake".

The International Court of Justice could find nothing in international law specifically either authorising or forbidding the use of nuclear weapons but it interpreted Article VI of the 1968 Nuclear Non-Proliferation Treaty as an obligation on the part of the nuclear-weapons states to achieve nuclear disarmament at an early date under strict and effective international control. A nuclear weapons convention, analogous to the conventions on biological (1972) and chemical (1994) weapons, which would outlaw the testing, production, stockpiling, or use of all nuclear weapons is required. Through Abolition 2000, a coalition of over 700 medical and other peace groups worldwide, a draft version is available.

Making such a convention effective is not easy and verification of the final stage of destruction of nuclear stockpiles will present problems. The knowledge of how to make nuclear weapons will always be with us but as familiarity with them becomes more remote, the military would increasingly distrust them (as might the patients of a surgeon advising an operation he had never performed before).
Highly enriched uranium or plutonium is essential for nuclear weapons, so a country with a civil nuclear energy programme that is prepared to refuse International Atomic Energy Agency inspection could rapidly acquire such weapons. An end to reprocessing would thus offer the least likelihood of plutonium being made available for weapons at a later date.

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References

The rights of the severely mentally ill in post-conflict societies

Despite continuous debate about the value of implementing mental health and psychosocial programmes in the early reconstruction phase of societies that have undergone humanitarian emergencies. We are concerned that theoretical polarisations that have emerged in this field could undermine efforts to provide legitimate mental-health services to high-risk subgroups, especially those with severe mental illnesses.

Disagreement among experts in the field seems to stem mainly from an “either-or” fallacy, with some authorities implying that entire populations exposed to war are “traumatised”. Critics, however, have argued that normative social responses to extreme human-rights abuses should not be medicalised by labelling them as post-traumatic stress disorder (PTSD).1 It seems important, therefore, to identify separate if overlapping classifications of disorders and about the transcultural validity of western diagnostic categories in post-conflict populations. Questions remain about the translational validity of western diagnostic categories in classifying these disorders and about the effectiveness of indigenous methods for treating them. Nevertheless, psychoses and severe mood disorders rank high as causes of disability worldwide, and it is clear that these disorders are found across post-conflict societies, even if there may be cultural differences in conceptualising and dealing with such problems.

Indeed, certain risk factors to severe mental illness are accentuated in populations exposed to conflict and displacement. These factors include: poor antenatal health and nutrition; suboptimal perinatal care; increased risk of birth injuries; infantile malnutrition; early separation from care givers; neglect and understimulation of children; exposure to chronic communicable diseases that affect the brain; the risk of traumatic epilepsy; and exposure to extreme and repeated stress.

In times of civil war and mass displacement, those with established mental illnesses are vulnerable to abuse, neglect, abandonment, and exploitation. Institutions, including psychiatric facilities, are usually destroyed or abandoned, leaving patients without protection, medicalisation, or social support. Individuals with overt psychosis may be found living in states of gross dereliction, commonly falling prey to malnutrition, stigma, ostracism, and even violence. The mentally ill are at risk therefore of life-threatening physical illness, death from misadventure, or violence and suicide. Children born to psychotic mothers may be at high risk of death from malnutrition and disease resulting from maternal neglect. In some communities, people with mental illness are chained to trees or posts simply to prevent them from assaulting family members, from wandering, or from being attacked by neighbours or strangers. Having to care for a person with chronic mental illness may be the critical element that prevents a family unit from achieving some degree of self-sufficiency under already precarious conditions. When bizarre and disruptive social behaviour by a few psychotic individuals occurs repeatedly in a confined situation such as a refugee camp, it can have an erosive impact on the fragile social fabric of displaced communities.

Social networks and indigenous healing practices that may assist in the care of the mentally ill are usually disrupted by war and displacement. Emergency health services provided by relief organisations rarely include psychiatrists so that personnel are often at a loss as to how to deal with those with severe mental illness, and sufferers may be condemned to long periods without access to appropriate treatment.

What evidence is there that efficient, low-technology mental-health facilities can be effectively established in these contexts? Models now exist in Africa, Cambodia, and elsewhere that demonstrate the effectiveness of establishing such programmes. In a refugee camp in northern Kenya, the mental-health service is led by two psychiatric nurses and volunteer community workers from the relevant ethnic communities. In 1998, 600 people were treated by the service, representing about 1% of the total camp population. In Cambodia, since a community mental-health service was established in 1995 in Siem Reap, patients have travelled long distances from all around the country to seek treatment at the centre. In both settings the numbers of patients who attend the clinics has grown dramatically during a short period. Most of the early attendees have been those with severe mental illnesses. There are fewer people with trauma-related disorders, although the numbers are increasing, which suggests that the initial barriers of stigma and suspicion tend to decrease with time.

The impact of treatment can be dramatic. Individuals respond rapidly to the introduction of standard antipsychotic medications and supportive community follow-up. When visited by a consultant team some months after the initiation of treatment, a psychotic man chained to a tree for 8 months in Siem Reap, Cambodia, was found to be working in the rice fields with his family, apparently restored fully to his usual mental state. Traditional family structures often provide a supportive environment for the rehabilitation of psychotic patients. In refugee camps, community volunteers can be trained to provide outreach services, family education and support, and links to agencies that provide rehabilitation. Efforts to destigmatising and reintegrate people with psychiatric illness into society may be pursued by community-based awareness raising and education programmes for the whole population.

Critical issues in service development for the severely mentally ill remain. Psychotropic medications, particularly the newer and more expensive drugs, are scarce. Controversy continues about imposing...
Western models of mental illness on other cultures, but this concern needs to be balanced against the effects of rapid cultural change. Excessive zeal in “protecting” local cultures from global trends in disciplines such as mental health can be as patronising as devaluing indigenous approaches to healing. In Cambodia, one of us (RM) and his Harvard-based group have attempted to address these complex issues by giving equal emphasis to Western and traditional systems of diagnosis and treatment.

The second population subgroup that warrants consideration are those who experience extreme psychological reactions to trauma. Research in the field assists in clarifying some of the ongoing controversies about applying Western concepts of trauma and PTSD across diverse cultural settings. Epidemiological evidence indicates that PTSD can be identified in most cultures, but only a minority of those exposed to mass violence suffer from the disorder; numbers vary from 4 to 20%. In addition, most people with early symptoms of the disorder undergo natural remission over time. Consequently, there can be no justification for the blanket application of group-based early interventions such as debriefing. An important consideration for service provision is that those with severe PTSD are often the least likely to seek treatment. In addition, cultural, religious, and political factors seem to exert an appreciable influence on the ability to protect the security of the recovery environment, which indicates that part of the response to the problem may be to direct limited resources towards population-based interventions rather than to conventional one-to-one therapy.

PTSD is not the only psychiatric outcome of mass trauma exposure. Other disorders, such as drug and alcohol abuse, somatisation, anxiety, and especially depression, are common sequelae. An important finding in a study of Bosnian refugees is that comorbidity of PTSD and depression, a common clinical presentation, is associated with high rates of psychosocial disability. Thus, the available data suggest that for the subgroup with disabling psychological responses to trauma, further work is needed to: refine selection criteria for treatment; define the essential ingredients of therapeutic interventions; and to establish the appropriate balance between population-based and clinic-based interventions.

Whether mental health professionals have any role in offering interventions to most of the population who undergo normative adaptive responses to mass violence and displacement remains to be seen. Opinions are divided on this issue. Where there is a growing consensus, however, is that a community-development approach is most appropriate to the needs of the whole population because it aims to restore the capacity of communities to reconstruct and develop their own societies. From a psychosocial perspective, community programmes might focus on strengthening family and kinship ties, promoting indigenous healing methods, facilitating community participation in decision-making, fostering leadership structures, and re-establishing spiritual, religious, social, and cultural institutions and practices that restore a framework of cohesion and purpose for the whole community.

Events of the past decade have provided us with stark reminders of the health costs of mass violence. The problem is too grave to allow theoretical polarisations to paralyse humanitarian action. There is a risk that a singular focus on the psychological impact of trauma will obscure the multiplicity of psychosocial needs that require attention in the reconstruction phase. Mental health programmes that attract a small portion of total aid funding provided worldwide for societies emerging from humanitarian crises, yet individuals with severe mental illness are at particular risk of neglect, abuse, and disability. Lack of treatment for affected individuals undermines the capacity of families to attend to basic survival needs, and further erodes the fabric of the community as a whole. At the same time, the “either-or” fallacy alluded to earlier should be avoided, and strategies to assist people severely disabled by psychic trauma need to be developed in parallel with programmes for the severely mentally ill. The risk of ideological rigidity as to which subpopulation (and hence which set of interventions) should be given priority, risks confusing donors, relief organisations, and international agencies charged with setting priorities for humanitarian relief programmes in a field where competition for funds is intense. The risk of excessive dissent among mental-health experts in the field is that the casualties of mass conflict may become the unintended victims of our neglect.

**Tools to measure landmine incidents and injuries**

Despite an international treaty banning the use of landmines, thousands of people are killed or injured by these weapons every year. The pain and suffering for countless victims of landmines around the world is staggering. In Cambodia, one out of every 236 people is an amputee and in Afghanistan, almost one out of every 50 is a landmine victim. Studies show that 48% of victims may die before receiving assistance and most will ultimately need extensive rehabilitation. In many of these countries, the loss of a limb severely disables a person and impedes their ability to function as a productive member of society.

Epidemiological surveys are essential for properly quantifying the public-health consequences. The results of such studies facilitate the allocation of resources and aid in evaluating the impact of interventions. Physicians for Human Rights (PHR) has coordinated the development of standardised survey tools to ensure that data collection proceeds according to appropriate scientific methods and allows for the comparison of data between differing regions and countries. An instrument for hospital-based surveillance and a community survey tool were developed by PHR, WHO, the International Committee of the Red Cross, Injury Center Uganda, and the London School for Hygiene and Tropical Medicine. The goal of this tool is to establish a global reporting system so that injury data are collected and then transmitted to centres in ministries of health or international organisations responsible for the analysis and dissemination of data.
PHR and other members of the International Campaign to Ban Landmines have developed additional tools to measure prehospital care and hospital capabilities, prosthetic capabilities, and rehabilitation and social reintegration of landmine victims. These measure the effectiveness of the resources of hospitals and orthopaedic/rehabilitation centres to treat mine victims, provide medical care, and include characteristics of the physical plant, personnel, operating theatres, blood-donation capability, and sanitation. The data collected can help in the allocation of donor funding for specific projects or to individual facilities in need of necessary equipment and supplies. These tools also measure the extent to which a victim’s injuries are interfering with their ability to lead stable and self-sufficient lives and the degree to which they are receiving aid from the government. The UN Mine Action Service and the Information Management System for Mine Action have refined the hospital data tool so that it is standardised and universally accepted.

These core tools measure the morbidity and mortality associated with landmine injuries and collect information on demographical features, device-type, pre-hospital care, transportation time, and treatment. PHR is coordinating the pilot testing of these tools in collaboration with the participating organisations. PHR field-tested the tools in Azerbaijan in 1999. The tools will help identify areas where landmine injuries are a significant problem and thus target regions where more intensive surveys should be undertaken.

The tools were designed to be easy to use, inexpensive to administer, and can be used collectively or individually. Used as short surveys, they can be done quickly to determine need and can be repeated to measure change. A new manual available from PHR contains all seven tools and instructions on their use.

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Torture and the scientific community

The United Nations and professional umbrella organisations have stressed the importance of the prevention of torture and care for survivors, but also the duty of physicians to avoid any acts of complicity. Physicians in Turkey have been especially active not only in treatment, but also in the development and publication of methods to diagnose sequelae to torture.

Professor Veli Lok, an orthopaedic surgeon who is active in the Human Rights Foundation of Turkey, first published in the Lancet on the use of bone scintigraphy as a diagnostic tool in torture. This technique has become accepted world-wide as a standard procedure in specialised centres. Professor Lok and several of his co-workers, including psychiatrist Dr Alp Ayan and Dr Zeki Uzun, have now been targeted for acts of persecution in a campaign by Turkish government forces, who have been widely criticised for their extensive use of torture.

Lok is charged with having violated section 2, article 30, of the Turkish penal code which makes it a crime to violate a human being’s physical integrity. If convicted, Lok faces a maximum sentence of two years in prison. If convicted, Lok faces a maximum sentence of two years in prison. In his first sentence, Lok was sentenced to 2 years in prison for “abuse of authority” for his efforts to protect human rights in Turkey. He is currently under trial for “abuse of authority” for his efforts to protect human rights in Turkey.

The case highlights the need to ask not only the health professionals to refuse to collaborate with governments who use torture and to take an active role against human rights violations, but also to ask the international community to support those who have the courage to follow this request.

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