

Medicine and Nuclear War

From Hiroshima to Mutual Assured Destruction to Abolition 2000

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To determine how physicians might participate in the prevention of nuclear war in the post-Cold War era, we review, from a medical perspective, the history of the nuclear weapons era since Hiroshima and the status of today's nuclear arsenals and dangers. In the 1950s, physicians were active partners in governmental civil defense planning. Since 1962, physicians have stressed prevention of nuclear war as the only effective medical intervention. Public advocacy by physicians helped end both atmospheric nuclear testing in the 1960s and superpower plans for fighting a nuclear war in the 1980s. Today's dangers include nuclear arms proliferation, an increasing risk of nuclear terrorism, and the 35 000 warheads that remain in superpower nuclear arsenals, many still on hair-trigger alert. Physicians have recently joined with military and political leaders and over 1000 citizens' organizations in calling for the complete elimination of nuclear weapons. Global medical collaboration in support of a verifiable and enforceable Nuclear Weapons Convention would be a major contribution to safeguarding health in the 21st century.

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PHYSICIANS first confronted the implications of nuclear weapons on August 6, 1945, when surviving medical personnel struggled to care for the massive casualties in the aftermath of the Hiroshima nuclear explosion. In a city of 245 000, nearly 100 000 people were killed or doomed with one bomb, and 100 000 more were hurt. In *Hiroshima*, John Hersey described one physician's experience as follows:

"The people . . . wept and cried, for Dr Sasaki to hear, "Sensei! Doctor!" . . . Bewildered by the numbers, staggered by so much raw flesh, Dr Sasaki lost all sense of profession and

stopped working as a skillful surgeon and a sympathetic man; he became an automaton, mechanically wiping, daubing, winding, wiping, daubing, winding.¹

Dr Sasaki's patients soon developed the devastating features of acute radiation sickness, such as severe gastrointestinal problems, uncontrolled bleeding, hair loss, and extreme susceptibility to infection. With the city's medical facilities almost entirely destroyed, effective care was virtually impossible.²

1945-1946: ONE WORLD OR NONE?

Widespread joy over the ending of World War II was tempered by profound disquiet over the awesome destructive power unleashed by the splitting of the atom. President Harry S Truman's initial reaction to news from Hiroshima—"This is the greatest thing in history!"³—evolved by October 1945 into doubts that humanity and nuclear weapons could safely coexist. With leaders of Great Britain and Canada, Truman called for a United Nations (UN) commission to prepare recommendations "for the elimina-

tion from national armaments of atomic weapons and of all other major weapons adaptable to mass destruction."⁴

In 1946, the Federation of American Scientists published the best-seller *One World or None*.⁵ Also during that year, a top-level US government committee urged a UN-enforced verifiable global ban on all nuclear weapons, stating that only "if the dangerous aspects of atomic energy are taken out of national hands . . . is there any reasonable prospect of devising safeguards against the use of atomic energy for atomic bombs."^{4,6} In June 1946, the Soviet Union rejected

See also p 467.

the US-proposed Baruch Plan and called on the United States to eliminate its own nuclear arsenal (2 warheads in November 1946) as a precondition for further steps in developing a comprehensive and verifiable global abolition regime.⁴ The United States refused and, with rapidly developing Cold War tensions, efforts to achieve abolition faded.⁶⁻⁸

FROM ABOLITION TO THE BEST, THE BIGGEST, AND THE MOST

In the absence of a global abolition regime, the United States embraced the position of Manhattan Project Director General Leslie Groves: "If there are to be atomic weapons in the world, we must have the best, the biggest and the most."⁶ In 1952, spurred in part by the first Soviet nuclear test in 1949, the United States exploded a hydrogen bomb, with a yield 1000 times greater than the Hiroshima bomb. The Soviet Union followed suit less than a year later. Britain (1952), France (1960), and China (1964) soon conducted their own successful atomic test explosions. Just

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as the nations of India and Pakistan would argue in 1998, each nation insisted that if others were to have nuclear weapons then they must also.^{4,9}

Government officials in countries with nuclear weapons regularly minimized the dangers of radiation.^{3,9} General Groves even testified before the US Congress that radiation poisoning was “a very pleasant way to die.”⁶ In March 1954, radioactive fallout from the test explosion of a US hydrogen bomb at the Bikini Atoll caused severe radiation sickness to the crew of the Japanese fishing vessel *Lucky Dragon* 136 km (85 m) away, killing 1 crewman.⁹ Public opposition to nuclear testing mounted rapidly. But few medical voices of protest were heard, with such notable exceptions as David Bradley, MD, and 1952 Nobel Peace Laureate Albert Schweitzer, MD.^{6,9,10}

ORGANIZED MEDICINE EMBRACES CIVIL DEFENSE

In 1950, the US Federal Civil Defense Administration disseminated 16 million copies of a booklet titled *Survival Under Atomic Attack*, with widespread media support.⁶ That same year, organized medicine joined as an active partner in civil defense planning. The American Medical Association (AMA), the US Atomic Energy Commission, and the Federal Civil Defense Administration together brought physicians to leading medical schools for intensive training about organizing civil defense efforts in their home areas. Also, articles were published in *JAMA* and *The New England Journal of Medicine* that advised physicians on how to prepare for a nuclear attack.^{6,11-15}

By the early 1960s, total US and Soviet arsenals had grown to approximately 30 000 warheads and 4000 warheads, respectively, with a combined explosive force of nearly 4 tons of TNT (trinitrotoluene) for every man, woman, and child on the planet.¹⁶ In 1961, President John F. Kennedy called for a massive US fallout-shelter program and *Life* magazine ran a lengthy article assuring readers that 97 of 100 Americans would survive a nuclear war if only they built bomb shelters. Black-and-yellow fallout shelter signs were posted on public buildings and duck-and-cover drills were conducted throughout US school systems.^{6,9,17}

1962: PREVENTION IS THE ONLY CURE

The relationship of the medical profession to nuclear weapons policy changed abruptly in 1962 when an issue of *The New England Journal of Medicine* was dedicated to articles on the medical consequences of thermonuclear

war.¹⁸⁻²² Analyzing an attack on the United States postulated in 1959 by the Joint Congressional Committee on Atomic Energy, a new group called Physicians for Social Responsibility (PSR) documented the health effects of nuclear explosions in clinical detail. Severe traumatic injuries and massive burns, combined with life-threatening radiation exposure, would kill 1 300 000 people and injure 1 250 000 in the Boston, Mass, area alone. With widespread destruction of health care facilities, approximately 1 million of these injured would die. The authors of the articles concluded that attempted responses by health professionals after nuclear weapons had exploded would be almost entirely futile and that civil defense efforts offered little benefit. The articles and an accompanying editorial²³ argued that physicians, because of their special knowledge of the medical effects of these weapons and their special responsibility to protect the health of patients and their communities, had a special responsibility to help prevent the use of nuclear weapons.

The articles gained worldwide attention, and PSR grew rapidly. Other medical studies documented increasing levels of strontium 90, a component of radioactive fallout, in the deciduous teeth of children in the United States and Europe.²⁴⁻²⁶ In October 1962, the Cuban missile crisis brought the world to the brink of actual nuclear war.²⁷ Public concern about nuclear weapons rose to new heights.

In 1963, the United States, United Kingdom, and Soviet Union signed the Limited Test Ban treaty (LTBT), which banned nuclear test explosions in the atmosphere or underseas. In actuality, the pace of nuclear test explosions afterward increased, with more than 1000 additional tests over the next 2 decades.²⁸ The nuclear arms race had not slowed, it had simply disappeared from public view. It had, literally, gone underground.

1964-1979: MUTUAL ASSURED DESTRUCTION

After the 1963 LTBT, public concerns about nuclear weapons dissipated almost overnight.⁶ The nuclear confrontation between the United States and the Soviet Union appeared to have settled into an uneasy era of nuclear deterrence through mutual assured destruction (MAD).²⁹ Mutual assured destruction was not, however, a steady equilibrium state; from 1970 to 1984, the Soviet strategic arsenal increased from 1400 warheads to 7900, while the US strategic arsenal increased from 2200 to 7400.³⁰ Furthermore, the underground testing programs permitted by the LTBT led to the

development of progressively lighter and more compact hydrogen bombs. These made the creation of multiple, independently targeted, reentry vehicles (MIRVs) possible, through which up to 16 warheads could be delivered with great accuracy by a single ballistic missile. The MIRVs, in turn, raised the specter of a possible disarming first strike and sparked increased reliance on dangerous hair-trigger, use-them-or-lose-them launch-on-warning policies.^{31,32}

CAN NUCLEAR WAR BE WON?

With the Soviet invasion of Afghanistan in 1979, President Jimmy Carter's subsequent decision to withdraw the SALT II treaty from the US Senate ratification process, and plans by the Soviet Union and the North Atlantic Treaty Organization (NATO) to place SS-20, Pershing II, and cruise missiles in Europe as “theater nuclear weapons,” public opposition to nuclear weapons was reignited. Of greatest concern was growing evidence of superpower plans for nuclear war.

In 1976, US Secretary of Defense James Schlesinger and others warned that the Soviet Union was determined to be able to fight and prevail in a nuclear war and urged a large-scale expansion of US nuclear forces and expanded civil defense preparations.³³⁻³⁵ In an influential 1980 article titled “Victory Is Possible,” future Reagan Defense Department Adviser Colin Gray wrote that “the United States must possess the ability to wage nuclear war rationally. . . . Once the defeat of the Soviet state is established as a war aim, . . . an intelligent US offensive strategy, wedded to homeland defense should reduce US casualties to approximately 20 million. . . .”³⁶

In March 1981, Richard Pipes, President Ronald Reagan's senior adviser on the Soviet Union, warned publicly that Soviet leaders would “have to choose between peacefully changing their Communist system . . . or going to war.”³⁷ The following year, Reagan proposed a \$4.3 billion civil defense program centering on “crisis relocation” of America's urban population. The US Federal Emergency Management Agency estimated that with effective evacuation over 4 to 7 days, proper sheltering, and other civil defense measures, 80% of the US population could survive a large-scale nuclear attack.³⁷

1980s: PHYSICIANS AND MUTUAL ASSURED SURVIVAL

Concerned by these developments, in 1980 Bernard Lown, MD, of the United States and Evgueni Chazov, MD, Deputy Minister of Health of the Soviet Union, joined with other colleagues in founding International Physicians for the Prevention of Nuclear War (IPPNW). Members

of IPPNW disseminated updated information about the medical effects of nuclear explosions in the West and in the Soviet Union, consistently underscoring the near-total inability of the medical profession to provide effective care in the aftermath of a nuclear attack.³⁸⁻⁴⁵ Insisting that physicians and others could and must transcend all other political or national differences to work together for mutual survival, IPPNW grew rapidly and gained support from prominent leaders of medicine worldwide.⁴⁶⁻⁵⁴

In striking contrast to its partnership in government civil defense planning in the 1950s, the 1980s opposition of US physicians to preparations for nuclear war was strong and decisive. In 1981, the AMA Board of Trustees passed a landmark resolution stating, “[A]vailable data reveal that there is no adequate medical response to a nuclear holocaust.”⁵⁵ The resolution concluded that the AMA should “inform the President and the Congress of the medical consequences of nuclear war so that policy decisions can be made with adequate factual information.” Since 1983, *JAMA* has devoted the first issue of each August, in commemoration of the anniversary of Hiroshima, to articles addressing the prevention of nuclear war, the health effects of nuclear radiation, and related subjects of war, conflict, and human rights.⁴⁶ Other national medical organizations, such as the British Medical Association, published detailed studies about the inadequacies of medical care after nuclear attack, but like the AMA refrained during the Cold War from making specific policy recommendations regarding how nuclear war might best be prevented.^{56,57}

In 1984, PSR (IPPNW-USA) published *The Counterfeit Ark*, a point-by-point technical refutation of the claimed effectiveness of the Federal Emergency Management Agency’s plans, combined with a moral condemnation of nuclear war fighting plans. The book’s editors pointed out that to “accept the survival of 80% of the US population as a reasonable policy goal is also to accept as reasonable the deaths of 45 million people.”⁵⁸ The Federal Emergency Management Agency’s plans were soon widely discredited, and in 1985 President Reagan and Mikhail Gorbachev jointly proclaimed that “a nuclear war cannot be won and must never be fought.”⁵⁹

Awarding the 1985 Nobel Peace Prize to IPPNW, the Nobel Committee honored physicians for “spreading authoritative information and . . . creating an awareness of the catastrophic consequences of atomic warfare . . . this in turn contributes to an increase in the pressure of public opposition to the proliferation of atomic weapons. . . .”^{60,61}

Stressing the unique effectiveness of IPPNW regarding nuclear weapons, Gorbachev commented that in light “of their arguments and the strictly scientific data which they possess, there seems to be no room left for politicking.”⁵⁹

On January 15, 1986, Gorbachev proposed a 15-year plan for the stage-by-stage elimination of nuclear weapons by the end of the 20th century. At their summit meeting in Reykjavík, Iceland, in October 1986, Gorbachev and Reagan seriously discussed nuclear abolition, but a tentative agreement to eliminate all strategic offensive weapons within 5 years fell apart when Reagan would not agree to permanent adherence to the Antiballistic Missile (ABM) treaty, since that would foreclose plans for his Strategic Defense Initiative (Star Wars).⁵⁹

RECENT RESEARCH ON NUCLEAR WEAPONS AND WAR

As the 1980s progressed, scholarly reports by the World Health Organization, the Institute of Medicine of the US National Academy of Sciences, and others described previously unsuspected dangers of nuclear warfare.⁶²⁻⁶⁴ Scientists warned that a superpower nuclear war might cause a “nuclear winter” that could threaten the extinction of the human species,⁶⁵ leading Jonathan Schell to reflect in *The Fate of the Earth* about the unprecedentedly grave medical and moral challenges of the nuclear weapons era.⁶⁶ Even the more modest temperature drop predicted by subsequent calculations would cause serious disruptions of agriculture.⁶⁷ Mass starvation and illness resulting from disruption of agricultural, transportation, industrial, and health care systems would cause between 1 and 4 billion deaths worldwide.⁶⁸ The prevention of nuclear war thus became a matter of urgent and shared importance for every nation on earth—nuclear or nonnuclear, rich or poor, in the North or in the South.

Later medical studies provided additional information about the toll of nuclear weapons production and testing. The US National Cancer Institute estimated that the release of iodine 131 in fallout from US nuclear test explosions was by itself responsible for 49 000 excess cases of thyroid cancer among Americans.⁶⁹ An IPPNW study estimated that the strontium 90, cesium 137, carbon 14, and plutonium 239 released worldwide in all nuclear test explosions would be responsible for 430 000 cancer deaths by the year 2000.⁷⁰ A separate study by IPPNW and the Institute for Energy and Environmental Research summarized additional widespread health and environmental effects of nuclear weapons production with mas-

sive contamination of land by radioactive materials and toxic chemicals.⁷¹

1989-1998: THE COLD WAR ENDS; NUCLEAR WEAPONS REMAIN

With the euphoria that accompanied the 1989 fall of the Berlin Wall, public antinuclear concerns again dissipated rapidly, exactly as had happened after the LTBT in 1963. Again, however, dangers from nuclear weapons continue.

Despite some reductions, 35 000 nuclear weapons remain in today’s arsenals.⁷² Even if all existing US-Russian arms-control treaties were fully implemented (by the year 2003), nearly 20 000 nuclear warheads would remain, with an explosive force of 200 000 Hiroshima bombs. Although nuclear weapons are often thought of as a relatively inexpensive source of military strength, a recent Brookings Institution study concluded that the cost since 1940 of the US arsenal alone has been more than \$5 trillion, larger than the entire US national debt.⁷³ The United States continues to spend \$35 billion annually on nuclear weapons, including \$4.5 billion per year to monitor the reliability of the stockpile and to develop new weapon designs—similar to the budget for those activities during the Cold War.^{73,74} In 1998, the Brookings Institution estimated that \$35 billion continues to be spent annually on nuclear weapons by the United States alone, including \$4.5 billion per year to maintain existing weapons and develop new weapon designs.⁷⁴

Dangerous Cold War launch-on-warning procedures also remain in place. An April 1998 study reported that the risk of “accidental” nuclear war was increasing, as a result of deterioration in Russian computer and radar systems.⁷⁵ The study estimated that an accidental or unauthorized nuclear attack by a single Russian submarine would likely cause at least 6.8 million immediate US deaths in urban firestorms, even though concrete steps to eliminate that danger are available.

Other risks include the possibility of nuclear terrorism by subnational groups.⁷⁶⁻⁷⁸ A recent, authoritative book concluded that with “the end of the Cold War . . . the risk of a nuclear detonation on American soil has increased . . . the leakage of weapons-usable nuclear materials from the former Soviet Union is already occurring and could easily get worse in frequency and magnitude . . . no reality of the post-Cold War international environment constitutes a more direct threat [to US security]. . . .”⁷⁸

India and Pakistan

The May 1998 series of Indian and Pakistani nuclear test explosions sparked fears both of a South Asian nuclear war and of an unraveling of global efforts to

prevent nuclear proliferation and to implement the Comprehensive Nuclear Test Ban treaty. Reiterating its opposition to the perpetuation of “nuclear apartheid,” under which the 5 permanent members of the UN hold tightly to their own nuclear arsenals while denying them to all others, India has repeatedly called for a serious global commitment to nuclear abolition.^{79,80}

ABOLITION 2000: A NUCLEAR WEAPONS CONVENTION

In December 1994, the IPPNW united all of its anti-nuclear weapons activities within a campaign titled Abolition 2000, with the goal of a signed global agreement by the year 2000 that would commit the world to the permanent elimination of nuclear weapons within a specified time frame.⁸¹

In April 1995, a broad-based coalition of more than 100 citizens’ organizations united behind a more detailed 11-point Abolition 2000 statement (Table). By early 1998, Abolition 2000 had grown to involve more than 1000 citizens’ organizations in 75 countries.⁸² Building on lessons learned from the first 50 years of unsuccessful efforts to achieve a definitive solution to the dangers of nuclear weapons, today’s Abolition 2000 campaign has integrated global grassroots activities with legal initiatives and collaboration with military, political, and other world leaders, all aiming to culminate in a global treaty banning nuclear weapons. Important milestones in the past 2 years have transformed nuclear abolition from a utopian dream to a serious objective.

In 1995, the German Medical Association called for nuclear abolition, followed by national medical organizations in Japan, Norway, Switzerland, and elsewhere.⁸³ In the United States, the American College of Physicians, the American Public Health Association, and PSR (IPPNW-USA) have all called for an abolition agreement by the year 2000.^{84,85} In December 1996, the AMA called for the abolition of all weapons of mass destruction: nuclear, chemical, and biological.⁸⁶

In July 1995, US Air Force General Charles A. Horner, responsible for defending the United States and Canada against nuclear attack in his role as head of the US North American Aerospace Defense Command, issued a public appeal for the abolition of nuclear weapons that was unprecedented for an active-duty officer: “I want to get rid of them all. . . . Think of the high moral ground we secure by having none. . . . It’s kind of hard for us to say. . . . ‘You are terrible people, you’re developing a nuclear weapon’ when the United States has thousands of them.”⁸⁷

Abolition 2000 Statement

A secure and livable world for our children and grandchildren and all future generations requires that we achieve a world free of nuclear weapons and redress the environmental degradation and human suffering that is the legacy of 50 years of nuclear weapons testing and production. . . .

We call upon all states, particularly the nuclear weapons states, declared and de facto to take the following steps to achieve nuclear weapons abolition. We further urge the states’ parties to the Nuclear Nonproliferation Treaty to demand binding commitments by the declared nuclear weapons states to implement these measures:

1. Initiate immediately and conclude by the year 2000 negotiations on a nuclear weapons abolition convention that requires the phased elimination of all nuclear weapons within a time-bound framework, with provisions for effective verification and enforcement.
2. Immediately make an unconditional pledge not to use or threaten to use nuclear weapons.
3. Rapidly complete a truly comprehensive test ban treaty with a zero threshold and with the stated purpose of precluding nuclear weapons development by all states.
4. Cease to produce and deploy new and additional nuclear weapons systems, and commence to withdraw and disable deployed nuclear weapons systems.
5. Prohibit the military and commercial production and reprocessing of all weapons-usable radioactive materials.
6. Subject all weapons-usable radioactive materials and nuclear facilities in all states to international accounting, monitoring, and safeguards, and establish a public international registry of all weapons-usable radioactive materials.
7. Prohibit nuclear weapons research, design, development, and testing through laboratory experiments including but not limited to nonnuclear hydrodynamic explosions and computer simulations, subject all nuclear weapons laboratories to international monitoring, and close all nuclear test sites.
8. Create additional nuclear weapons-free zones such as those established by the treaties of Tlatelolco and Raratonga.
9. Recognize and declare the illegality of threat or use of nuclear weapons, publicly and before the World Court.
10. Establish an international energy agency to promote and support the development of sustainable and environmentally safe energy sources.
11. Create mechanisms to ensure the participation of citizens and nongovernmental organizations in planning and monitoring the process of nuclear weapons abolition.

A world free of nuclear weapons is a shared aspiration of humanity. This goal cannot be achieved in a nonproliferation regime that authorizes the possession of nuclear weapons by a small group of states. Our common security requires the complete elimination of nuclear weapons.

In July 1996, the World Court unanimously ruled that nations have “an obligation to pursue in good faith and to bring to a conclusion negotiations leading to nuclear disarmament in all its aspects,” under Article VI of the Nuclear Nonproliferation treaty.⁸⁸

In August 1996, the Canberra Commission on the Elimination of Nuclear Weapons, which included military and political experts from all countries with nuclear weapons, outlined a series of concrete steps toward abolition that could begin immediately and concluded that the “proposition that nuclear weapons can be retained in perpetuity and never used accidentally or by decision defies credibility. The only complete defence is the elimination of nuclear weapons and assurance that they will never be produced again.”⁸⁹

In December 1996, 63 generals and admirals from 17 nations, including General Horner, General Lee Butler (director of the US Strategic Command from 1991 to 1994, responsible for the entire US strategic nuclear arsenal), and US General Andrew J. Goodpaster (former Supreme Allied Commander of NATO forces in Europe), issued an unequivocal call for nuclear abolition: “We have been presented with a challenge of the high-

est possible historic importance: the creation of a nuclear weapons-free world. The end of the Cold War makes it possible. The dangers of proliferation, terrorism, and a new nuclear arms race render it necessary.”⁹⁰

In June 1997, the US National Academy of Sciences report on *The Future of US Nuclear Weapons Policy*,¹⁶ preferring the word *prohibition* to *abolition*, concluded that the “potential benefits of comprehensive nuclear disarmament are so attractive relative to the attendant risks—and the opportunities presented by the end of the Cold War and a range of other international trends are so compelling—that . . . increased attention is now warranted to studying and fostering the conditions that would have to be met to make prohibition [of nuclear weapons] desirable and feasible.”

Subsequently, Gorbachev, Carter, and 115 other political leaders from 46 nations issued a statement adding their support for nuclear abolition, stating that “the long-sought prospect of a world free of the apocalyptic threat of nuclear weapons is suddenly within reach” but warning that “it is also perishable.”⁹¹

A Nuclear Weapons Convention draft has been developed by an international

consortium of lawyers, scientists, and disarmament experts and is now a formal UN document, available in the 6 official UN languages for consideration and debate.⁹² An important precedent is the Chemical Weapons Convention, ratified by the US Senate in 1997, which establishes a timetable for the permanent elimination of all chemical weapons and specifies procedures for the unprecedentedly intrusive on-site inspections necessary to provide international confidence regarding treaty compliance.

MEDICINE AND NUCLEAR WAR—LESSONS FROM THE FIRST 50 YEARS

As the millennium approaches, the world appears to be at a crossroads with 2 options: either a continuation of the nuclear weapons era in some form, with permanent risks of proliferation, terrorism, and deliberate or accidental nuclear war, or global nuclear disarmament.

In the 1980s, the editors of *JAMA* and *The New England Journal of Medicine* emphasized that the voice of the medical community would be most effective if the medical profession were united in its views.^{46,52,53} Today, a striking consensus has evolved in support of abolition as the only reliable long-term solution to the threat of nuclear weapons. In light of its role over the past half century, how should the medical profession respond to today's challenges?

First, at crucial stages physicians have proven uniquely effective in ensuring that discussions of nuclear weapons policies are based in a vivid appreciation of the unparalleled destructive effects of nuclear explosions. Although it has been said that "a single death is a tragedy, a million is a statistic,"⁹³ physicians can help create and sustain a global culture in which nuclear weapons are universally seen as incompatible with the sense of reverence for life that underlies all medical work.^{10,54}

Second, as is true of any dire health warning, engendering fear of nuclear war is not enough; concrete steps that individuals or groups can take to mitigate the danger must be identified. If, however, these steps involve only partial solutions, as was true both for the LTBT in 1963 and for the public renunciation in 1985 by Reagan and Gorbachev of plans to win a nuclear war, the dangers of nuclear arsenals will continue to resurface in new forms. The Abolition 2000 Statement articulates concrete steps that in combination would constitute a comprehensive and permanent solution.

Third, today's global dangers of nuclear arsenals require truly global solutions. The Indian and Pakistani test explosions have cast grave doubt on

whether it is even plausible that the world can still maintain a double standard, in which some nations insist that nuclear arsenals are vital to their own security while denying those same arsenals to others. A united global voice of medicine could play a powerful role in establishing for nuclear weapons the single global norm that applies to chemical and biological weapons: zero.

Finally, as was true in the period immediately following Hiroshima and Nagasaki, the current window of opportunity to build global support for nuclear abolition is almost certain to be brief.

Although the abolition of nuclear weapons today has stronger support than ever before,⁷² dramatically increased efforts will be required of organizations like the American College of Physicians, AMA, American Public Health Association, PSR, and their international counterparts if the massive burn, blast, and radiation casualties that Dr Sasaki and his colleagues¹ faced in August 1945, and the global devastation that today's thermonuclear arsenals threaten, are to be definitively prevented. A successful campaign by medical organizations worldwide in support of a verifiable and enforceable Nuclear Weapons Convention would be an extraordinary contribution to safeguarding health in the 21st century.

As Albert Schweitzer taught, "Example is not the main thing in influencing others; it is the only thing."⁹⁴ Nuclear abolition cannot be achieved without US leadership, yet the United States has not yet seriously questioned its commitment to maintaining a massive nuclear arsenal. According to a 1997 telephone survey of a stratified sample of 1006 US households using random digit dialing, more than 87% of US citizens want the United States to negotiate an agreement to eliminate nuclear weapons.⁹⁵ US physicians and other citizens thus have a special opportunity and responsibility to convince elected leaders to make the abolition (or prohibition) of nuclear weapons a major national priority, as senior US officials advocated in the 1940s,^{4,6} as senior US military leaders and the US National Academy of Sciences advocate today,^{16,87,90} and as Article VI of the Nuclear Nonproliferation treaty legally requires.⁸⁸

Albert Einstein warned that "the explosive force of nuclear fission has changed everything except our modes of thinking and thus we drift toward unparalleled catastrophe. We shall require an entirely new pattern of thinking if mankind is to survive."⁹⁶ To this warning Lown, who joined with his Russian colleague Chazov in accepting the Nobel Peace Prize on behalf of IPPNW, has

added, "The new way of thinking must be an awakening to our common origins, to our shared problems, as well as to our common fate. If we are to prevail, we must never delegate in the presence of challenge and never whisper in the presence of wrong."⁹⁷

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References

1. Hersey J. *Hiroshima*. New York, NY: Vintage Books; 1989.
2. Committee for the Compilation of Materials on Damage Caused by the Atomic Bombs in Hiroshima and Nagasaki. *Hiroshima and Nagasaki*. New York, NY: Basic Books Inc Publishers; 1981.
3. McCullough D. *Summer of decision*. Truman. New York, NY: Simon & Schuster; 1992:454.
4. Wittner LS. *One World or None: The Struggle Against the Bomb*. Vol 1. Stanford, Calif: Stanford University Press; 1993:250, 254, 277-285.
5. Masters D, Way K, eds. *One World or None: A Report to the Public on the Full Meaning of the Atomic Bomb*. New York, NY: Ayer Co; 1971.
6. Boyer P. *By the Bomb's Early Light: American Thought and Culture at the Dawn of the Atomic Age*. Chapel Hill: University of North Carolina Press; 1994:53, 102, 322-328, 353, 355.
7. Hershberg J. The only possible solution of a desperate problem: trying to control the bomb, 1945-1946. In: *James B. Conant: Harvard to Hiroshima and the Making of the Nuclear Age*. New York, NY: Alfred A Knopf Inc; 1993:258-322.
8. Lifton RJ, Mitchell G. The afterlife. In: *Hiroshima in America: A Half Century of Denial*. New York, NY: Avon Books; 1995:168-174.
9. Wittner LS. *Resisting the Bomb: A History of the World Nuclear Disarmament Movement, 1954-1970*. Stanford, Calif: Stanford University Press; 1997:2, 118-124, 187, 260, 307, 314.
10. Jack HA, ed. *Albert Schweitzer on Nuclear War and Peace*. Elgin, Ill: Elgin Press; 1988.
11. Boyer P. Physicians confront the apocalypse: the American medical profession and the threat of nuclear war. *JAMA*. 1985;254:633-643.
12. Day B, Waitzkin H. The medical profession and nuclear war: a social history. *JAMA*. 1985;254:644-651.
13. Armstrong GE. Teaching the clinical aspects of atomic energy. *JAMA*. 1948;137:105-106.
14. Physicians training against atomic warfare [Medical News]. *JAMA*. 1950;142:1090.
15. Warren R, Jackson JH. Suggestions for first-aid treatment of casualties from atomic bombing. *N Engl J Med*. 1950;243:696-698.
16. Committee on International Security and Arms Control, National Academy of Sciences. *The Future of US Nuclear Weapons Policy*. Washington, DC: National Academy Press; 1997.
17. Winkler AM. A 40-year history of civil defense. *Bull Atomic Scientists*. June-July 1984:16-22.
18. Nathan DG, Geiger HJ, Sidel VW, Lown B. The medical consequences of thermonuclear war: introduction. *N Engl J Med*. 1962;266:1126-1127.
19. Ervin FR, Glazier JB, Aronow S, et al. The medical consequences of thermonuclear war, I: human and ecologic effects in Massachusetts of an assumed thermonuclear attack on the United States. *N Engl J Med*. 1962;266:1127-1137.
20. Sidel VW, Geiger HJ, Lown B. The medical consequences of thermonuclear war, II: the physician's role in the postattack period. *N Engl J Med*. 1962;266:1137-1145.
21. Aronow S. The medical consequences of thermonuclear war, III: a glossary of radiation terminology. *N Engl J Med*. 1962;266:1145-1149.
22. Leiderman PH, Mendelson JH. The medical consequences of thermonuclear war, IV: some psychiatric and social aspects of the defense-shelter program. *N Engl J Med*. 1962;266:1149-1155.
23. Garland J. . . . Earthquake, wind and fire [editorial]. *N Engl J Med*. 1962;266:1174.

24. Rosenthal HL, Gilster JE, Bird JT. Strontium-90 content of deciduous human incisors. *Science*. 1963;140:176-177.
25. Santholzer W, Knaif J. Strontium-90 content of deciduous human teeth. *Nature*. 1966;212:820.
26. Starkey WE, Fletcher W. The accumulation and retention of strontium-90 in human teeth in England and Wales—1959 to 1965. *Arch Oral Biol*. 1969;14:169-179.
27. McNamara RS. Appendix: the nuclear risks of the 1960s and their lessons for the twenty-first century. In: *In Retrospect*. New York, NY: Vintage Books; 1996:338-343.
28. Norris RS, Arkin WM. Known nuclear tests worldwide, 1945-1995. *Bull Atomic Scientists*. 1996; 52:61-63.
29. Remarks by Secretary of Defense Robert S. McNamara, September 18, 1967. *Bull Atomic Scientists*. December 1967:26-33.
30. Pipes R. What can we do? In: *Survival Is Not Enough*. New York, NY: Simon & Schuster; 1984:238.
31. Russett B, Chernoff F, eds. Introduction. In: *Readings From Scientific American: Arms Control and the Arms Race*. New York, NY: WH Freeman & Co; 1985:10-11.
32. Allison GT, Carnesale A, Nye JS, eds. An agenda for action. In: *Hawks, Doves, & Owls: An Agenda for Avoiding Nuclear War*. New York, NY: WW Norton & Co Inc; 1985:230-234.
33. Turner S. Appendix A: lethality of nuclear weapons. In: *Caging the Nuclear Genie: An American Challenge for Global Security*. Boulder, Colo: Westview Press; 1997:125.
34. Drell SD, von Hippel F. Limited nuclear war. In: Russett B, Chernoff F, eds. *Readings From Scientific American: Arms Control and the Arms Race*. New York, NY: WH Freeman & Co; 1985:96-106.
35. Tyroler C, ed. Alerting America. In: *The Papers of the Committee on the Present Danger*. Washington, DC: Pergamon-Brassey's; 1984:183.
36. Gray CS, Payne K. Victory is possible. *Foreign Policy*. Summer 1980:39. Reprinted in: Cassel C, McCally M, Abraham H, eds. *Nuclear Weapons and Nuclear War: A Sourcebook for Health Professionals*. New York, NY: Praeger; 1984:49-56.
37. Scheer R. *With Enough Shovels: Reagan, Bush & Nuclear War*. New York, NY: Random House; 1982:8, 104-119.
38. Lown B, Muller J, Chivian E, Abrams H. The nuclear arms race and the physician. *N Engl J Med*. 1981;304:726-729.
39. Chivian E, Chivian S, Lifton RJ, Mack JE. *Last Aid: The Medical Dimensions of Nuclear War*. New York, NY: WH Freeman & Co; 1982.
40. Lown B. Physicians and nuclear war. *JAMA*. 1981;246:2331-2333.
41. Abrams HL. Medical problems of survivors of nuclear war: infection and the spread of communicable disease. *N Engl J Med*. 1981;305:1226-1232.
42. Abrams HL. Medical resources after nuclear war. *JAMA*. 1984;252:653-658.
43. Hiatt HH. Preventing the last epidemic [editorial]. *JAMA*. 1980;244:2314-2315.
44. Hiatt HH. Preventing the last epidemic, II [editorial]. *JAMA*. 1981;246:2035-2036.
45. Scrimshaw NS. Food, nutrition, and nuclear war. *N Engl J Med*. 1984;311:272-276.
46. Lundberg GD. Hiroshima [editorial]. *JAMA*. 1983;250:617.
47. Hiatt HH. The final epidemic: prescriptions for prevention. *JAMA*. 1984;252:635-638.
48. Physicians on the anti-nuclear warpath [editorial]. *Lancet*. 1983;1:565-566.
49. Sidel VW. Destruction before detonation: the impact of the arms race on health and health care. *Lancet*. 1985;2:1287-1289.
50. Sidel VW. Weapons of mass destruction: the greatest threat to public health. *JAMA*. 1989;262: 680-682.
51. Cassel CK, Jameton AL, Sidel VW. The Physician's Oath and the prevention of nuclear war. *JAMA*. 1985;254:652-654.
52. Relman AS. Physicians, nuclear war, and politics. *N Engl J Med*. 1982;307:744-745.
53. Relman AS. The physician's role in preventing nuclear war. *N Engl J Med*. 1986;315:889-891.
54. Lown B, Chazov EI. Physician responsibility in the nuclear age. *JAMA*. 1995;274:416-419.
55. American Medical Association. Policies 520.999 and 520.997. Chicago, Ill: American Medical Association; 1981.
56. British Medical Association. *Report of the Board of Science and Education: The Medical Effects of Nuclear War*. Chichester, England: Wiley; 1983.
57. British Medical Association. *Report of the Board of Science and Education: The Long-term Environmental and Medical Effects of Nuclear War*. London, England: British Medical Association; 1986.
58. Leaning J, Keyes L, eds. *The Counterfeit Ark: Crisis Relocation for Nuclear War*. Cambridge, Mass: Ballinger Publishing Co; 1984:xxv.
59. Gorbachev M. *Perestroika: New Thinking for Our Country and the World*. New York, NY: Harper & Row; 1988:140, 212, 216-218.
60. Nobel Peace Prize Committee. Citation to the International Physicians for the Prevention of Nuclear War; October 11, 1985. Available at: <http://www.healthnet.org/IPPNW/NobelStatement.html>. Accessed July 1, 1998.
61. Lown B. Nobel Peace Prize lecture: a prescription for hope. *N Engl J Med*. 1986;314:985-987.
62. World Health Organization. *Effects of Nuclear War on Health and Health Services*. 2nd ed. Geneva, Switzerland: World Health Organization; 1987.
63. Institute of Medicine. *The Medical Implications of Nuclear War*. Washington, DC: National Academy Press; 1986.
64. Leaf A. New perspectives on the medical consequences of nuclear war. *N Engl J Med*. 1986;315: 905-912.
65. Turco RP, Toon OB, Ackerman TP, Pollack JB, Sagan C. Nuclear winter: global consequences of multiple nuclear explosions. *Science*. 1983;222:1283-1292.
66. Schell J. *The Fate of the Earth*. New York, NY: Alfred A Knopf Inc; 1982.
67. Turco RP, Toon OB, Ackerman TP, Pollack JB, Sagan C. Climate and smoke: an appraisal of nuclear winter. *Science*. 1990;247:166-176.
68. Harwell MA, Harwell CC. Nuclear famine: the indirect effects of nuclear war. In: *The Medical Implications of Nuclear War*. Washington, DC: National Academy Press; 1986:117-135.
69. National Cancer Institute. Calculation of the estimated lifetime risk of radiation-related thyroid cancer in the United States from the Nevada test site fallout; 1997. Available at: <http://rex.nci.nih.gov/massmedia/falloutQ%26A.html>. Accessed July 1, 1998.
70. International Physicians for the Prevention of Nuclear War. *Radioactive Heaven and Earth: The Health and Environmental Effects of Nuclear Weapons Testing in, on, and Above the Earth*. New York, NY: Apex Press; 1991.
71. Makhijani A, Hu H, Yih K, eds. *Nuclear Wastelands: A Global Guide to Nuclear Weapons Production and Its Health and Environmental Effects*. Cambridge, Mass: MIT Press; 1995.
72. Schell J. *The Gift of Time: The Case for Abolishing Nuclear Weapons Now*. New York, NY: Henry Holt & Co Inc; 1998.
73. Schwartz SI. *Atomic Audit: The Costs and Consequences of US Nuclear Weapons Since 1940*. Washington, DC: Brookings Institute Press; 1998.
74. Paine CE, McKinzie MG. *End Run: The US Government's Plan for Designing Nuclear Weapons and Simulating Nuclear Explosions Under the Comprehensive Test Ban Treaty*. Washington, DC: Natural Resources Defense Council; 1997. Available at: <http://www.NRDC.ORG/nrdcpro/fppubl.html>. Accessed July 10, 1998.
75. Farrow L, Blair BG, Helfand I, et al. Accidental nuclear war: a post-cold war assessment. *N Engl J Med*. 1998;338:1326-1331.
76. International Physicians for the Prevention of Nuclear War. *IPPNW Global Health Watch Report Number 1: Crude Nuclear Weapons—Proliferation and the Terrorist Threat*. Cambridge, Mass: IPPNW; 1996.
77. Leventhal P, Alexander Y, eds. *Nuclear Terrorism: Defining the Threat*. Washington, DC: Pergamon-Brassey's; 1986.
78. Allison GT, Cote OR Jr, Falkenrath RA, Miller SE. *Avoiding Nuclear Anarchy: Containing the Threat of Loose Russian Nuclear Weapons and Fissile Material*. Cambridge, Mass: MIT Press; 1996: 10.
79. Mukherjee SS. Tests do not contaminate India's principles. *Boston Globe*. May 24, 1998:D2.
80. We are a nuclear power: interview with Indian Prime Minister Vajpayee. *Newsweek*. May 25, 1998: 32D.
81. Farrow L, Mutalik G, Christ M, eds. *Abolition 2000: Handbook for a World Without Nuclear Weapons*. Cambridge, Mass: International Physicians for the Prevention of Nuclear War; 1995.
82. Abolition 2000. Nuclear Age Peace Foundation. Available at: <http://www.napf.org/abolition2000/index.html>. Accessed July 1, 1998.
83. International Physicians for the Prevention of Nuclear War. *Vital Signs*. 1995;8:1.
84. American College of Physicians. Resolution from the Board of Governors, approved by the Board of Regents. Presented at: Meeting of the American College of Physicians; October 1996; Philadelphia, Pa.
85. American Public Health Association. Cessation of nuclear testing and abolition of nuclear weapons: policy statement No. 9605 (adopted by the Governing Council November 20, 1996). *Am J Public Health*. 1997;87:500.
86. American Medical Association. House of Delegates Resolution 617 (I-96). Presented at: Meeting of the House of Delegates, American Medical Association; December 1996; Chicago, Ill.
87. Diamond J. Air Force general calls for end to atomic arms. *Boston Globe*. July 16, 1994:3.
88. International Court of Justice Communiqué No. 96/3. July 8, 1996. Available at: <http://www.web.pgs.ca/pages/wcp0/html>. Accessed July 1, 1998.
89. The Canberra Commission Web site. Available at: <http://www.dfat.gov.au/dfat/cc/echome.html>. Accessed July 1, 1998.
90. Statement on Nuclear Weapons by International Admirals and Generals. Available at: <http://www.stimson.org/zeronuke/index.html>. Accessed July 1, 1998.
91. Statement on Nuclear Weapons by International Civilian Leaders. Available at: <http://www.worldforum.org>. Accessed July 1, 1998.
92. Nuclear Weapons Convention. Available at: <http://www.ddh.nl/org/fialana/modelin.html>. Accessed July 1, 1998.
93. Bartlett J. *Familiar Quotations*. 15th ed. Boston, Mass: Little Brown & Co Inc; 1980:776.
94. Anderson E, Exman E. *The World of Albert Schweitzer*. New York, NY: Harper & Brothers; 1955.
95. Lake Sosin Snell & Associates. Poll commissioned by GRACE for Abolition 2000, April 1997. Available at: <http://www.psr.org/abolitionpoll.html>. Accessed July 1, 1998.
96. Levy BS, Sidel VW, eds. *War and Public Health*. New York, NY: Oxford University Press; 1997:82.
97. Lown B. *Never Whisper in the Presence of Wrong: Selections from Speeches on Nuclear War and Global Survival*. Cambridge, Mass: International Physicians for the Prevention of Nuclear War; 1993:26.