EDITORIAL

Nuclear war and physicians' social responsibility

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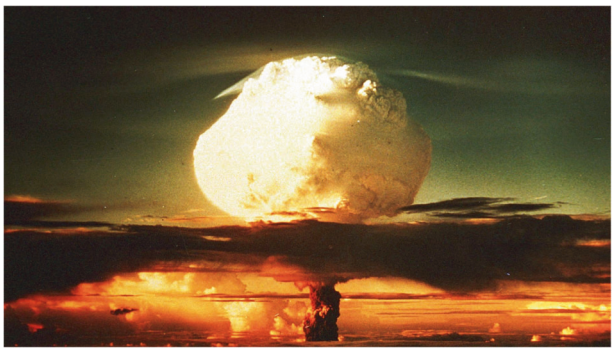
NB: There is a global effort to have medical journals publish statements on physicians' social responsibility in the face of the increasing threat of a nuclear war. A copy of the statement is available in ref. [1].



The 1st thermonuclear explosion October 21, 1952. (The Bradbury Science Museum)

Now I Am Become Death, the Destroyer of Worlds.
Bhagavad Gita

The atomic age began at the Trinity test in Alamogordo on July 16, 1945 with the explosion of the world's 1st atomic bomb. One month later 2 A-bombs, *Little Boy* and *Fat Man*, were dropped on Hiroshima and Nagasaki. The decision to drop the bombs was made by the military but they were created by scientists. Revisiting these events with a 78 year perspective we think development of the A-bombs and their deployment over Japan were inevitable. Theories underlying developing an A-bomb were clear, the only challenge was implementation. Had the US not developed the A-bombs others would have. Nazi Germany tried but failed but the Soviets succeeded only 4 years later.

Given these conditions it was also inevitable the Trinity explosion would precipitate a nuclear arms race, especially the Cold War standoff between the US and Russia followed by the global proliferation of nuclear weapons. The demise of the Soviet Union decreased the risk of a nuclear confrontation, but only briefly. A recent report from the United Nations suggests the risk of a nuclear conflict is higher than at any time since the end Cold War and the Doomsday Clock of the Bulletin of Atomic Scientists has been advanced to 90 s before midnight [2, 3].

During the 1970s and 1980s organisations such as the Pugwash Conferences and the International Physicians for the Prevention of Nuclear War (IPPNW) alerted scientists and physicians to the risks and consequences of a nuclear war. The hope was to inspire global action which was partially successful. However, this momentum was lost with the collapse of the Soviet Union. Few people think of the nuclear threat with the same immediacy and urgency today as they did during the Cold War. This is a potentially fatal mistake.

Several recent developments on the nuclear front deserve our attention. 1st, the continued global proliferation of nuclear weapons. There are now nine nuclear-armed states: China, North Korea, France, India, Israel, Pakistan, Russia, the UK and the US with nearly 13,080 nuclear weapons. Russia and the US have about 90% of the world's nuclear weapons each with over 5500. Several other states such as Iran seem poised to enter the nuclear weapons club.

It's easy to understand why countries want nuclear weapons. Consider this. When the Soviet Union collapsed Ukraine was briefly the world's 3rd largest nuclear-armed state but relinquished its nuclear arsenal to Russia after the Budapest Accord in which the territorial sovereignty of Ukraine was assured (not guaranteed) by the US, the UK and (believe it or not) Russia. Would Russia have invaded had Ukraine not relinquished its nuclear weapons? (Russia had command and launch control of the weapons and maintaining them operational is hugely expensive.) It is naïve to think we can contain proliferation of nuclear weapons with security assurances such as that being currently pursued with Iran. If this sounds like guarantees from the UK and France to Poland immediately before WWII you would be not far off.

A 2nd disturbing development is the collapse of several nuclear arms control treaties. In the 1970s and 80s the US and Soviet Union signed a series of treaties including the Anti-Ballistic Missile Treaty (ABM' 1972), the Strategic Arms Limitation Treaties (SALT-1 and-2), the Intermediate-Range Nuclear Forces Treaty (INF; 1987), the Strategic Arms Reduction Treaty (START; 1991) and in 2011 and Measures for the Further Reduction and Limitation of Strategic Offensive Arms (2011; New START). Only New START remains in effect. It is scheduled to expire in 2026 but given current circumstances it's difficult to imagine it being renewed. The Treaty on the Non-Proliferation of Nuclear Weapons (NPT), signed in 1968; commits the 190 signatories to pursue negotiations on cessation of the nuclear arms. 50 years later there is little, if any, progress.

A 3rd disturbing but predictable development is the targeting of nuclear power facilities in an otherwise conventional war such as in the Russian invasion of Ukraine [4]. We and other have discussed the danger linked to Russia control of the Zaporizhzhia nuclear power facility [5]. This winter Russia is expected to target other nuclear power facilities in Ukraine to destroy energy infrastructure.

A 4th concern is nuclear terrorism, an issue we also discussed recently [6]. Consider, for example, Pakistan, a politically unstable nuclear-armed state. To prevent a hostile takeover of its nuclear arsenal Pakistan distributed its approximately 100 nuclear warheads around the country under control of local military. How secure can this be in a country unable to find Osama bin-Laden living within a kilometre of a military base? A disaster waiting to happen. A. Q. Khan, father of Pakistan's atomic bomb, confessed to selling nuclear secrets to Iran, North Korea and Libya in 2004, hardly reassuring.

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And things are getting worse. Russia recently positioned tactical nuclear weapons in Belarus. It's uncertain if command and launch control of these weapons remain with Moscow. Exile of the mercenary Wagner group to Belarus after its recent attempted coup hardly assures security of these weapons. Add to this development of hypersonic missiles which can deliver a nuclear warhead before conventional defenses can be effective.

What would be the medical consequences of a nuclear war? The Hiroshima bomb is estimated to have killed 90,000–140,000 people and the Nagasaki bomb, 60,000–80,000 not including cancer deaths caused by radiation decades later. The combined power of *Little Boy* and *Fat Man* was (190 TJ). For perspective consider a US thermonuclear weapon, (H-bomb; Castle Bravo; 63,000 TJ) 1000 times more powerful compared with the Hiroshima bomb. Russia has a thermonuclear weapon 3000 times more powerful (Tsar Bomba; 210,000 TJ). You can estimate the potential death toll from these enormous modern nuclear weapons.

For perspective it's important to compare causalities from the Japan A-bombs with other bombings during WWII. For example, in February, 1945 the UK and US fire bombed Dresden, The bombing and the resulting firestorm destroyed more than 2.5 square miles (6.5 kmE + 2) of the city centre killing an estimated 25,000 civilians. In March, 1945 the US fire bombed Tokyo, the single most destructive bombing in human history. 16 square miles (41 kmE + 2) of central Tokyo were destroyed, with an estimated 100,000 civilian deaths. But these actions required thousands of bombs, not 1 bomb.

The paradox is the massive destructiveness of nuclear weapons is a disincentive to use them under the threat or mutually assured destruction. Unfortunately, this calculus has recently changed. The US and Russia now have so-called *tactical* nuclear weapons far less destructive compared with *strategic* nuclear weapons which might encourage deployment under circumstances not unlike those facing Russia today in Ukraine. Russia is estimated to have about 2000 such weapons. The US has the variable yield B16 Model 12 weapon adjustable to deliver as little as 2.5% of its firepower (1.2 TJ) which can travel at supersonic speeds. The US also has the W76 Model 2 which has one-half the firepower of the Hiroshima bomb (30 TJ) and is deployed on US nuclear submarines.

Some military strategists argue this range of destructiveness could help avoid a *strategic* nuclear war because it provides the US and Russia the possibility of a proportionate response to a tactical nuclear strike. We are unconvinced. Rather, we think it makes use of a nuclear weapon more likely. Interestingly, General McArthur suggested to President Truman using nuclear weapons during the Korean War; Truman declined even though he approved the atomic bombings of Japan. Paradoxically, Truman later approved development of the H-bomb despite contrary to advice from Oppenheimer and colleagues in a *Report of the General Advisory Committee* of the Atomic Energy Commission who suggested: *The extreme danger to mankind inherent in the proposal [to develop thermonuclear weapons] wholly outweighs any military advantage* [7].

Lastly, but most importantly for our readers, we turn to the social responsibility of physicians and scientists in the context of this increasing nuclear threat. The nuclear weapons genie is out of the box. As J. Robert Oppenheimer, father of the atomic bomb said soon thereafter the A-bombings: *Physicists have known sin; and this is a knowledge which they cannot lose*.

In a medical context it's important to acknowledge there is no effective response to the use of a strategic nuclear weapon on a civilian population. Planning for such an event is dangerous by making people think a meaningful response is possible. Remarkably, The US Federal Emergency Management Agency has a website title: Be Prepared for a Nuclear Explosion (https://www.ready.gov/sites/default/files/2020-11/ready_nuclear-explosion_fact-sheet_0.pdf). There is even an app for your smart phone (Ready.gov: https://www.ready.gov/nuclear-blast). Other Federal Agencies have similar websites. Good luck!

Consider this scenario: detonation of a nuclear weapon over Detroit, 75 times more powerful compared with the Hiroshima bomb [8]. About 470,000 people of a population of 4.3 million would be killed and 630,000 injured. Blast and burn effects would dominate amongst the injured. There would be 440,000 blast injuries, 409,000 thermal injuries and 157,000 persons exposed to moderate or marked radiation. These numbers emphasises that although these are nuclear weapons their damage and destruction is mostly percussive and thermal. Treating the survivors would require 352,000 hospital beds or one-third of all US hospital beds including 42,000 burn unit beds and 142,000 ICU beds. About 13,000 physicians and 130,000 nurses would be needed to care for the injured. More than 1 million units of whole blood and the same number of RBC units would be needed along with more than 15 million units of platelets. Because physicians and nurses are concentrated in urban centres like Detroit many or most would be killed or injured by the blast and unavailable to treat the injured. Now increase the scale to a 250 nuclear weapon exchange and the danger of suggesting an effective medical response becomes obvious.

Now consider an H-bomb. The average H-bomb in the US and Russian arsenals deployed over a major population centre would result in about 1 million immediate deaths with many more casualties and thousands of late occurring cancers and other health related problems. A nuclear war involving 250 nuclear weapons is estimated to kill 120 million people and cause global climate disruption and nuclear famine. A large-scale nuclear war could kill 200 million people and potentially precipitate a *nuclear winter* which could threaten the survival of humanity and make climate change seem minor [9].

In all medicine prevention should always be the goal. But how? The cause of the threat of nuclear annihilation is that there are nuclear weapons. But is abolishing them a viable option? We think not. So what's the solution, if any? We think an answer lies in education and awareness, especially amongst physicians, and scientists, the public and government/military officials. 1st, physicians have to understand this is a public health problem which makes the SARS-CoV-2 pandemic seem trivial (it isn't). Public health challenges, by definition, must involve the public and it's physicians' responsibility to educate them. 2nd, we need to increase physicians' awareness of the nuclear threat. 3rd, we need to encourage their involvement. Many people rely on physicians for health information and guidance and physicians have unique access to governments and the military. These audiences must be convinced to the dangers of nuclear weapons. Physicians are a powerful and influential lobby. We must raise our voices.

The initiative spearheaded by the World Association of Medical Editors and IPPNW cited above suggests 4 actions for physicians: (1) encourage nuclear-armed states to adopt a no 1st use policy; (2) encourage these states to take their nuclear weapons off hair-trigger alert; (3) urge all states involved in current conflicts to pledge publicly and unequivocally that they will not use nuclear weapons in these conflicts; and (4) ask nuclear-armed states to work for a definitive end to the nuclear threat by supporting negotiations for a verifiable, timebound agreement to eliminate their nuclear weapons in accordance with commitments in the NPT and opening the way for all nations to join the Treaty on the Prohibition of Nuclear Weapons.

Not all of these actions are achievable. For example, readers may be surprised to learn only India and Pakistan have no 1st use (NFU) policies for nuclear weapons. For example, the 2022 US miliary Nuclear Posture Review rejects the principle of NFU (https://fas.org/wp-content/uploads/2023/07/2022-Nuclear-Posture-Review.pdf). Russia has also rejected the NFU principle.

A few years after the Trinity bomb Oppenheimer recalled: *We knew the world would not be the same. A few people laughed, a few people cried, most people were silent*. Physicians should not remain silent.

Robert Peter Gale[1]✉ and Andreas Hochhaus[2]

[1]Centre for Haematology, Department of Immunology and Inflammation, Imperial College of Science, Technology and Medicine, London, UK. [2]Klinik für Innere Medizin II, Universitätsklinikum Jena; Comprehensive Cancer Center Central Germany, Jena, Germany.
✉*email: robertpetergale@alumni.ucla.edu*

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Correspondence and requests for materials should be addressed to Robert Peter Gale.

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