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Nuclear war and public health: preparedness, protection and the case for prevention

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ABSTRACT

Background According to the Stockholm International Peace Research Institute, the year 2018 saw a continuing 'drift into global instability' in which 'both the USA and Russia are on a path of strategic nuclear (weapons) renewal' with 3750 nuclear bombs globally deployed 'ready to fire'. Treaties are being abrogated with increasingly aggressive language exchanged, and discredited tactics such as 'limited use' revived. These developments risk an amplifying cascade of nuclear weapon fire, whether started by intent, miscalculation or unintentionally.

Results A nuclear war would cause immediate and massive loss of human life, unprecedented damage to societal infrastructures and climatic disruption resulting in a 'nuclear winter' or 'nuclear famine'.

Conclusions The systems defending national territory against nuclear warhead missiles do not guarantee protection, and neither would hastily erected domestic shelters. Any post-survival world would be utterly different and severely challenging. The only effective preventative measures require nuclear disarmament through treaty.

Keywords disaster and emergency planning, nuclear weapons, prevention, public health

Introduction

This paper, based on available evidence, aims to give an objective review of the impacts nuclear war would have on public health, locally and globally.[1]

'What nuclear weapons do'

A nuclear detonation splits (fissions) the bomb's uranium and plutonium atoms, instantly creating a highly radioactive flash and an intensely hot fireball. Of the bomb's energy, about 5% goes into the flash and 35% into the fireball. Anything within range will be vaporized. People further away may escape the fireball but receive about a thousand times more ionizing radiation from the flash than they would from a year's natural background exposure, dying within days from acute radiation poisoning. About 50% of the detonation's energy goes into ejecting the fission products with surrounding air to produce the destructive hypersonic, radially spreading shock blasts: the remaining 10% goes into the high radioactivity of the fission products (neutrons and isotopes.[2]

The fireball sucks in surrounding air, which rises to form the classic 'mushroom cloud'. Fireballs touching the ground ('ground-burst', GB) take up solid particles which absorb fission products and 'fallout' downwind, making large areas of ground fatally radioactive for several hours: carcinogenic levels of radioactivity linger for years.

'Airbursts' (AB) produce less fallout, but fission products get dispersed globally around the upper atmosphere and the blast is amplified by bouncing off the ground. Very high-altitude detonations release a powerful pulse of photons (electromagnetic pulse, EMP) which damage electronic devices across borders,[3] severely disrupting communications.

The 'yield' of nuclear weapons is expressed as equivalents of the explosive power of trinitrotoluene (TNT) in tons or kilotons (kt—1000 tons).

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Historical experience and modelling of multiple detonations

By late 1945, up to 160 000 people had died from Hiroshima's 15-kt bomb, and 80 000 from the 21-kt bomb on the more sheltered, hillier Nagasaki.[4] Epidemiological analyses from Hiroshima and Nagasaki are still used to predict exposure effects.[5]

By 1963, when the 'Limited Nuclear Test Ban Treaty' came into effect, there had been 420 tests over oceans, remote islands or deserts. A test ('Castle Bravo') on the Marshall Islands' Bikini Atoll in 1954 had a far greater yield than expected and irradiated Rongelap, 94 miles away: seafarers and islanders suffered long-term ill-effects; Rongelap became uninhabitable.[6]

In the mid 1980's, the North Atlantic Treaty Organisation (NATO) used computer simulations to model a response to a Soviet invasion of Western Europe using 'tactical' low-yield (less than 10 kt) nuclear weapons to limit casualties to military 'battlefield' personnel. Each simulation featured tit-for-tat escalation to a worldwide nuclear holocaust.[7] The eyes of 'limited use' proponents were opened to what they already suspected—nuclear war's inherent uncontrollability. The subsequent Soviet/American 1987 intermediate-range nuclear forces (INF) Treaty contributed significantly to nuclear arms reduction.[8]

'Operation Square Leg'—a 'modelling' exercise conducted by the British Ministry of Defence in September 1980—envisaged a nuclear attack with 69 GBs and 62 ABs (205 000 kt total yield) on strategic targets in UK including cities, RAF stations and nuclear power plants.[9,10] Out of a population of 56 million, 29 million UK citizens would be killed and 6.4 million seriously injured. Taking Square Leg's five targets on London's periphery (Fig. 1), of London's population of nearly 7 million, an estimated 5 million would die and half a million be injured. All services, including health care provision, transport, energy and law and order would be completely disrupted. Hospital bed capacity would fall from 60 000 to 25 000. Unprotected people in Greater London would be killed by fallout within hours. Biological hazards would emerge as millions of human and animal corpses decayed.

Campbell[10] described another modelling exercise 'Hard Rock', with a smaller yield of 4800 kt, as the 'most absurd nuclear strike ever seen in a serious civil defence exercise … bearing little resemblance to a realistic plan of attack' and showed that, with public relations in mind, the UK Home Office purpose was to persuade the public of the value of government policy when preparing for nuclear war by testing 'selected civil and armed forces procedures post-strike' (p 53).[10] The Department of Health and Social Services commented 'the overwhelming part of the Health Service and its assets will be destroyed during the attack'.

Public health protection: 'protect and survive'

After the 1962 Cuban missile crisis, the Home Office developed but did not publish a booklet 'Advising the Householder on Protection Against Nuclear Attack.'[11] The BBC's 'The War Game'[12] featured the immediate radiation and physical effects; however, general release was delayed for 20 years. In 1980, the Home Office distributed 'Protect and Survive,'[13] a booklet reproducing much of 'Advising the Householder' and widely criticized for impracticability.[14,15] Examples included a fallout room and inner refuge even if the home-occupier was not the owner; storing food, water and toiletries; disposing waste and excreta; following hand hygiene; keeping first-aid kits; putting the dead aside; keeping spare batteries for tuning to radio announcements; removing all flammable objects including books and magazines (and survival manuals?) from the whole dwelling; and staying in the (inadequately radiation protective) refuge for 2 weeks or until the 'all-clear'. It gave no indication of what to expect after an all-clear, but as Greene *et al*. showed, there might well be no piped water, no sewage disposal and no food in the shops.[9] The recommendation to stay in the inner refuge has similarities with the London Fire Service's advice in June 2017 to the occupants of Grenfell Tower who stayed in their apartments.

Public health advocacy

The UK 'Medical Campaign Against Nuclear Weapons' (MCANW)—founded in 1981 and affiliated to the International Physicians for the Prevention of Nuclear War (IPPNW)—published a 40-page booklet 'The Medical Consequences of Nuclear Weapons'[16] showing that nuclear war was 'unthinkable' despite claims that many could survive. In the proceedings of a 1983 MCANW conference, 'The Human Cost of Nuclear War,'[17] June Crown, then District Medical Officer for Bloomsbury, concluded 'when the public learn about the number killed in a nuclear attack, the appalling conditions faced by survivors and the responsibilities they would need to survive, they must surely realize that the only realistic plan is prevention.'[18] The conference was told by the Foreign and Commonwealth Office that 'NATO's strategy is to prevent war by having a credible nuclear deterrent, and that, on risk grounds, NATO does not have a 'first strike' policy'[17] (it does now).

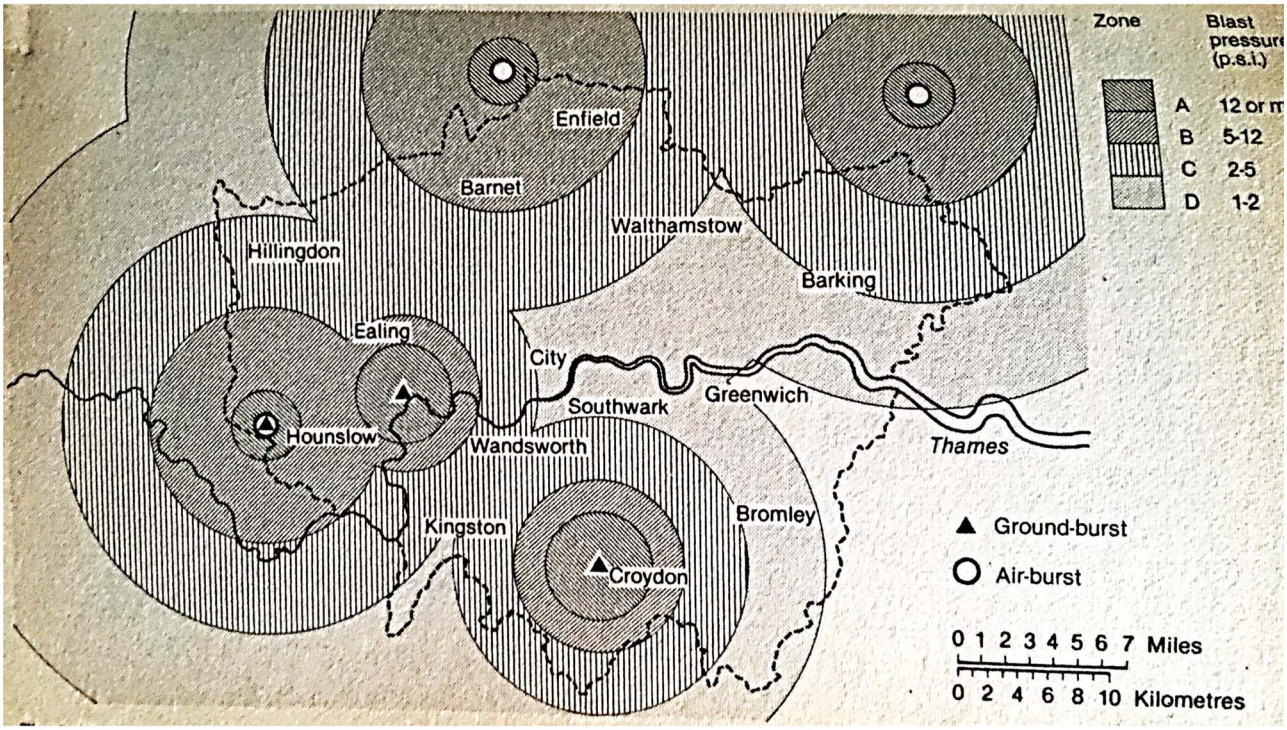

Fig. 1 London after the bomb, and fire zones around the five targets. Greater London boundary.[9]

The British Medical Association's publication 'The Medical Effects of Nuclear War'[19] comments: 'Feeding children, people with diabetes and other special needs would present insuperable problems; they would have to fend for themselves' (p 110); and 'Shelters may improve the chances of survival for some in the short term but the overwhelming problems of infection, bacterial contamination of water and the scarcity of food and fuel would remain to be faced when survivors emerged' (p 111).

In December 1985, IPPNW gained the Nobel Peace Prize. A Lancet editorial led to correspondence revealing the wide diversity of opinion among British medical practitioners with some feeling that criticizing nuclear war advocates on medical grounds was professionally inappropriate while others defended IPPNW.[20,21]

First responders: the Red Cross

The Red Cross was early on the scene at Hiroshima in 1945 when about 120 000 were killed following a 15-kt detonation.[22,23] Loye and Coupland briefly reviewed the challenges to society of using nuclear weapons: 'The main risk for anyone bringing assistance to survivors is from exposure to the radioactive material in the dust, water or air.'[24] In current Red Cross guidance, a passing reference to nuclear war is made in the 'Nuclear and radiological emergency guidelines' (p 34).[25]

Recent single detonation models

A 100-kt AB modelled on the UK city of Manchester would kill 81 000 out of 510 000 total population with 212 000 injured. Housing and commercial buildings, vital infrastructure and local emergency services would be destroyed[26], and the entire UK blood supply would be consumed, with every intensive care bed occupied.[27]

A detailed US model plan for an urban 10-kt nuclear detonation, such as by terrorists, shows dramatic medical and public health impacts: the guidance includes 'duck and cover' (shades of 'Protect and Survive'), which, without prior warning, could only happen after the flash is seen.[28]

Modern nuclear weapons

US and UK forces flew 178 263 missions during World War II and dropped about 3.4 million tons of conventional bombs detonating about 1.4 million tons of TNT-equivalent.[28,29,30] Scientists for Global Responsibility quote US and Russian

estimates of 3 million tons (Megatons) TNT for all bombs exploded in WW2.[31]

These impressive figures are dwarfed today. Just one of the Royal Navy's four nuclear-armed 'Trident' submarines (the UK's sole nuclear arsenal) carries four megatons of TNT-equivalent on 40 nuclear warheads on eight ballistic missiles.[32] Each warhead has a maximum yield of 100 kt, about three times that laid on Hiroshima and Nagasaki in 1945. A full discharge from one UK Trident submarine could kill millions of citizens and have long-term adverse effects on the environment and climate.[33]

The world stockpile of 9 330 usable nuclear weapons[34] is meant to 'deter' hostilities.[35] Although bomb yields vary widely, they commonly exceed 100 kt. Russia and the NATO states deploy 3750 weapons 'ready to fire'[34]—many can reach their targets and detonate within an hour of receiving the order. Although the US has invested multi-billion dollars on missile defence systems such as its Strategic Defence Initiative (SDI or 'Star Wars'), expert commentators describe their effects as more psychological than physical and question their efficacy, 'We have never had ballistic missile defence.'[36] Lewis and Unal warn that cyberattacks could destabilize these missile systems and paradoxically provoke premature launching.[37]

Cities have experienced growth and architectural revolution making them more vulnerable to nuclear attack. London has 8.8 million people and high-rise developments such as Canary Wharf are vulnerable to attack or disasters. In 1996, a bomb set by the IRA caused two deaths, 100 injuries and over £150 million damage.[38] About 20 million people in UK now live in flats, mostly low rise but about 800 000 in high rises[39] where 'Protect and Survive' would be difficult to implement. Although a complex issue, UK hospitals are much transformed: bed numbers have halved since 1987 and intermediate care capacity in 2017 could meet only half the demand.[40]

Nuclear 'winter'

Several studies have drawn attention to the possible long-term atmospheric effect of nuclear war where pollution from the soot from a nuclear firestorm obscures sunlight, causing global cooling and a 'nuclear winter'.[41–44] The late Carl Sagan's celebrity science-writer status helped raise the profile of nuclear winter. In 1986, the US Institute of Medicine published a detailed and largely still applicable multi-authored text 'The Medical Implications of Nuclear War'[45,46] but eminent nuclear scientists[47–49] claimed analytical uncertainties. Martin recounts how the nuclear winter theory was received differently by environmentalists and militarists; however, the militarist deniers did not have all available models.[50] Several nuclear winter deniers went on to deny anthropogenic climate change.[51,52]

More sophisticated modelling found that 100 weapons of 15 kt yield (much less than 'Square Leg' and 'Hard Rock') detonated in populated areas could not only loft fire-storm debris and soot into the stratosphere, but fireball-generated nitrogen oxides (NOx) could destroy 20–50% of stratospheric ozone, enhancing summer UV indices by 30–80% and shortening annual growing seasons by 10–40 days.[53] This would be aggravated for decades by land contamination with radio-caesium and radio-strontium, even if farming restrictions were less severe than in Britain after Chernobyl.[54] The nuclear winter hypothesis gave rise to the 'nuclear famine' hypothesis. A remote exchange of 2.5% of the world's nuclear arsenal could lead to climatic and agricultural disruption so vast that several hundred million people in North Africa, Malaysia, South Korea, Taiwan and Japan dependent on food imports could starve.[55] Any concept of 'limited nuclear war' is thus firmly discredited.

The nuclear famine hypothesis was taken up by the Red Cross, World Medical Association and IPPNW,[56–58] who supported the United Nations General Assembly's 2017 adoption of the 'Treaty for the Prohibition of Nuclear Weapons.'[59]

Current US nuclear policy

In 2017, President Trump called for a new 'Nuclear Posture Review' to renew investment in nuclear weapons. Published in February 2018, it envisages a new generation of nuclear weapons, and more of them. According to Péczeli, it 'emphasized nuclear modernizations rather than arms control measures .... By its confrontative tone towards Russia and China it risks lowering the nuclear war threshold.'[60]

In 2018, the US withdrew from two treaties—the Joint Comprehensive Plan of Action—the UN-brokered deal with Iran to curb its nuclear weapons ambition and the INF Treaty of 1987.[61] International responses supported comprehensive nuclear arms reduction, preventing further nuclear developments and reducing international tensions.[7,62] The US contribution to the 2020 Review Conference of the Nuclear Non-proliferation Treaty is awaited with interest, as Christopher Ford, Assistant Secretary US Bureau of International Security and Non-proliferation remarked, controversially, on the 'need to maintain nuclear deterrence wisely.'[63]

Current threats: global instability

By mid-June 2019, six oil tankers in the Iranian Gulf had been damaged by mines: the US blamed Iran and moved

troops, ships and the nuclear-driven aircraft carrier 'Abraham Lincoln' into the Gulf; Iran downed a US unmanned drone and President Trump repeatedly threatened oblivion. There are clear dangers of spiralling hostilities in a region, which includes nuclear-armed states (Israel and Pakistan) and proxy states for the major nuclear-armed powers, Russia and the US.

These threats are amplified by global political instability and the new technologies of 'machine learning' and AI. AI has the potential to exacerbate emerging challenges to nuclear strategic stability.[64] A SIPRI document highlights that 'machine learning is not transparent and may not be fully understandable and predictable to the humans who design and use them.'[65] The Financial Times' 2019 series on AI and the arms race[66] claims that 'the growing competition between the US and China in deep-tech fields such as AI and machine learning will have an impact on the contest for military superiority . . . '

Public health responses: health and social systems for survivors

Communities surviving a nuclear attack may lack survival skills such as engineering or health care. The EMP would affect electronic communications and power grids as would the iCloud where much valuable information is archived but be unavailable to survivors without broadband or Wi-Fi. Law and order could break down.[9] Traumatized societies would cope poorly with mental ill health, non-communicable diseases such as diabetes and care for older people. Power outages and lack of refrigeration would disrupt supplies of food, cold-chain-dependent essential medicines, insulin, monoclonal antibodies, laboratory reagents, vaccines and blood. The manufacture of antibiotics, other medications and even soap could be compromised. Many of these points were foreshadowed in the 1983 Institute of Medicine's report on 'The Medical Implications of Nuclear War.'[67]

NHS England comprehensive 'Emergency, preparedness, resilience and response framework' (2015)[68] includes nuclear terrorism but has no contingency planning for nuclear war. As Public Health England is a first responder to public health emergencies and provides expert guidance on radiation, these plans—including its resilience and response functions, vaccine supply systems, its communicable disease surveillance function and modelling capability—need re-appraisal and the consequences of nuclear war spelt out clearly.

Conclusions: there is only prevention

Although it is very difficult to risk assess the likelihood of nuclear war, the impact clearly would be high with long-term human survival severely prejudiced.

Using nuclear weapons would invalidate deterrence theory and cannot be justified by pretending that there could be many survivors. Nuclear war would cause catastrophic loss of life worldwide. A nuclear winter would cause climatic and dramatic global loss of ecosystems, destabilize economies and destroy health care facilities and lead to a nuclear famine. The global consequences mean that even if just the UK was obliterated by a few dozen strategic 100-kt bombs, public health disasters could be experienced in distant parts. Conversely, the UK could suffer a severe public health disaster from a distant nuclear war in which it had no part.

Publications such as 'Protect and Survive' underestimate the scale of the challenges for survival. Prevention is the core business of public health, and preventing nuclear war anywhere is clearly a UK public health priority. The best prevention would be global nuclear de-escalation and eliminating all nuclear arsenals by verifiable agreements among nuclear-weapon states, with intermediate progressive steps such as taking nuclear weapons off hair-trigger alert, adopting 'no first use' policies and cancelling modernization of nuclear arsenals.

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