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Weapons of Mass Destruction

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Chapter Contents

Reader's Guide

Since the late 1990s, policy makers everywhere have been deeply concerned about the possibility that weapons of mass destruction—chemical, biological, nuclear, and radiological weapons—are not only becoming fixtures in the arsenals of states, but might fall into the hands of terrorists. This chapter explains how these weapons work and the effects they might have if used on the battlefield or against civilian targets. It describes how they have been used in war and how they have shaped the practice of international politics.

Introduction

Although many observers hoped that the danger posed by weapons of mass destruction (WMD)—chemical, biological, nuclear, and radiological weapons—would fade with the end of the Cold War, these armaments continue to pose a worldwide threat. Some progress has been made in terms of rolling back WMD proliferation. Iraq no longer menaces its neighbours with its chemical arsenal, and its efforts to acquire nuclear and biological weapons have been thwarted. Libya has also abandoned its nuclear weapons programme. The international community has bolstered the non-proliferation regime by undertaking a series of diplomatic efforts, for example the **Chemical Weapons Convention**, the 1972 **Biological and Toxin Weapons Convention**, the Proliferation Security Initiative, and the **2002 Moscow Treaty**. In his April 2009 speech delivered in Prague, Czech Republic, President Barak Obama embraced nuclear disarmament as a long-term policy objective for the United States, a sentiment that was echoed in the United Kingdom's October 2010 *Strategic Defense and Security Review*. Despite these concerted efforts, however, several state and non-state actors find WMD to be an attractive part of their arsenals. Black-market trade in nuclear materials, technology, and know-how is increasing. In 2004, revelations that the Pakistani scientist A. Q. Khan might have provided information about gas centrifuges (used to produce weapons-grade uranium) and nuclear-bomb designs to North Korea, Iraq, Iran, Libya, and Syria sent a shock wave through the non-proliferation community (Clary 2004; Albright and Hinderstein 2005). Indigenous nuclear programmes are also making existing proliferation safeguards obsolete (Braun and Chyba 2004). For some states, WMD provide a way to offset their inferiority in conventional armaments compared to stronger regional rivals or the United States and its allies. Leaders of these regimes probably hope that the threat of chemical, biological, or nuclear warfare might deter stronger opponents contemplating attack, defeat those opponents once battle has been joined, or even threaten domestic opponents (Lavoy et al. 2000). Weapons of mass destruction also serve as status symbols that highlight the 'success' of otherwise dubious regimes.

If the threat posed by WMD proliferation to state actors is of increasing concern, then the possibility that these weapons could fall into the hands of terrorists or even individuals is alarming. A chemical weapons attack against a major sporting venue could kill thousands of people, while a successful anthrax attack might place hundreds of thousands at risk. A 'dirty bomb', a device that uses high explosives to spread radioactive contamination, could poison scores of city blocks. It would be extraordinarily difficult for even a well-funded terrorist organization to construct a primitive gun-type nuclear weapon, but international terrorist networks, domestic terrorist organizations, or even individuals have the resources and materials to construct and use chemical, biological, and radiological weapons. Weapons of mass destruction have been used in terrorist attacks, albeit with relatively limited effects. In 1995, for instance, Chechen rebels planted a radiological source (caesium-137) in Moscow's Izmailovsky Park, probably to show Russian authorities that they had the capability to make a 'dirty bomb'. The Aum Shinrikyo (Aum Supreme Truth) cult experimented with several toxic substances before launching their Sarin attack against the Tokyo subway in 1995 that injured thousands of people. In the wake of the 9/11 terrorist attacks against the World Trade Center and Pentagon, some person or group in 2001 used the US postal system to mail letters contaminated with anthrax, which was probably derived from materials supplied to US weapons laboratories.

Weapons of mass destruction vary greatly in terms of their availability, lethality, and destructive potential, and the ease with which they can be manufactured and employed. High-yield, lightweight nuclear weapons are some of the most sophisticated machines ever manufactured by humans, while some chemical and biological weapons have been available for centuries. What separates WMD from conventional weapons, created from chemical-based explosives, however, is their potential to generate truly catastrophic levels of death and destruction. A small nuclear weapon can devastate a city: the fission device that destroyed Hiroshima produced an explosive blast (yield) that was equivalent to about 20 kilotons (kt) of trinitrotoluene (TNT). A smallpox attack against an unprotected (unvaccinated) population could kill 30 per cent of its victims and leave survivors horribly scarred for life. Because of their ability to strike terror worldwide, these weapons are attractive as political instruments.

The remainder of this chapter will first describe the technology that underlies nuclear, chemical, and biological weapons, and explain how they are constructed. What is reassuring about this overview is the fact that, while these weapons can be extraordinarily destructive, state and non-state actors would have to overcome significant technical hurdles before they could maximize their destructive power. The chapter will also describe their destructive effects, the systems used to deliver them, and the history of their use in war. It will then outline the impact these weapons have on national defence policy and international security.

Nuclear weapons

The design and development of nuclear weapons were based on advances in theoretical and experimental physics that began at the start of the twentieth century. By the late 1930s, Leo Szilard, a physicist who escaped Nazi persecution by fleeing to the United States, realized that it might be possible to construct an 'atomic bomb'. Unlike conventional (chemical) explosions, which are produced by a rapid rearrangement of the hydrogen, oxygen, carbon, and nitrogen atoms that are components of TNT, for example, Szilard suggested that a nuclear explosion could be created by a change in atomic nuclei themselves. If an atom of **uranium-235**, for instance, is fragmented into two relatively equal parts, the remaining mass of the two new atoms would have less mass than the original atom. The lost mass would be instantaneously converted into energy. Nuclear weapons are so powerful because, as Albert Einstein predicted, under certain conditions mass and energy are interchangeable ($E = MC^2$). The difficult aspect of setting off this interchange would be to create a device that would sustain a nuclear reaction for a fraction of a second before it is destroyed in the resulting nuclear explosion.

Szilard's opinion was not widely shared among American scientists or government officials, so he enlisted the aid of his friend, Albert Einstein, to bring the issue to the attention of President Franklin D. Roosevelt. In a letter dated 2 August 1939, Einstein informed Roosevelt that it was theoretically possible to construct an atomic bomb and that the Nazis might be hard at work constructing such a device. It took the USA's entry into the Second World War to launch a full-scale project to construct a nuclear weapon: the UK–US **Manhattan Project**, which began in September 1942. The first nuclear (fission) device was ready for testing at Alamagordo New Mexico on 6 July 1945. It was quickly followed by the detonation of 'Little Boy' over Hiroshima on 6 August 1945 and 'Fat Man' over Nagasaki on 9 August 1945.

Fission weapons all share similar components: fissile material (for example, U-235 or plutonium); chemical explosives; non-fissile materials to reflect neutrons and tamp the explosion; and some sort of neutron generator to help initiate the nuclear reaction. Weapons also need triggers, a mechanical safety, arming, and firing mechanisms. There are two basic types of fission weapons. 'Little Boy' was a gun-type fission device. This is the simplest and least-efficient nuclear weapon design (the design requires a relatively large amount of fissile material to produce a relatively small blast). In a gun design, two sub-critical masses of U-235 are fired down a barrel, striking each other at extremely high velocities producing a fission reaction. Gun-type devices, however, are rugged and have a relatively high probability of 'going critical'—that is, producing a nuclear detonation. The second design, an implosion-type device, uses high-explosive lenses to compress the fissile material—'Fat Man' utilized plutonium—until it reaches criticality. Implosion devices are relatively difficult to manufacture and assemble because the shaped charges that compress the fissile material need to be manufactured to critical tolerances and detonated with more than split-second timing. The physics and engineering behind the design and manufacture of nuclear weapons are widely available. What is far more difficult is to acquire the highly enriched uranium (U-235) and plutonium. These materials are under safeguards, and their production and storage are monitored by the **International Atomic Energy Agency** (IAEA) and the declared and undeclared nuclear-weapons states themselves.

A fusion weapon is a three-stage bomb that uses an implosion device to trigger a fission reaction, which in turn detonates a fusion reaction (a process whereby one heavier nucleus is produced from two lighter nuclei). When the nuclei of light elements are combined, the resulting heavier element has less mass than the two original nuclei, and the difference in mass is instantaneously translated into energy. Often referred to as a thermo-nuclear weapon, or a hydrogen bomb, fusion weapons can be relatively small and lightweight, and pack virtually unlimited destructive force. During the Cold War, large nuclear weapons had yields in the millions of tons—megatons (mgt)—of TNT. On 31 October 1952, for example, the United States tested its first fusion device (Test Mike) at Eniwetok atoll in the Pacific Ocean. It produced a yield of about 10 mgt, which is equivalent to 10,000 kt. The most powerful nuclear weapon ever detonated was the Tsar Bomba (King of Bombs), which was a reduced-yield test of a 100-mgt bomb design. A product of Soviet science, the device was detonated with a 50-mgt yield on 30 October 1961 at the Mityushikha Bay Test range, Novayua Zemlya Island, producing a flash so bright that it was visible 1,000 km away. Bombs in the multi-megaton range generally have limited military utility since their destructive radius often exceeds the size of potential urban or military targets.

Nuclear-weapons effects

Compared to the devices we encounter in our everyday lives, nuclear weapons operate at the extremes of time, pressure, and temperature. The entire explosive process of a hydrogen bomb, for example, occurs over the period of a few thousand

Table 18.1 Nuclear-weapons states

Country	Fission device	Fusion device
United States	1945	1952
Soviet Union	1949	1953
United Kingdom	1952	1957
France	1960	1966
PRC	1964	1967
Israel	1967?	1973?
India	1974	1998?
Pakistan	1998	1998?
North Korea	2006	
Iran	?	

nanoseconds (a nanosecond is 1/100,000,000 of a second). Pressure within a fusion bomb core can reach up to 8,000,000,000 tons per square inch and temperatures exceeding those found on the surface of the sun (6,000°C). Nuclear weapons introduce galactic scale forces into a terrestrial environment, producing devastating consequences.

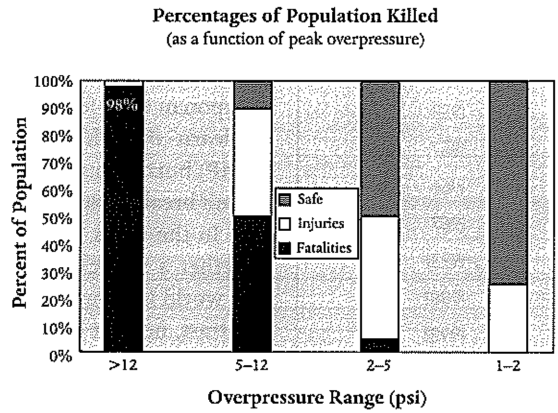
Nuclear-weapons effects are shaped by a variety of factors, including the weapon's explosive yield, its height of detonation, weather conditions, and terrain features. For example, an airburst occurs when the nuclear fireball does not touch the ground. Airbursts distribute the explosive blast and the radiation burst produced at detonation over a relatively wide area. Raising the height of burst lowers the pressure generated immediately below the detonation, but covers a larger area with somewhat lower overpressure. A ground burst maximizes the overpressure against a specific target—a missile silo or a command and control complex. A ground burst produces a great deal of fallout, because the fireball irradiates and lofts dirt and debris high into the atmosphere. Nuclear weapons can also be driven deep beneath the earth's surface in an effort to couple their explosive power more efficiently to the ground to destroy deeply buried and hardened targets.

All nuclear weapons produce similar effects, although the balance between these effects can be altered somewhat by design. An average nuclear weapon (about 100 kt) detonated in the atmosphere will deliver 50 per cent of its energy as blast, 35 per cent as thermal radiation, and about 15 per cent in gamma and residual radiation. A so-called neutron bomb, for instance, shifts some of the energy involved in a nuclear detonation from blast into radiation effects. Not all nuclear effects, however, are known or well understood. In the aftermath of a US high-altitude test of a 1.4 mgt weapon in 1962, for example, scientists were surprised to learn that the resulting electro-magnetic pulse (EMP) burned out street lights and fuses and opened circuit breakers 800 miles away in Oahu (Hansen 1988: 87). In the 1980s, scientists and analysts also debated whether a full-scale nuclear exchange would plunge the world into nuclear winter (Turco et al. 1990). By contrast, nuclear blast and thermal effects can be predicted with great precision; the US military generally relies on blast effects to estimate the damage that will be produced by a nuclear detonation.

The best-known and most important nuclear-weapons effects are EMP, a thermal-light pulse, blast, and fallout. EMP and the thermal-light pulse are produced at the instant of detonation. Electro-magnetic pulse occurs when **gamma radiation** interacts with matter (for example, the atmosphere)—a process known as the Compton effect. EMP produces a high-voltage electrical charge, which is harmless to humans, but can destroy electronic systems that are not specifically shielded against its effects. EMP effects are maximized by detonating weapons at relatively high altitudes (100,000 feet). In theory, a single high-altitude nuclear detonation could temporarily knock out most electronic systems in a medium-sized country. Thermal-light pulse, which lasts about two seconds, can cause flash blindness and fire. A 1-mgt airburst could produce flash blindness in individuals 53 miles away on a clear night and 13 miles away on a clear day. This airburst would cause first-degree burns on unprotected skin 7 miles away, second-degree burns at about 6 miles away, and third-degree burns at about 5 miles away.

A shockwave (a sudden rise in atmosphere pressure) and dynamic overpressure (wind) follow a few seconds behind the thermal light pulse. At about one mile away, a 1-mgt airburst will produce 20 lb per square inch (psi) overpressure and 470 mph winds, pressure sufficient to level steel-reinforced concrete structures. At 3 miles away, overpressure reaches 10 psi, producing winds of about 290 mph, sufficient to destroy most commercial structures and private residences. At 5 miles away, winds reach about 160 mph and overpressure reaches 5 psi, enough to damage most structures and subject people caught in the open

Figure 18.1 Percentages of population killed (as a function of peak overpressure)



Source: NRDC (2001) *The US Nuclear War Plan: A Time For Change* (New York: Natural Resources Defense Council)

to lethal collisions with flying debris. Blast effects were generally used by military planners to calculate casualty rates in a nuclear attack: it was estimated that about 50 per cent of the people living within 5 miles of a 1-mgt airburst would be either killed or wounded by blast effects (see Figure 18.1).

Individuals can be exposed to the fourth nuclear effect, radiation, either in the initial nuclear detonation or from fallout, which is irradiated debris picked up by the nuclear fireball and lofted into the atmosphere. A REM (roentgen-equivalent-man) is a measure of radiation energy absorbed by living creatures: 600 REM is likely to produce lethal radiation sickness in an exposed population, while a dose of 300 REM would produce lethal radiation sickness in about 10 per cent of an exposed population (United States Congress 1979).

A dirty bomb uses chemical high explosive to disperse radioactive material. It relies primarily on radiation to produce a lethal effect. A dirty bomb's lethality thus would be governed by how far radioactive materials might be lofted by the conventional chemical explosive and the radioactivity of the material used in the bomb. Many observers believe that the explosive blast produced by a dirty bomb, not the radioactive material it disperses, would cause the greatest amount of actual damage. Panic set off by even a limited dispersion of radioactive material, however, might be more costly in terms of the disruption it causes than the actual casualties or damage to property produced by the detonation of a dirty bomb.

Methods of delivery

Nuclear weapons have taken a variety of forms over the years. Early weapons were relatively large and heavy; only four-engine bombers were capable of lifting them. With the advent of thermonuclear (fusion) weapons, the size and weight of weapons began to decrease as their yields increased. Nuclear 'warheads' were soon mounted on cruise missiles, medium-range ballistic missiles, and eventually intercontinental ballistic missiles (ICBMs) and submarine-launched ballistic missiles (SLBMs) that were launched beneath the surface of the ocean from nuclear-powered submarines. By the 1970s, multiple independently targetable re-entry vehicles were being installed aboard US and Soviet ICBMs, giving both superpowers the ability to strike up to a dozen targets with one missile. Nuclear warheads were soon available for air-to-air missiles that were to be fired by aircraft to knock down incoming bombers, artillery shells, and even man-portable demolition charges. Neutron warheads were created to arm interceptor missiles that were part of the Safeguard Anti-Ballistic Missile System, which was developed by the United States in the 1970s. Both superpowers also investigated the possibility of deploying Fractional Orbital Bombardment Systems (FOBS)—that is, parking nuclear weapons in orbit so that they could be armed and targeted following an alert from ground-control stations. Mercifully, officials on both sides of the Cold

War divide thought better of living literally with a sword of Damocles over their heads, and in the 1967 Outer Space Treaty they banned the placement of nuclear weapons in space.

Methods of delivery sometimes help to characterize the way analysts view nuclear weapons. For instance, analysts describe delivery systems and the nuclear weapons associated with them as survivable (unlikely to be destroyed before they are used), reliable (likely to reach their targets without malfunctioning), accurate (likely to detonate near their target), or as likely to penetrate the target (evade air or missile defences). Weapons deployed on ballistic missiles carried by submarines that operate at sea are seen as desirable because they are highly survivable, although the cost involved in deploying nuclear weapons in this way is extremely high. It is less expensive to deploy warheads on land-based ICBMs and because of fixed communications they can be launched more quickly than their submarine-based counterparts, but these weapons are potentially more vulnerable to attack. ICBMs deployed in the United States have an additional drawback: using them to attack targets in the Middle East, for instance, would require a polar trajectory and over flight of Russia, a fact that might produce unintended and quite catastrophic consequences. Piloted bombers allow a human to reassess target options or fly routes that respect neutral air space, but it can take many hours to deliver weapons from aircraft and they are vulnerable to attack while on the ground. Nuclear weapons also can be placed on air-launched, ground-launched, or sea-launched cruise missiles to attack areas protected by heavy air defences, but it is unlikely that policy makers would be willing to trust this sort of 'robot' weapon in anything other than the direst circumstances. Because of various arms control agreements, Russians and Americans are also not free to develop new delivery systems or deploy them as they please.

Today, officials are worried about the possibility that terrorists might somehow manufacture or acquire a nuclear weapon or a radiological device. Although a missile or airborne attack is possible, there is much concern that a weapon might be smuggled into a country in one of the thousands of marine shipping containers that travel the world's oceans everyday. There is also a possibility that a weapon's components could be shipped separately and assembled on site. Local police forces and national intelligence agencies also closely monitor efforts to sell radioactive materials on the black market. In 1998, for instance, Mamdough Mamud Salim, an al-Qaeda operative, was arrested after attempting to buy 'enriched uranium' in Western Europe (Boureston 2002). Nuclear or radiological weapons manufactured by terrorists would probably be relatively crude, suggesting that they would be relatively large and difficult to transport. Small, man-portable nuclear devices (for example, atomic demolitions) were manufactured by the superpowers during the Cold War, which has raised concerns that these weapons might find their way onto the black market. In September 1997, for instance, the CBS news programme *Sixty Minutes* reported that former Russian National Security Adviser Aleksander Lebed claimed that the Russian military had lost track of 100 'suitcase bombs', each with a yield of about 10 kt. Russian officials confirmed that such devices had been constructed, but it remains unclear if they have been secured or destroyed.

Impact on international politics

Despite the fact that it is over sixty years since nuclear weapons emerged on the world scene in 1945 and that they played a dominant role in the Cold War standoff between the North Atlantic Treaty Organization (NATO) and the Warsaw Pact, debate continues about their impact on world politics (Paul et al. 1998). Disarmament advocates bemoan the failure of the existing nuclear powers to reduce their reliance on nuclear weapons, the failure of the US Senate to ratify the **Comprehensive Test Ban Treaty**, and the decision of the George W. Bush administration to withdraw from the 1972 **Anti-Ballistic Missile Treaty**, which in their mind threatens a new round in the arms race. They are also concerned that the non-proliferation regime is slowly losing ground, as several states continue to press ahead with covert and overt programmes to develop nuclear weapons. Others see the cup as half full. The United States and Russia have greatly decreased the size of their deployed nuclear forces—the 2002 Moscow Treaty cuts Russian and American nuclear forces to about 20 per cent of the level they reached during the Cold War. The New START Accords, which were signed on 8 April 2010, further cut the Russian and US nuclear arsenals, limiting each side to only 1,550 deployed strategic warheads. The international community has also taken a series of steps to address the issue of non-compliance with non-proliferation norms and to imbed international non-proliferation norms into domestic laws. United Nations Resolution 1540, for instance, obliged all nations to criminalize trafficking in WMD and to establish domestic controls over the export and use of materials that could be used in WMD programmes. Resolution 1540 extends the reach of existing international efforts to combat nuclear proliferation. The Global Initiative to Combat Nuclear Terrorism, announced jointly by President Bush and President Vladimir Putin in July 2006, refocuses international efforts in the battle against nuclear terrorism. It is a multinational effort to coordinate policy and transmit best practices.

Scholars are divided about the impact of nuclear weapons on world politics (Sagan and Waltz 2003). Some believe that a nuclear arsenal helps to deter attack by other states armed with conventional and nuclear weapons. The ability to retaliate with nuclear weapons after suffering an attack—known as a secure second-strike capability—is especially desirable, because it can effectively eliminate an opponent's potential gain produced by using nuclear weapons first, a situation known as crisis stability. Because even a few nuclear weapons can cause catastrophic destruction, and it is virtually impossible to defend against the effects of nuclear weapons, these scholars believe that they are truly revolutionary weapons that force militaries to concentrate on preventing, not fighting, wars (Brodie 1946). Some, focusing on Soviet–American relations during the Cold War, suggest that peace is the logical outcome, especially if potential enemies obtain secure second-strike capabilities: it is not logical for officials to engage in conflicts if they know in advance that a nuclear exchange will devastate, if not completely destroy, their country (Jervis 1989).

By contrast, proliferation pessimists worry that the superpower Cold War experience was at best an anomaly, and at worse a situation that often teetered on the brink of disaster. They worry that human frailty, communication failures and misperception, bureaucratic snafus, or psychological or technological breakdowns in a crisis can cause failures of deterrence, leading to inadvertent or accidental nuclear war. Others point to normal accidents—the inability to anticipate all human–machine interaction in complex systems—as a potential path to accidental nuclear war, especially because nuclear warning and command and control systems interact intensively during a crisis. Proliferation pessimists also point out that there is no guarantee that all militaries and governments will be good stewards of their nuclear arsenals. Those who possess nuclear weapons might take risks that expose their arsenals to sabotage, loss through theft, or accidental or inadvertent use. Some governments might use their newly found weapons not for deterrence purposes, but instead for purposes of intimidation or aggression. They might gravitate towards nuclear war-fighting strategies that seek to introduce nuclear weapons quickly and massively on the battlefield in an attempt either to pre-empt an adversary's use of nuclear weapons or to end a conflict with a quick knock-out blow.

Two divergent trends thus characterize the role of nuclear weapons on the international stage. Some states—the United Kingdom, France, the United States, Russia, and China—have embraced modest nuclear modernization programmes or have taken steps to reduce the size of their nuclear arsenals or their reliance on nuclear weapons in their foreign and defence policies. Sometimes ageing weapons systems are not replaced—the United States will no longer deploy nuclear-armed air launched cruise missiles as part of its strategic deterrent. Sometimes modernization programmes are minimized—in the UK the pace and scale of the Trident submarine replacement programme has been slowed, culminating in nearly a 30 per cent reduction in the number of nuclear weapons deployed on a day-to-day basis. In these states, nuclear weapons programmes can no longer be considered as a 'growth industry', In other states—Iran, North Korea, Pakistan, and India—nuclear weapons are apparently viewed as desirable national assets. Tehran seems intent on acquiring a nuclear arsenal despite international opposition. Pakistan is enhancing its stockpile of fissile material and is undertaking a host of development and modernization programmes to improve its short-, medium-, and intermediate-range ballistic missile delivery systems and is acquiring various types of cruise missiles. It is unclear which of these trends—nuclear armament or disarmament—will ultimately come to dominate world politics.

Chemical weapons

Although poisons and chemicals have been used in war since ancient times, chemical weapons emerged in the late 1800s as part of the modern chemical industry. Scholars debate whether chemical weapons should be considered a weapon of mass destruction, because

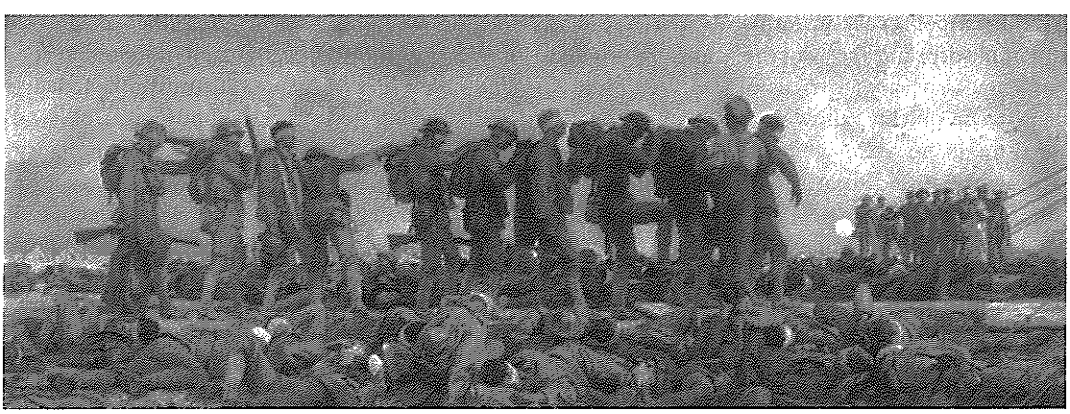
KEY POINTS

- A gun-type fission device is a relatively simple, reliable, and rugged nuclear weapon design that would be attractive to terrorist organizations or states developing a nuclear programme.
- Fusion weapons are highly complex devices that can produce enormous destructive energy from relatively small, light-weight packages.
- Primary nuclear effects are electromagnetic pulse, thermal-light energy, blast, and radiation.
- Although the risk of nuclear Armageddon has receded since the end of the Cold War, concerns are increasing that terrorists might acquire and detonate a dirty bomb or a gun-type device.
- Scholars continue to debate if nuclear weapons are a source of peace in world politics or an unjustified risk to international security.

large quantities of chemical weapons often have to be used on the battlefield to have a significant effect against a prepared opponent, and these weapons have to be expertly employed to produce massive casualties. On 20 March 1995, for instance, the Aum Shinrikyo cult launched a Sarin attack against the Tokyo subway system that resulted in twelve deaths. By contrast, the al-Qaeda attack against the Madrid train system on 11 March 2004 used conventional explosives and killed nearly 200 innocent civilians. What worries analysts, however, is that any state with a chemical industry could quickly convert production processes from civilian use to weapons manufacturing and that even readily available household products can be mixed to create relatively dangerous concoctions. Weapons can be created from commonly available chemicals using well-understood technologies. Household insecticides, for example, are simply 'watered-down' nerve agents.

The first significant employment of chemical weapons occurred in the First World War, as both sides sought a way to break through the stalemate of trench warfare. On 22 April 1915, German units unleashed a cloud of chlorine gas (an asphyxiating agent) against allied lines at Ypres, Belgium, but failed to exploit the gap created in the French lines. Petrified by the sight of corpses that exhibited no obvious causes of death, attacking German soldiers refused to advance. The Germans introduced mustard gas (a blistering agent) on the battlefield on 12 July 1917. The Allies also developed their own blister agent, Lewisite, but it was just reaching the battlefield as the First World War came to an end. Although chemical weapons caused only about 4 per cent of the casualties suffered by all sides during the First World War, the use of gas on the battlefield affected societies everywhere as veterans related stories of helpless soldiers struggling to put on gas masks as they chocked to death or were blinded by blister agents. This imagery, best exemplified by the painting of a field dressing station in Arras, France, made by the American artist John Singer Sargent, highlighted the horror and cruelty of gas warfare (see Figure 18.2).

Figure 18.2 John Singer Sargent, *Gassed* (1918)



Source: Reproduced with permission from the Art Archive/Imperial War Museum

Although the Italians employed mustard agent against Ethiopia in 1935 and the Japanese attacked Chinese troops with chemical weapons in the 1930s, chemical weapons were not used extensively on Second World War battlefields. Many speculate that Adolf Hitler, a mustard-gas casualty in the First World War, was personally reluctant to be the first to introduce these weapons in Europe (although this apparent aversion did not stop the Nazis from using Zyclon-B, a prussic-acid-based substance used as a pesticide and disinfectant, to kill thousands of victims in gas chambers). In fact, only one major chemical-weapons incident occurred during the war. On 2 December 1943, a Nazi air raid on the harbour in Bari, Italy, damaged a merchant ship carrying 2,000 100 lb M 47A1 bombs filled with mustard agent. The accidental release of agent affected thousands of allied soldiers and civilians. It was not until the Iran–Iraq War, however, that chemical weapons were again employed on the battlefield. In 1982, Iraqi units, hard pressed by far more numerous Iranian forces, dispensed mass concentrations of the riot control agent CS to break up opposing formations. By 1983, Iraq was using mustard agents on the battlefield and continued experimenting with more lethal agents and concoctions. In a February 1986 strike against al-Faw, the Iraqis employed a mixture of mustard and tabun (a nerve agent) against the Iranians, which resulted in thousands of casualties. Saddam Hussein's murderous regime also attacked its own citizens with chemical weapons. On 16 March 1988 Iraq forces sprayed a mixture of mustard and nerve agents over the Kurdish village of Halabja, killing more than 10,000 civilians.

Chemical-weapons effects

Chemical weapons vary in terms of their lethality, their complexity, and the way they cause injury and death. They also vary in terms of their persistence: some disperse quickly, allowing attacking troops to move through an area, while 'area denial agents', which might be used to attack an airfield to reduce the tempo of flight operations, might persist for a long time. Traditionally, chemical weapons have been characterized as blood agents, choking agents, blister agents, nerve agents, and incapacitants.

Blood agents, which are generally based on hydrocyanic acid (HCN), interfere with the body's ability to transport oxygen in the blood. Because cyanide has been used as a poison throughout history, several countries experimented with using this agent as a weapon. Owing to its high volatility—it evaporates quickly, making it hard to create a lethal concentration over a battlefield—most states long ago abandoned it as a toxic agent for military use.

Choking agents—phosgene and chlorine—get their name from the fact that their victims literally drown in the fluids produced when the tissues lining the lungs interact with the agent. Choking agents produce hydrochloric acid when they are inhaled, causing blood and fluid to infiltrate the lungs. Phosgene, which reacts with water in the body to produce hydrochloric acid, is a common industrial chemical that is more toxic than chlorine. Most of the deaths caused in the First World War by chemical weapons were caused by phosgene.

Blister agents are primarily intended to generate serious casualities in an opposing force, thereby placing enormous demands on supporting medical services. Before the development of more lethal nerve agents, sulphur mustard was considered to be the chemical weapon of choice. It exists as a thick liquid at room temperature, but can be suspended in air (that is, turned into an aerosol that can be inhaled) by using a conventional explosive. It can also be used to contaminate people, terrain, or equipment. Although the exact reason why mustard agent is an extreme irritant is not well understood, it causes severe blistering on exposed skin and mucous membranes. It can also cause temporary blindness. Long-term effects from a single moderate exposure to mustard agent are not usually lethal. The effects of mustard can sometimes take several hours to develop; Lewisite, another blister agent, works more rapidly than mustard.

Nerve agents are by far the most lethal chemical weapons. Invented during the 1930s as insecticides, they entered Nazi and Allied military inventories in the Second World War but were not used in combat. The name 'nerve agent' reflects the fact that these chemicals interfere with the body's neurological system by irreversibly inactivating acetyl cholinesterase (AChE), which 'deactivates' the neurotransmitter acetylcholine. Nerve agents bind to the active site of AchE, making it incapable of deactivating acetylcholine. Without an ability to deactivate acetylcholine, muscles fire continuously and glandular hypersecretion occurs (for example, excess saliva), leading to paralysis and suffocation. Second-generation nerve agents, G (German) series agents (GA) Tabun, (GB) Sarin, (GD) Soman, (GF) Cyclosarin, are considered to be non-persistent agents. G series agents are all water and fat soluble, and can enter the skin and cause lethal effects. Third-generation V Series—VX, VE, VG, VM—nerve agents, a product of British science, are persistent agents that are about ten times more lethal than Sarin. Less is publicly known about fourth-generation A-series agents (also known as 'Novichok' agents), a product of Soviet science. Exposure to high aerosol concentrations of nerve agents causes prompt collapse and death.

Incapacitants are used for riot control (CS or tear gas) or for personal protection (CN or mace). They are less toxic than other chemical weapons and usually do not produce lethal effects when used in the open at a proper concentration. Vomiting agents (adamsite) have been developed for use in combat. Both Soviet and US scientists also experimented with psychochemicals (that is, lysergic acid diethylamide [LSD] and BZ) in an effort to cause altered states of situational awareness. BZ was weaponized by the United States, but it was dropped from its arsenal because its effects were unpredictable. In October 2002, Russian security forces used an opiod form of fentanyl in an attempt to incapacitate Chechin separatists who were holding 800 hostages in a Moscow theatre. Owing to either a lack of prompt medical attention or an overdose of fentanyl, 126 people died from this 'incapacitant'.

Methods of delivery

Chemical weapons are delivered from either a line or a point source. Bombs, artillery shells, missile warheads, or parcels, for instance, are all point sources, because they deliver chemical weapons to a specific location. A line source, which is generated by a series of dispensing devices, a crop duster, or even a moving crop sprayer, creates a cloud or 'line' of gas that drifts towards the target. Wind, temperature, and terrain can affect the lethality and persistence of an agent. For example, a gallon of VX is sufficient to kill thousands of people, but only if individuals are brought into contact with the correct amount of agent to cause casualties. Agents can be blown off target, diluted by rain, or even solidify, if the temperature drops too low.

Because proper dispersal is the key to employing chemical weapons, analysts are most concerned about their use in closed venues such as sporting arenas or large buildings with ventilation systems that could be subject to tampering. Aum Shinrikyo targeted the Tokyo subway because of the large numbers of people who travel daily through its contained spaces and choke points. The cult experimented with a suitcase mechanism to deliver Sarin aerosol in the subway: two small electric fans were used to disperse the chemical agent after it was released from vials stored inside the suitcase. To conduct the actual attack, however, the cult relied on a far simpler method: they punched holes in plastic bags containing Sarin and simply allowed the agent to evaporate in the subway cars.

Impact on international politics

By the 1970s, NATO militaries began to view chemical weapons as a deterrent, not as a weapon they preferred to use on the battlefield. Chemical weapons pose obvious difficulties in terms of transportation and handling, and most military observers agree there are safer and more efficient ways to hold targets at risk. Thus the preferences of military professionals helped to foster a taboo against the use of chemical weapons in war, restraint codified in the **1925 Geneva Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous, or Other Gases, and of Bacteriological Methods of Warfare**. Although the Geneva Protocol banned first use of chemical weapons, it did not prevent states from stockpiling chemical munitions. The Chemical Weapons Convention (CWC), which entered into force on 29 April 1997, makes it illegal for signatories to possess or employ chemical weapons, with the exception of small samples used to test protective equipment. States party to the CWC are required to declare their existing stocks of chemical weapons, to identify facilities that were once involved in chemical-weapons production, and to announce when their existing stocks will be completely destroyed. The Organization for the Prohibition of Chemical Weapons (OPCW) is authorized to verify compliance with the CWC and can undertake challenge inspections when demanded by states parties (Larsen 2002).

While 148 nations have ratified the CWC, about twenty countries, some of which maintain a large chemical arsenal (for example, North Korea and Syria), have not signed the treaty. Most military analysts believe that these large arsenals would only have a modest effect on well-equipped and trained troops on the battlefield. In their view, a chemical arsenal is the 'poor man's' weapon of mass destruction, because it is based on old, relatively simple, and inexpensive technologies that have limited military utility. Nevertheless, if employed deliberately against relatively defenceless civilian populations, these weapons could wreak havoc. Analysts are most concerned that terrorist organizations or even individuals might gain access to poisonous chemicals that are part of industrial processes and attack urban targets. Iraqi use of chemical weapons in war is considered an anomaly. The fear is that Aum Shinrikyo's Sarin attack might be a harbinger of things to come.

KEY POINTS

- There are five types of chemical weapons: blood agents, choking agents, blister agents, nerve agents, and incapacitants.
- Chemical agents can be persistent or non-persistent and can be delivered from a point or a line source.
- State and non-state actors with access to even a rudimentary chemical industry can acquire chemical weapons.
- The nearly universal Chemical Weapons Convention bans the manufacture or use of chemical weapons and allows signatories to possess only small amounts of agents for research into defensive equipment and prophylaxis.

Biological weapons

Biological weapons (BW) make use of living organisms or toxins to sicken or kill humans, animals, and plants. These organisms and toxins all occur in nature, which makes it difficult to differentiate natural disease outbreaks from a BW attack. BW is probably the most potentially destructive weapon known to humans in the sense that a single organism or infected individual can affect millions of human beings, although scientists debate the degree of difficulty any state or non-state actor might encounter in infecting large numbers of people quickly. Although extremely contagious diseases are generally not lethal, some, smallpox, for example, are easily transmitted and produce high morbidity. Sometimes, diseases that are considered relatively mundane can be extremely lethal: the 1918–19 Spanish Flu killed upwards of forty million people, striking hardest among healthy adults between the ages of 20 and 40.

Disease has been a part of war throughout history. Until recently, most people died in war from illness, not from wounds suffered in combat. Deliberate use of disease as a weapon of war, however, has been sporadic, producing mixed results. In 1346, Mongol invaders hurled the corpses of soldiers who had died from bubonic plague into the besieged city of Kaffa in a deliberate effort to spread disease. The Mongols did not know, however, that the causative bacteria of plague *Yersinia pestis* is spread by fleas that feed only on live hosts. At the end of the Seven Years War (1756–63), British forces apparently provided American Indians with smallpox-infected blankets, although it is difficult to determine whether or not they succeeded in infecting anyone, because smallpox was already endemic in the Americas and had decimated Indian populations about two hundred years earlier. During the First World War, German saboteurs apparently succeeded in infecting horses used by the allies with glanders. During the Second World War, the Japanese filled glass bombs with plague-infected fleas to spread disease, and Japanese scientists working in the infamous Unit 731 conducted biological warfare experiments on prisoners of war.

Although the United States, the UK, and Canada conducted research into the weaponization of Anthrax, Tularemia, Q-fever, Venezuelan equine encephalitis, and anti-agricultural agents, biological weapons were generally viewed in the West as lacking military utility. By contrast, Soviet researchers concentrated on perfecting a variety of biological agents during the Cold War and exploited the emerging science of genetic engineering better to weaponize naturally occurring diseases. According to Ken Alibek (2000), who was a leading figure in Biopreperat, the Soviet Union's complex of biological weapons facilities, Soviet science worked with a variety of bacteria (for example, an antibiotic-resistant strain of anthrax), viruses (for example, smallpox) and even haemorrhagic fevers (for example, Ebola). Although the 'Soviet' biological weapons programme apparently ended in Russia in the early 1990s, experts still debate what motivated the Soviets to undertake such an extensive BW programme. The Soviets probably saw their BW programme as a counter to the precision, global-strike complex that was emerging in NATO in the 1970s or as a way to retard Western recovery following an all-out nuclear exchange. The Soviets apparently loaded several SS-18 intercontinental ballistic missiles with plague in an attempt to provide Western survivors of a nuclear war with an additional reason to envy the dead.

Table 18.2 Possible biological warfare agents: bacterial and rickettsial agents

Agent/disease	Organism	Lethality	Onset	Symptoms	Target
Anthrax	*Bacillus anthracis*	80% lethality, non-contagious	1–5 days	Pulmonary form: chest cold symptoms, respiratory distress, fever, shock death	Area attack
Brucellosis	*Brucella*	3–20% lethality, non-contagious	5–60 days	Fever, headaches, pain in joints and muscle fatigue	Area attack
Plague	*Yersinia pesstis*	80% lethality, contagious	2–3 days	High fever, headache, extreme weakness, haemorrhages in skin and mucous membranes	Area attack
Tularemia	*Francisella tularensis*	50% lethality contagious	2–10 days	Chills, fever, headache, loss of body fluids	Area attack
Q Fever	*Coxiella burnettii*	2% lethality non-contagious	10–40 days	Fever, headache, cough, muscle and joint pain	

Table 18.3 Possible biological warfare agents: viral agents

Agent/Disease	Organism	Lethality	Onset	Symptoms	Target
Smallpox	Variola virus	2–49% lethality, contagious	7–17 days	Severe fever, small blisters on skin, bleeding on skin and mucous	Area attack
Viral encephalitis	Eastern Equine Encephalitis (EEE) virus	80% lethality, non-contagious	1–14 days	Headache, general aches and pains, photophobia	Area attack
Viral haemorrhagic fevers	Ebola	80% lethality, contagious	4–21 days	Subcutaneous haemorrhage, bleeding from body orifices, headache, fever, stupor, convulsion	Area attack

Biological weapons effects

Although naturally occurring diseases have been a scourge of humankind, not every disease provides the basis for an effective biological weapon. An agent's storage, delivery, mode of transmission, and its very resilience (that is, how long can it survive in the environment) can shape its effects on a target population. Military professionals believe that most biological weapons are simply too unpredictable in their effects to be a reliable weapon. Because they are easy to manufacture and can be potentially highly lethal in small quantities—any basic medical laboratory has the capability to cultivate a biological agent—biological agents might be attractive and available to terrorists. Relatively large industrial facilities are needed to produce militarily significant quantities of chemical weapons, but relatively small fermenters used to make legitimate vaccines, for instance, could be quickly converted to produce biological agents.

There are three varieties of biological agents: bacteria, viruses, and toxins. As an area attack agent, anthrax is probably the best-known bacterial agent. Its spores are extremely hardy (they can live for literally hundreds of years) and it can be spread quickly across large areas. Anthrax is not contagious, so its effects can be relatively contained and focused on specific targets. It also can be genetically engineered to be resistant to most antibiotics and it can be formulated with inert matter better to form an aerosol. These qualities make anthrax the agent of choice for many biological-weapons programmes. The cutaneous form of anthrax occurs in the animal industry and can be treated relatively easily; by contrast, the inhalation form of the disease is extremely dangerous. By the time the victim begins to show symptoms of inhalation anthrax, a near-lethal dose of toxins produced by the anthrax bacteria has already built up in the body. The Aum Shinrikyo cult attempted to disperse anthrax in Tokyo in 1996; they failed because they used a non-toxic vaccine strain of the virus. The terrorist who sent anthrax through the US mail in autumn 2001, however, used a deadly 'Ames' strain, which US weapons laboratories employ to test defensive equipment and prophylaxis (Stern 2000).

Although haemorrhagic fevers—Marburg, Lassa fever, or Ebola—are viral agents that could serve as potent weapons, policy makers are most worried about the threat posed by smallpox. As smallpox was eradicated as a naturally occurring disease, global vaccination programmes were terminated, leaving entire generations unprotected against the disease for the first time in hundreds of years. Smallpox is an airborne virus that is about as contagious as the flu, but it has a lethality of about 30 per cent in its ordinary form (rarer malignant and haemorrhagic forms of smallpox are 100 per cent lethal). Smallpox vaccination can stop the disease, even if administered a few days after exposure, but, to prevent a pandemic, potentially millions of doses of vaccine need to be made quickly available. Reintroduction of general inoculation programmes, however, have not been advocated by public health authorities, because the smallpox vaccine itself leads to about fifty instances of side effects per one million people vaccinated. The impact of a smallpox outbreak, however, cannot be underestimated. The 'Dark Winter' exercise run by the US Federal Emergency Management Agency in June 2001 was based on a smallpox outbreak in the American Midwest. Within 30 days, over 300,000 people in 25 states and 10 foreign countries had already contracted the disease. Smallpox truly has the capability of creating a global catastrophe.

Although toxins are not living organisms and are in fact a by-product of metabolic activity, they are generally discussed as a biological weapon. Toxins are probably best thought of as a poison, which is often used to attack specific individuals. Like chemical weapons, individuals have to be brought into direct contact with the toxin to suffer from its effects. Toxins, however, can be extremely lethal. Ricin, which is made from castor bean, kills by inhibiting protein synthesis within cells. Used as an assassination weapon—the Bulgarian dissident Georgy Markov was killed by a Ricin injection in 1978—it can kill within three days. Because it can be made easily from readily available materials, many analysts believe that terrorists will seek to use ricin. In 2003, for instance, British officials arrested a terrorist who was plotting to smear Ricin on the door handles of cars and buildings in London. In 2008, a man was sickened by the Ricin he had stockpiled in a Las Vegas hotel room. In 2004, Victor Yushchenko was badly disfigured from a toxin attack (see Think Point 18.1).

! THINK POINT 18.1 Who poisoned Yushchenko?

Although toxins could be employed against troops in the field or against large groups of individuals in sporting arenas or transportation systems, history suggests that they often serve as an exotic weapon for assassination. In the latest example of attempted 'toxin assassination', Austrian doctors reported in December 2004 that Ukrainian presidential candidate Victor Yushchenko was suffering from dioxin poisoning. Yushchenko apparently developed symptoms—fatigue, pain, and disfiguring chloracne—quickly after he had apparently ingested TCDD dioxin in his food. The concentration of dioxin in Yushchenko's body, the second highest ever recorded, was as least 1,000 times more than is found in most people. Some observers speculate that dioxin was used because it would disfigure and sicken Yushchenko, literally making him an unattractive candidate to the Ukrainian electorate. Campaigning in extreme pain, and badly disfigured by dioxin, Yushchenko went on to ride the 'Orange Revolution' in Ukraine that followed the electoral fraud in the November 2004 presidential elections. He took office as the Ukraine's President on 23 January 2005.

Methods of delivery

Biological agents are generally delivered in the form of an infectious aerosol. Precise preparation of the aerosol is crucial because the agent has to be the proper size to infect a host by lodging in the small alveoli of the lungs. Vectors—lice, fleas, mosquitoes—transmit disease in nature, but it would be difficult to use this mode of transmission as a military weapon because it is inherently difficult to control. Terrorists might attempt to infect individuals surreptitiously with a disease such as smallpox, but the disease is difficult to grow in vitro and the terrorists themselves would have to be vaccinated to work with the virus. Because smallpox vaccine is not readily available, seeking vaccine might allow public health officials to detect some nefarious scheme. The difficulty of controlling infectious diseases should also give terrorists pause. Unleashing highly contagious diseases can backfire, because a pandemic does not respect religious, political, or cultural boundaries, although public health services in rich countries are far more likely to cope with an outbreak of infectious disease than poorer countries whose health-care system is already stretched to breaking point.

Impact on international politics

Following revelations in the early 1990s about the Soviet biological weapons programme and renewed concerns about biological warfare following the 1991 Gulf War, policy makers devoted renewed attention to strengthening the 1972 **Biological and Toxin Weapons Convention (BWC)** by devising an inspection

Table 18.4 Possible biological warfare agents: toxins

Agent/Disease	Organism	Lethality	Onset	Symptoms	Target
Botulinum Toxin	*Clostridium botulinum*	80% lethality, non-contagious	1–5 days	Blurred vision, photophobia, paralysis	Proximity attack
SEB Toxin	*Staphylococcus aureus*	2% lethality	1–6 hours	Headache, sudden fever, nausea, vomiting	Proximity attack

Figure 18.3 Who poisoned Yushchenko? This combination image shows the changing face of Ukraine's opposition leader Viktor Yushchenko in file photos taken on 4 July 2004 (left) and 1 November 2004 (right)

Source: Reproduced with permission from Reuters/Gleb Garanich and Vasily Fedosenko protocol similar to the verification mechanism embedded in the CWC. By late 2001, however, negotiations over an inspection protocol for the BWC reached an impasse. Officials concluded that it was too difficult to devise an inspection regime that could provide any significant insight into what was being manufactured in the tens of thousands of medical laboratories around the planet and that, regardless of the efforts of inspection teams, it was simply too easy to conceal work on biological agents. Efforts instead shifted from the diplomatic realm to strengthening domestic criminal laws against the manufacture or possession of biological weapons or agents and improving international health monitoring to spot the outbreak of infectious diseases.

KEY POINTS

- Biological weapons are derived from naturally occurring diseases and can be manufactured in medical laboratories.
- Biological weapons vary in terms of their lethality and whether or not they are contagious.
- Anthrax is a biological agent of great concern because it is a hardy, non-contagious agent that can be used to contaminate large areas. It can potentially directly infect many people quickly.
- The revolution in genetic engineering has been used to weaponize naturally occurring diseases.

Conclusion

In some respects, the WMD threat has greatly receded since the end of the Cold War. The number of deployed Soviet (Russian) and American strategic nuclear warheads has been reduced by 80 per cent since the 1990s, and US tactical nuclear weapons have largely been withdrawn from service. The threat of Armageddon produced by a massive nuclear exchange is now only a remote possibility. The International Non-Proliferation Regime has survived the 1998 Indian and Pakistani nuclear tests and a *de facto* nuclear test ban remains in place, despite the fact that the US Senate failed to ratify the Comprehensive Test Ban Treaty. The CWC and BWC not only provide a basis in international law to stop the spread of these deadly chemical and biological agents, but they also serve as a useful diplomatic framework for devising new ways to stop the spread and use of these weapons. The Proliferation Security Initiative (PSI), for instance, is a new international undertaking to stop the illicit trade in materials related to chemical, biological, and nuclear weapons. The PSI also reflects a shift towards counter-proliferation in the international effort to stop the spread of chemical, biological, and nuclear weapons. In the wake of revelations about A. Q. Khan's clandestine nuclear supply network and the interception of a shipment of North Korean SCUD missiles that were bound for Yemen, officials are taking more active steps to stop trading in illicit materials, weapons, and delivery systems.

Although Iranian efforts to develop a nuclear weapon or the fact that North Korea has a nascent nuclear arsenal dominates headlines, officials today are most concerned by the prospect that WMD is escaping the control of state actors. The biological and medical sciences are undergoing a period of revolutionary development based on advances in genetics and genetic engineering. These capabilities are now widely available to researchers and manufacturers. This raises the possibility that new biological weapons will inevitably find their way into the hands of individuals or non-state actors. The so-called renaissance in nuclear energy, the turn towards nuclear power as an answer to global warming and peak oil, also creates opportunities for more state and non-state actors to gain access to radiological materials and know-how. The emerging challenge is to devise ways to safeguard these nuclear, biological, and chemical technologies and materials in both a domestic and an international setting so that they cannot be diverted to nefarious purposes. Since the First World War, the use of WMD in war has been episodic. Nation states have mostly abandoned their chemical and biological arsenals. Terrorists' efforts to use chemical, biological, or radiological weapons have been largely ineffective. Nuclear weapons, the centrepiece of the Soviet–American Cold War competition, have been used on the battlefield twice. Lingering questions remain. Is there a taboo against the use of weapons of mass destruction? Will the quest to obtain nuclear weapons trump international trends that foster nuclear stasis or even disarmament among the great powers? Have we all just been incredibly lucky?

QUESTIONS

1. Why might nuclear weapons be a source of stability in international relations?
2. Why do you think that the use of weapons of mass destruction in war is relatively rare?
3. Why would terrorists be attracted to chemical, biological, radiological, or nuclear weapons?
4. What effect would another use of nuclear weapons have on world politics?
5. Toxins are often used against what type of target?
6. Which variety of WMD is most destructive? Which is most easily manufactured?
7. What steps should governments take to prevent WMD terrorism?
8. Is direct action or international negotiation the best way to counter the spread of WMD?
9. Do you think Aum Shinrikyo's experience with Sarin will be emulated by other groups or individuals?
10. Do you think that weapons of mass destruction serve as status symbols in world politics?

FURTHER READING

- Bernstein, Jeremy (2008), *Nuclear Weapons: What You Need To Know*, New York: Cambridge University Press. This volume offers a fascinating account of how scientific puzzles and technical hurdles were overcome in the quest to build nuclear weapons.
- Croddy, Eric A. and Wirtz, James J. (2005) (eds), *Weapons of Mass Destruction: An Encyclopedia of Worldwide Policy, Technology, and History*, 2 vols, Santa Barbara, CA: ABC-Clio. A handy reference on WMD.
- Freedman, Lawrence (2003), *The Evolution of Nuclear Strategy*, 3rd edn, New York: Palgrave Macmillan. This is the best single volume on the history of nuclear arsenals and the strategic thinking that guided nuclear strategy.
- Pant, Harsh V. (2012), *Handbook of Nuclear Proliferation*, New York: Routledge. Provides an overview of various national policies on nuclear weapons.
- Sagan, Scott D. and Waltz, Kenneth (2003), *The Spread of Nuclear Weapons: A Debate Renewed*, 2nd edn, New York: Norton. Provides an engaging debate between proliferation optimists and pessimists.
- Schell, Jonathan (1982), *The Fate of the Earth*, New York: Knopf. This is probably the best description of the existential threat posed by the widespread use of nuclear weapons.

IMPORTANT WEBSITES

- **http://www.cdc.gov** Center for Disease Control and Prevention. The Center provides information on diseases.
- **http://www.ucsusa.org** Union of Concerned Scientists. Established in 1969, this is an independent non-profit alliance of more than 100,000 citizens and scientists concerned by the misuse of science and technology in society.
- **http://www.nps.edu/Academics/Centers/CCC/** Center on Contemporary Conflict. Launched in 2001, the CCC conducts research on current and emerging security issues and conveys its findings to US and Allied policy makers and military forces.
- **http://nuclearweaponarchive.org** Nuclear Weapons Archive. The purpose of this archive is to illuminate the reader regarding the effects of these destructive devices, and to warn against their use.
- **http://cns.miis.edu** Center for Nonproliferation Studies, Monterey Institute of International Studies. The Center strives to combat the spread of weapons of mass destruction (WMD) by training the next generation of nonproliferation specialists and disseminating timely information and analysis.

- **http://www.fas.org/index.html** Federation of American Scientists. Formed in 1945 by atomic scientists from the Manhattan Project, the FAS conducts research and provides education on nuclear arms control and global security; conventional arms transfers; proliferation of weapons of mass destruction; information technology for human health; and government information policy.

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