Global Health Security and Weapons of Mass Destruction Chapter

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1 Introduction

The global proliferation of weapons of mass destruction (WMD) presents a clear and present danger to global health security. Unlike conventional weapons that confine themselves to a defined and targeted area, WMD's cross international boundaries and borders and thus threaten global health security. This chapter will focus on the ease of access to WMDs, the impact biological weapons and bioterrorism plays on global health security, United States global policies on public health, and the role actors and non-state actors play in the global health landscape. Chemical, biological, radiological, nuclear, and explosive weapons, also known as weapons of mass destruction (WMD), have the potential to kill thousands of people in a single incident [1]. This fact, in and of itself, is why a thorough understanding of the threat is necessary. In addition, this chapter will focus on global WMD proliferation prevention to include international efforts, treaties, and conventions. The chapter will conclude with a discussion of ongoing research initiatives, identification of emerging threats, and additional recommended readings.

2 Global Proliferation

There is not anywhere on the planet that is truly safe from the weapons of mass destruction (WMD) threat. Indeed, the threat to public health by the deliberate use of these weapons impacts every living person. Whether by hostile nations or by terrorism, these weapons present a clear and present danger to all nations. The proliferation of WMD has risen dramatically since the fall of the former Soviet

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Union and other failed nation states. WMD includes chemical, biological, radiological, nuclear weapons and explosives. In addition, there is great concern regarding the spread of scientific knowledge among terror groups who can produce chemical and biological weapons with little technical expertise. Both the proliferation of WMD and spread of scientific knowledge to terrorists preset a global WMD threat.

Dennis Blair [2] states in an DNI Threat Assessment, "Most terrorist groups that have shown some interest, intent or capability to conduct CBRN attacks have pursued only limited, technically simple approaches that have not yet caused large numbers of casualties. In particular, we assess the terrorist use of biological agents represents a growing threat as the barriers to obtaining many suitable started cultures are eroding and open source technical literature and basic laboratory equipment can facilitate production" [2]. In his opening statement before the Senate Committee on Homeland Security and Governmental Affairs, Senator Joseph Lieberman, summarized his concerns surrounding global proliferation of legitimate biotechnology research and expertise. As Senator Liberman noted, *"...while so much of a benefit in so many ways, also creates this problem because that work can be used to create weapons of mass bioterror"* [3].

Attacks Using WMD

- 1994 (Chemical) – Sarin in Matsumoto, Japan killing 8 and hospitalizing 200
- 1995 (Chemical) – Sarin in a Tokyo subway, 12 dead, 5500 affected
- 1995 (Explosive) – LVB attack at the Federal Building in Oklahoma City, 168 dead
- 1995 (Radiological) – Chechens placed a 14 Kilo package of radioactive Cesium 137 and explosives in a Moscow park
- 2001 (Biological) – Anthrax released through mail system in the United States, kills 5, thousands affected
- 2013 (Chemical) – The Syrian government and opposition trade accusations over a gas attack that killed some 26 people, including more than a dozen soldiers, in the town of Khan al-Assal in northern Syria. A U.N. investigation later finds that sarin nerve gas was used, but does not identify a culprit
- 2017 (Chemical) – More than 90 people are killed in a suspected nerve gas attack on the town of Khan Sheikhoun in the rebel-held Idlib province. Victims show signs of suffocation, convulsions, foaming at the mouth and pupil constriction. Witnesses say the attack was carried out by either Russian or Syrian Sukhoi jets. Moscow and Damascus deny responsibility.
- 2017 (Chemical) – Assassination of Kim Jong Nam, the exiled half brother of North Korean dictator Kim Jong Un, by two women assailants in the Kuala Lumpur International Airport last week. On Friday, Malaysian officials announced that toxicologists found VX nerve agent on his face.

The fall of the Soviet Union and Warsaw Pact Nations resulted in the rise of concern that WMD weapons held by these nations would find themselves on the black market and perhaps, made available to terrorists. This added dimension to proliferation makes it even more difficult to mitigate. The potential for non-state actors, which includes both domestic and international terrorists, successfully obtaining access to WMD's is a very real threat to the safety and security of all people [4]. One should realize that a nexus exists between WMD and terrorism. The driving motivation for terrorism is to inflict fear and create destruction to achieve their goals. The prospect of a terrorist faction successfully obtaining WMD poses one of the gravest risks to civilization. A successful WMD terror attack could potentially kill thousands and result in many more thousand casualties. Likewise, the social, political, and economical impacts of such an attack would threaten the civilized world. The interconnected nature of people, economies, and international infrastructure around the world can infuse seemingly isolated or remote events with global consequences [5].

Significant efforts have been made in the United States and other countries to eliminate the threat of the spread of WMD. In 2003, President George Bush signed the Proliferation Security Initiative (PSI), which was designed to stop the global trafficking of WMD. On 31 May 2003, President Bush unveiled the Proliferation Security Initiative (PSI) in Krakow, Poland, which outlined a new interdiction cooperative agreement outside of treaties and multilateral export control regimes [6]. PSI is not a program housed in only one agency, but instead is a set of activities with participation by multiple U.S. agencies and other countries [7]. In its December 2002 National Strategy to Combat Weapons of Mass Destruction (WMD) Proliferation, the Bush Administration articulated the importance of countering proliferation once it has occurred and managing the consequences of WMD use. In particular, interdiction of WMD-related goods gained more prominence. U.S. policy sought to "enhance the capabilities of our military, intelligence, technical, and law enforcement communities to prevent the movement of WMD materials, technology, and expertise to hostile states and terrorist organizations [8]. President Bush's efforts follow a long line of previous efforts to curb the proliferation of WMD (Illustration 1).

In 1972, beginning with the signing of the Biological Weapons Convention, which prohibited the development, production, stockpiling, acquisition, retention or transfer of biological weapons, was the first multilateral disarmament treaty

Major Developments in the Use and Prohibition of Chemical Weapons		
1972	Biological Weapons Convention	Comprehensive BW prohibition – 170 parties, 10 signatories by 2014, but, no verification mechanism; commitment to negotiate on CW.
1993	Chemical Weapons Convention	Signing of the CWC in Paris, 13 January.
1997	OPCW, The Hague	CWC enters into force and the OPCW commences its operations.
2007	Tenth Anniversary of the CWC	182 Member States 25,000 metric tons of chemical weapons certified by the OPCW as destroyed, 3,000 inspections carried out.
2013	Syrian Conflict	Use of chemical weapons in the civil war.
2013	Nobel Peace Prize	OPCW recieves the Nobel Peace Prize for its efforts to eliminate CW.

Illustration 1 Organization for the Prohibition of Chemical Weapons [9]

banning an entire category of WMD. While this was a valiant attempt, the agreement fell short as there was no built-in verification mechanism [10]. In 1993, the landmark Chemical Weapons Convention was held in Paris that resulted in 130 countries agreeing on the elimination of chemical weapons [9]. It also established the Organization for the Prohibition of Chemical Weapons (OPCW), whose mission is to assure the objectives outlined in the CWC are carried out and for ensuring the implementation the CWC provisions. This includes the verification of compliance of CWC directives (43, 44). The year 2007 marked the tenth anniversary of the CWC, which boasted 182-member states. In the preceding years between 1993 and 2007, approximately 25,000 metric tons of chemical weapons were destroyed, with over 3000 international inspections conducted. Even with the successes of the OPCW, the world witnessed Syria launch a chemical WMD attack on civilians, which we will discuss later in the chapter. According to the Worldwide Threat Assessment of the US Intelligence Community, the Mideast nations of Iraq and Syria have already demonstrated their use of WMD on civilians. In his statement for the record, United States Director of National Intelligence, Daniel R. Coats [11] outlined the following situation status:

2.1 Russia

Russia has developed a ground-launched cruise missile (GLCM) that the United States has declared is in violation of the Intermediate-Range Nuclear Forces (INF) Treaty. Despite Russia's ongoing development of other Treaty-compliant missiles with intermediate ranges, Moscow probably believes that the new GLCM provides sufficient military advantages to make it worth risking the political repercussions of violating the INF Treaty. In 2013, a senior Russian administration official stated publicly that the world had changed since the INF Treaty was signed in 1987. Other Russian officials have made statements complaining that the Treaty prohibits Russia, but not some of its neighbors, from developing and possessing ground-launched missiles with ranges between 500 and 5500 km.

2.2 China

The Chinese People's Liberation Army (PLA) continues to modernize its nuclear missile force by adding more survivable road-mobile systems and enhancing its silo-based systems. This new generation of missiles is intended to ensure the viability of China's strategic deterrent by providing a second-strike capability. China also has tested a hypersonic glide vehicle. In addition, the PLA Navy continues to develop the JL-2 submarine-launched ballistic missile (SLBM) and might produce additional

JIN-class nuclear-powered ballistic missile submarines. The JIN-class submarines—armed with JL-2 SLBMs—give the PLA Navy its first long-range, sea-based nuclear capability. The Chinese have also publicized their intent to form a triad by developing a nuclear-capable nextgeneration bomber.

2.3 Iran and the Joint Comprehensive Plan of Action

Tehran's public statements suggest that it wants to preserve the Joint Comprehensive Plan of Action because it views the JCPOA as a means to remove sanctions while preserving some nuclear capabilities. Iran recognizes that the US Administration has concerns about the deal but expects the other participants—China, the EU, France, Germany, Russia, and the United Kingdom—to honor their commitments. Iran's implementation of the JCPOA has extended the amount of time Iran would need to produce enough fissile material for a nuclear weapon from a few months to about 1 year, provided Iran continues to adhere to the deal's major provisions. The JCPOA has also enhanced the transparency of Iran's nuclear activities, mainly by fostering improved access to Iranian nuclear facilities for the IAEA and its investigative authorities under the Additional Protocol to its Comprehensive Safeguards Agreement. Iran's ballistic missile programs give it the potential to hold targets at risk across the region, and Tehran already has the largest inventory of ballistic missiles in the Middle East. Tehran's desire to deter the United States might drive it to field an ICBM. Progress on Iran's space program, such as the launch of the Simorgh SLV in July 2017, could shorten a pathway to an ICBM because space launch vehicles use similar technologies.

2.4 North Korea

North Korea's history of exporting ballistic missile technology to several countries, including Iran and Syria, and its assistance during Syria's construction of a nuclear reactor—destroyed in 2007—illustrate its willingness to proliferate dangerous technologies. In 2017 North Korea, for the second straight year, conducted a large number of ballistic missile tests, including its first ICBM tests. Pyongyang is committed to developing a long-range, nuclear-armed missile that is capable of posing a direct threat to the United States. It also conducted its sixth and highest yield nuclear test to date. The assessment is that North Korea has a longstanding BW capability and biotechnology infrastructure that could support a BW program. We also assess that North Korea has a CW program and probably could employ these agents by modifying conventional munitions or with unconventional, targeted methods.

2.5 Pakistan

Pakistan continues to produce nuclear weapons and develop new types of nuclear weapons, including short-range tactical weapons, sea-based cruise missiles, air-launched cruise missiles, and longer-range ballistic missiles. These new types of nuclear weapons will introduce new risks for escalation dynamics and security in the region.

2.6 Syria

The Syrian regime used the nerve agent sarin in an attack against the opposition in Khan Shaykhun on 4 April 2017, in what is probably the largest chemical weapons attack since August 2013. We continue to assess that Syria has not declared all the elements of its chemical weapons program to the Chemical Weapons Convention (CWC) and that it has the capability to conduct further attacks. Despite the creation of a specialized team and years of work by the Organization for the Prohibition of Chemical Weapons (OPCW) to address gaps and inconsistencies in Syria's declaration, numerous issues remain unresolved. The OPCW-UN Joint Investigative Mechanism (JIM) has attributed the 4 April 2017 sarin attack and three chlorine attacks in 2014 and 2015 to the Syrian regime. Even after the attack on Khan Shaykhun, we have continued to observe allegations that the regime has used chemicals against the opposition [11].

The danger from hostile state and non-state actors who are trying to acquire nuclear, chemical, radiological, and biological weapons is increasing. The Syrian regime's use of chemical weapons against its own citizens undermines international norms against these henious weapons, which may encourage more actors to pursue and use them. ISIS has used chemical weapons in Iraq and Syria. Terrorist groups continue to pursue WMD-related materials [12]. With respect to proliferation, it is important to remember the line between countries and terrorist groups is not always distinct. It is clear that some terrorist groups are supported by nation-states and vice versa. And it is evident that some terrorist groups act as proxies for nation-states. In addition, leading scientists working within a country might not be under the control of national authorities, as was the case in the history of nuclear weapons proliferation (www.fas.org/sgp/crs/nuke/RL34248.pdf).

In 2004, the United Nations Security Council passed Resolution 1540, with the intent of keeping WMD out of the hands of non-state actors, which included nuclear, biological, and chemical weapons, their means of delivery, and related materials. Resolution 1540 included the following three core directives: [13].

1. All States are prohibited from providing any form of support to non-state actors seeking to acquire weapons of mass destruction, related materials, or their means of delivery.

2. All States must adopt and enforce laws criminalizing the possession and acquisition of such items by non-state actors, as well as efforts to assist or finance their acquisition.
3. All States must adopt and enforce domestic controls over nuclear, chemical, and biological weapons, their means of delivery, and related materials, in order to prevent their proliferation.

3 Biological

Biological weapons are perhaps, the most insidious form of WMD's. These are weapons that contain viruses and/or bacterial pathogens or poisonous substances that have been engineered to cause severe illness or death in human beings, animals and vegetation. In their natural state, these pathogens or substances are not normally fatal to living beings and must be amplified or weaponized to become a threat. In addition, biological weapons also require a delivery mechanism. The Centers for Disease Control (CDC) categorizes biological threats into three distinct categories based on lethality, with each category containing specific biological agents. Category A contains the most lethal agents that pose the greatest threat, as they are easily disseminated and have the highest mortality rates [14]. Category A agents include Anthrax- *Bacillus anthracis*, Botulism- Clostridium botulinum, Plague- Yersinia pestis, Smallpox- Variola virus, Tularemia- Francisella tularensis, and Viral Hemorrhagic Fever Viruses (which includes the Ebola Virus) [15].

Category B agents have a low to moderate morbidity and are less threatening to the general public. Category B agents include Bacterial, Rickettsial, and Protozoal agents (Brucellosis, Glanders, Melioidosis, Q Fever, Psittacosis, Typhus Fever, Cholera, and Cryptosporidiosi); Toxins (Staphylococcus Enterotoxin B, *C. Perfringens* Epsilon Toxin, and Ricin Toxin); and, Viral agents (Viral Encephalitides, including Venezuelan, Western, and Eastern Equine Encephalitis) [14, 15]. The final category is Category C, which are those pathogens that can be engineered for mass dissemination because they are readily available, have a general ease of production, and their potential for high mortality rates [14]. These include emerging viral pathogens, including Nipah Virus, Hantavirus, which also includes Hantavirus Pulmonary syndrome and Hantavirus Hemorrhagic Fever Syndrome. These pathogens have a higher mortality than Cat B Agents [15].

One only need look at history to see the impact of biological weapons. The Greeks contaminated the water wells of their enemies in 300 B.C. Later, in the French and Indian War, the British Army distributed smallpox infected blankets to the Indians. British General Sir Jeffrey Amherst proposed presenting local Indian tribes with the smallpox-laden blankets, which would allow colonist an easier path to colonization [16]. At a peace conference, the blankets were presented as gifts to the unsuspecting Indians. What the tribes did not realize, was that the blankets came from a smallpox-infected soldiers that were located in the area. The resulting impact

was an outbreak of smallpox in the Indian tribes of the area which was estimated to have a case fatality rate of almost 90% [16].

In the Second World War, the most notorious was conducted by the Japanese Army under the leadership of Lt. Gen. Shiro Ishii. Ishii commanded the infamous Unit 731 and employed over 3000 scientists [17]. Unit731 operated in over six different cities with more than 3000 researchers who all focused on the development of deadly biological agents [18]. Among the biological toxins researched included anthrax, plague, and typhus. Their test subjects included prisoners and innocent populations. It is estimated that over 10,000 people endured this horrible experimentation and later died as a result [16]. One of Unit 731's most notorious attacks occurred in 1941 with the air distribution of plague infected wheat and mosquitos over the town of Chang the, China. Within a week, residents of the town began dying of plague. The final death toll estimate was 400 people [19]. In the 1950s, the United States Navy sprayed a low pathogenic bacterium over San Francisco Bay by boat to assess the vulnerability of a large American coastal town to a biological attack [17]. In the 1970s, the USSR maintained a clandestine biological weapons research lab that was known as Chief Directorate for Biological Preparation (Biopreparat) that produced plague, tularemia, anthrax, glanders, smallpox and Venezuelan equine encephalomyelitis [20].

Shortly after the September 11th, 2001 attacks on the World Trade Center and Pentagon, several US government leaders received "Anthrax Letters", which caused panic in Washington, DC. Although this was a relative small-scale attack, it still elicited fear from throughout the United States. One of the key goals of a terrorist is to disrupt normal day-to-day life. The Anthrax Letters did just that—they cause very little damage and no one was infected, but they caused widespread panic. Attacks do not have to be successful in creating casualties to be successful. Indeed, the psychological damage done by launching a biological attack will have a tremendous impact on the government and population.

Any response to an incident involving biological substances brings about a higher level of concern and will challenge a community's emergency response infrastructure. New or engineered pathogens can spread quickly throughout the world. In his book, "Hot Zone", author Richard Preston writes a fictional account of the spread of the Ebola Virus. Readers learned just how dangerous this pathogen was. Although this was a fictional account, an actual Ebola outbreak nearly occurred in Ranson, Virginia in 1989 at a CDC Primate Lab when monkeys became infected with a hemorrhagic fever outbreak. Although the incident was contained, it required the ethnicization of 450 primates by the United States Army Medical Research Institute of Infectious Diseases (USAMRIID). Fortunately for the primate lab scientists, their strain of Ebola was not harmful to humans. This outbreak gave birth to the new Ebola-Reston strain, which is only one of five Ebola strains not harmful to humans [21]. The world's attention was again focused on the Ebola virus when in 2014, a Dallas hospital nurse became infected with Ebola after treating an Ebola patient. As the world learned of the Ebola incident, citizens and concerned scientists concerns over laboratory safety began to be heard. The pandemic potential of accidental release of insufficient biosafety presents a danger [22].

Ebola is just one example of a biological threat—there are many others. It is important to note that each pathogen is unique and requires differing forms of response and treatment. As noted in the Department of Homeland Security's (DHS) Biological Incident Annex, individual pathogens present a real threat to public health and local plans should be written to deal with the aftermath of such threats [23]. Given the difficulty of weaponizing and distributing biological agents in enough quantity to create a mass casualty incident, it is unlikely that terror groups have this capability. In the Senate Committee on Homeland Security and Governmental Affairs report, the Commission concluded that the United States should be less concerned that terrorists will become biologists and far more concerned that biologists will become terrorists [3].

The cornerstone of international efforts to prevent biological weapons proliferation and terrorism is the 1972 Biological Weapons Convention (BWC). This treaty bans the development, production, and acquisition of biological and toxin weapons and the delivery systems specifically designed for their dispersal. The BWC forbids member states (now numbering more than 160) from assisting other governments, non-state entities, or individuals in obtaining biological weapons [3].

The future threat of biological weapons is also significant. Advances in bioengineering and biotechnologies that synthesize DNA has created a new biohazard known as "synthetic genomics." This capability allows scientists to synthesize any virus whose DNA has been decoded. Imagine the impact of synthesizing the smallpox virus. Although smallpox was eradicated in 1977, samples remain frozen in cryogenic containers [3]. Attention to global health security that includes efforts to help prepare for and address pandemic and epidemic diseases has grown significantly over the past few decades, driven by the ongoing threat posed by emerging infectious diseases (EIDs), including HIV, SARS, H1N1, Ebola, and Zika [24].

4 Chemical

The threat that weapons of mass destruction places on communities worldwide cannot be overstated. Chemical weapons present unique challenges to emergency responders and healthcare practitioners requiring specialized decontamination procedures and treatment. Chemical weapon use anywhere in the world poses a grave threat to the safety and security of all worldwide. The presence and usage of chemical weapons also pose a continuing threat and risk to global security and instability. A chemical attack is the spreading of toxic chemicals with the intent to do harm. A wide variety of chemicals could be made, stolen, or otherwise acquired for use in an attack. Industrial chemical plants or the vehicles used to transport chemicals could also be sabotaged [25]. Both the concentration and toxicity of a chemical impacts the severity of an attack. Similarly, whether the agent is released in a closed space or in the open air will impact the persistence of chemical agents. It is important to note that chemical weapons are banned under customary international law, the 1925 Geneva Protocol and the 1997 Chemical Weapons Convention (CWC) [26].

The Organization for the Prohibition of Chemical Weapons (OPCW) is the implementing body for the Chemical Weapons Convention, which entered into force on 29 April 1997. The OPCW, with its 193 Member States, oversees the global endeavor to permanently and verifiably eliminate chemical weapons [27]. The OPCW divides chemicals into three distinct schedules with each category listing chemicals by the threat they pose. Schedule 1 chemicals are those that present the highest risk, as they include those chemicals that are prohibited by the Chemical Weapons Convention. These chemicals have little or no use for peaceful purposes in commercial or industrial activities. Among them are chemicals that have actually been produced, stockpiled or used as weapons, such as VX, sarin, mustard and two biological toxins—ricin and saxitoxin (OPCW 2017).

Schedule 2 chemicals are those that present a significant risk because of their lethal, incapacitating or other properties that could enable them to be used as a chemical weapon. Examples include Amiton, BZ, thiodiglycol, and pinacolyl alcohol (OPCW 2017). Schedule 3 chemicals are similar to Schedule 1 chemicals in that many have been stockpiled or used as weapons, but different in that they generally are produced in large commercial quantities for purposes not prohibited by the Convention. They may represent a risk to the object of the CWC due to their toxicity or to their importance in producing any of the chemicals listed in Schedule 1 or precursors listed in Schedule 2. Examples of Schedule 3 chemicals include phosgene, hydrogen cyanide, triethanolamine, and phosphorus trichloride (OPCW 2017).

The history of chemical weapons can be traced back to World War I, where the Germans used chlorine and phosgene weapons that resulted in hundreds of thousands of chemical casualties. In 1915, in Ypres, Belgium, the Germans opened the valves on more than 6000 steel cylinders, releasing 160 tons of chlorine gas on the unsuspecting French trenches killing more than 1000 French and Algerian soldiers and wounding more than 4000 soldiers [28]. Again in 1917, the Germans introduced a new chemical agent—Mustard Gas—which was referred to as the "King of the Battle Gasses." Unlike chlorine or phosgene, mustard gas is a vesicant, also referred to as a "Blister Agent", whose symptoms may not be realized until 2–24 h after initial exposure [29]. Mustard gas produces large blisters on the skin and if inhaled, can cause blistering in the lungs. Mustard gas produced more chemical casualties than all the other agents combined, including chlorine, phosgene, and cyanogen chloride [28].

In 1988, Iraqi leader Saddam Hussein attacked the city of Halabja, Iraq with mustard gas and nerve agents, killing 50,000 civilians and injuring another 70,000 [30]. In 1995, an obscure Japanese religious cult, Aum Shinrikyo, launched a sarin gas attack on the Japanese subway system killing 12 and injuring more that 5000 other subway passengers (RAND 2005).

In 2012, the despot leader of Syria, President Bashar al-Assad attacked his own population in Khan Al Asal near Aleppo killing 25 civilians and injuring more than 100 others. Again, in 2017, he released another chemical attack in Douma, outside of Damascus, Syria that captured world attention after the bodies of children were

broadcast worldwide. In this attack, 1700 innocent civilians were killed, including women and children [26]. This attack prompted United States President Donald Trump to launch punitive strikes on Syrian targets that were associated with the Syrian regime's chemical-weapons programs [31].

The use of chemical weapons has continued into 2018 with countries attempting to thwart the Chemical Weapons Convention by simply adjusting their formulary to create new chemical compounds. On March 4th, 2018 former Soviet double agent Sergei Skripal and his daughter Yulia Skripal were both poisoned with the nerve agent Novichok, which is a military-grade nerve agent [32]. The Organization for the Prohibition of Chemical Weapons (OPCW) confirmed the United Kingdom's (UK) findings that Novichok was used to target the former Russian double agent and his daughter in the English city of Salisbury" [32]. According to former UK Foreign Secretary Boris Johnson, "there can be no doubt what was used and there remains no alternative explanation about who was responsible – only Russia has the means, motive and record" [32].

Numerous treaties and agreements have attempted to thwart the development and deployment of chemical weapons. Regulation attempts of chemical weapons dates back to 1675 when "the first international agreement limiting the use of chemical weapons was signed between France and Germany, prohibiting the use of poison bullets." [9] In 1874 the Brussels Convention on the Law and Customs of War was signed, which prohibited the employment of poison or poisoned weapons, and the use of arms, projectiles or material to cause unnecessary suffering [9]. In 1889, an agreement was signed that was a part of The Hague Peace Conference in which countries agreed to abstain from the use of projectiles, the sole object of which is the diffusion of asphyxiating or deleterious gases [9]. As we have read, the first half of the twentieth century witnessed nations putting great resources into the development of chemical weapons. From the Cold War years (1947–1991), the United States and the Soviet Union were the two major superpowers still producing and maintaining chemical weapons stockpiles. In 1997, the world's first multilateral disarmament agreement witnessed 130 signatory nations agree to specifically at eliminating chemical weapons stockpiles, which was known as the Chemical Weapons Convention (CWC) [9]. Their success was such that the OPCW was awarded the Nobel Peace Prize in 2013.

Illustration 2 depicts the efforts of disarmament and non-proliferation in CBRN weapons.

The danger that chemical weapons pose to the world's population is significant, as they have the ability to incapacitate, injure, and kill without discrimination. Their exposure presents dire consequences to any population or person who comes into contact with them. As we have read in this chapter, the sad history of chemical weapons use has resulted in nations attempting to stop the production and use of these agents. The public health impact cannot be overstated—from exposure, clean up, and contamination to decontamination and displacement of those impacted populations, it is critical that all public health personnel become familiar with the threat these weapons pose.

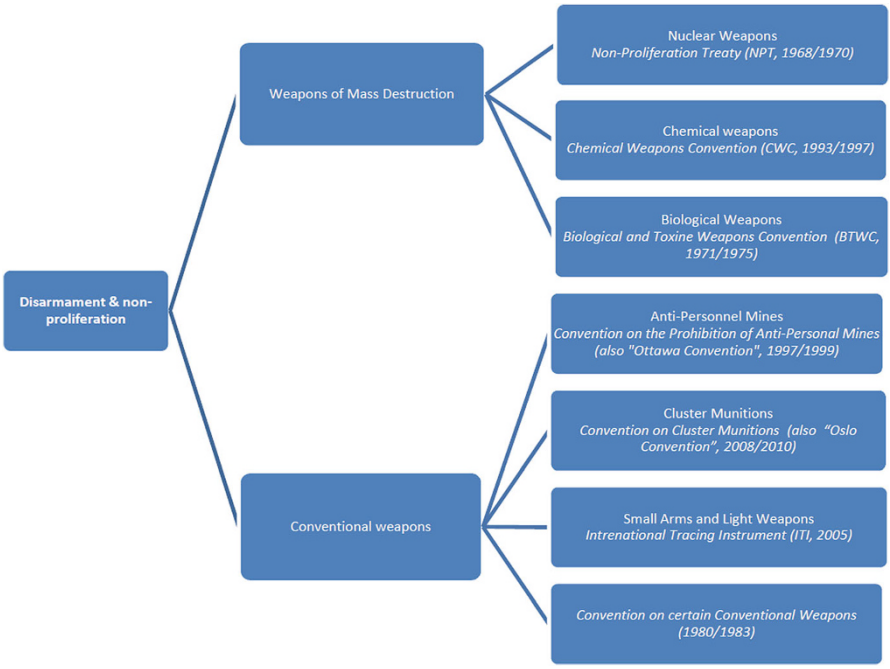


Illustration 2 Non-proliferation legislation. (Source: Disarmament & Non-Proliferation Infographic – Kingdom of Belgium)

5 Radiological

Radiological agents occur naturally and are used in everyday life, from medical x-rays to industrial applications. It is important to note that a radiological device is not a nuclear weapon. The threat radiological devices pose is through low-order detonation of explosives that spread the radiological agent in the atmosphere, ground and water. Topical exposure or inhalation of radiologically-contaminated substances is where the threat lays. As we have scene with biological and chemical substances, terrorists are always seeking the materials to construct Radiological Dispersal Devices (RDDs). Radiological events include the potential for terrorists to obtain these materials in an attempt to create the nonnuclear release of radioactive materials [33]. As we will read about under the Nuclear section of this chapter, the fall of the former Soviet Union and lapse of security in former nuclear sites potentially allowed for the sale of these materials on the black market. There are sites all around the world that radiological materials exist and many of these locations have virtually no security.

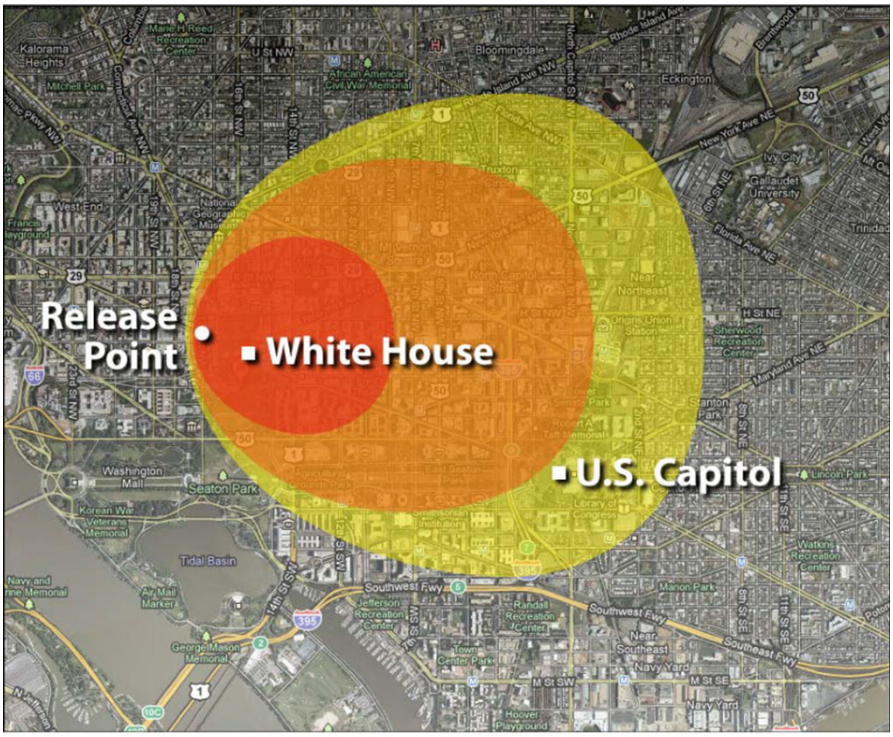
RDDs are likely to be the radiological weapon of choice because of their relative simplicity and widespread availability of RDD-adaptable radioactive materials in medicine, scientific research, and industries, such as civil engineering, petroleum engineering, aeronautics, and radio-thermal energy generation [34]. As stated previously, an RDD is not a nuclear weapon and its main purpose is spreading radioactive materials in a low-order explosive. Although far less catastrophic than a nuclear detonation, an RDD attack would likely result in few immediate casualties, but would certainly have longer term impacts on public health. The ancillary impacts of an RDD include the potential of widespread panic, economic loss, and costly cleanup [33].

According to the Congressional Research Service report, "Dirty Bombs": Technical Background, Attack Prevention and Response, Issues for Congress," the author states that governments and organizations have taken steps to prevent an RDD attack [35]. Within the United States, the Nuclear Regulatory Commission (NRC) has issued regulations to secure radioactive source, which has assisted both United States and other countries to secure and prepare for RDD attacks. Internationally, the International Atomic Energy Agency (IAEA) has led efforts to secure radioactive sources. Other nations and nongovernmental organizations have acted to secure sources as well. Key points include: [35]

- Nuclear Regulatory Commission actions have done much to instill a security culture for U.S. licensees of radioactive sources post-9/11.
- Many programs have sought to improve the security of radioactive sources overseas, but some incidents raise questions about security.

Even though tougher regulatory measures have been put into place, additional steps are needed to help reduce the RDD threat. It is truly a nightmare scenario if a terrorist detonates an RDD and spreads radioactive material across dozens of square miles, causing panic in the target area and beyond, costing tens of billions of dollars to remediate, costing further sums in lost wages and business, compelling the demolition and rebuilding of contaminated buildings, forcing difficult decisions on how to dispose of contaminated rubble and decontamination chemicals, and requiring people to relocate from areas with elevated levels of radiation [35].

In a scenario involving an RDD detonation in Washington, DC., the Sandia National Laboratories projected the impact of such an attack. Their scenario included the detonation of a RDD that included 1000 curies of cesium-137 chloride (about 50 grams). Their model includes exposure from radioactive material both deposited on the surface and resuspended into the air and inhaled. The following map is based on an atmospheric dispersion model, depicting where individuals would be projected to have an increased risk of developing cancers due to radiation exposure over a year or more [35].



Effects and Actions						
	Area km² mi²	Equivalent Dose (rem)	Exceeds relocation PAG for which year:	Population	All Cancers	Fatal Cancers
	2.10 0.81	>2.00	First year only	38,000	233	159
	7.60 2.93	>0.500	Any subsequent year	94,700	278	189
	13.2 5.10	>5.00	50 years (cumulative)	125,000	461	314
Areas and counts are cumulative. RDD detonated at 38.9 N, 77.0 W. PAG: Protective Action Guide						

Source: William Rhodes III, Senior Manager, International Security Systems Group, Sandia National Laboratories, September 2010; analysis by Heather Pennington; graphics by Mona Aragon.

One can see the increase in the cancer risk over time. Depending where they are at the time of the exposure, this type of attack would increase the lifetime incidence of cancer by 461 people, and lifetime deaths from cancer by 314. The Figure assumes no relocation, sheltering, or decontamination. All these actions would occur in the real world, significantly reducing cancer incidence and deaths caused by the attack [35].

6 Nuclear

Nuclear weapons and the materials that make them up presents a true danger to civilization. The Cold War years between 1947 and 1991 witnessed a dramatic rise in both the United States and Soviet Union's nuclear stockpiles. The conventional wisdom of stockpiling these weapons was the concept of "mutually assured destruction," which simply meant both the United States and Soviet Union would completely destroy one another in a nuclear war. Towards the end of the Cold War, other nations began acquiring nuclear weapons. These nations included China, Pakistan, North Korea, and India. The addition of these nations added to the complex calculus of mutual assured destruction. Twenty years ago, Russia and 14 other newly-independent states emerged from the breakup of the Soviet Union, which put into question the status of their 35,000 nuclear weapons spread out at thousands of sites across a vast Eurasian landmass that stretched across 11 time zones (Graham 2012).

The concern the world faces is what happens when a terrorist group obtains a nuclear weapon. One thing is for certain, we are in an age where terrorism is almost common place, with terrorists always seeking different ways to achieve mass casualties. While it is unlikely that a terrorist group could obtain an in-tact nuclear weapon, they could construct a crude device. Indeed, it is potentially within the capabilities of a technically sophisticated terrorist group, as numerous government studies have confirmed [36]. In 2004, a report written by Harvard University's Project on Managing the Atom concluded that "a capable and well-organized terrorist group plausibly could make, deliver, and detonate at least a crude nuclear bomb capable of incinerating the heart of any major city in the world." [37] The consequences of detonation of even a crude terrorist nuclear bomb would be severe, turning the heart of modern city into a smoldering radioactive ruin and sending reverberating economic and political aftershocks around the world [36].

Without argument, a nuclear detonation would be catastrophic and cause death and destruction the likes of which we have never seen. A more likely scenario for a terror group would be in the form of a "dirty bomb", or radiological dispersal device (RDD). This is a device that is a mix of explosives, such as dynamite, and radioactive powder or pellets. It is important to note a dirty bomb cannot create an atomic blast. When the bomb explodes, the blast carries radioactive material into the surrounding area where it can cause widespread radiation exposure and sickness. People nearby could be injured by pieces of radioactive material from the bomb. Only people who are very close to the blast site would be exposed to enough radiation to cause immediate serious illness. However, the radioactive dust and smoke can spread farther away and could be dangerous to health if people breathe in the dust, eat contaminated food, or drink contaminated water. People injured by radioactive pieces or contaminated with radioactive dust will need medical attention [38].

7 Public Health Concerns

Triaging, treating and transporting victims of radiation, chemical, or biological exposure require swift and effective decontamination procedures. The risk of spreading contaminates to healthcare workers is significant, which also includes workers, bystanders, or others who may be in the contamination area or downwind. Contaminated victims will require a special assessment for decontamination needs, which may include rapid decontamination on the scene of the incident and/or the hospital [39]. The risk of secondary contamination is a significant concern that needs to be addressed in emergency response plans.

Triage is the process of determining the priority of a victim's treatments based on the severity of their condition. Before treatment can begin, however, a mechanism must be in place to determine whether victims must also be decontaminated. It is equally important, however, to identify patients or victims who will not require decontamination and can be quickly evacuated from the incident site. The process of triage will determine the order of decontamination of victims. Quick observance of victim signs and symptoms will help determine whether decontamination is necessary. The three most important reasons for decontaminating exposed victims are: [40]

1. To remove the contaminant from the victim's skin and clothing, thus reducing further agent exposure and physical effects.
2. Protecting emergency responders, medical personnel, family members, or others from secondary transfer exposures.
3. Preventing victims from spreading contamination over additional areas of their body.

The decision to decontaminate victims must occur through the medical branch of the Incident Command System, with the approval of the Incident Commander. The decision points the medical branch utilizes to make this decision is based on the follow outside indicators: [39]

- The victim's signs and symptoms to include airway, breathing, and circulation.
- Visual proof of contaminants on the skin or victim's clothing.
- Whether the victim was in the contamination zone.
- Positive contamination results from the use of chemical detection paper/tape, chemical agent monitor, Geiger counter, or other technology.
- Proof of potential chemical exposure after reviewing the material safety data sheets (MSDS).

The ultimate goal of decontamination is to be expedient and thorough. One must also remember that the longer it takes for victims to undergo decontamination, the longer it will take for them to be transported and treated at a hospital. Decontamination can be divided into tiers, which allows for flexibility and adaptability based on the incident type. Additionally, each of the tiers can be conducted on the scene of the incident or at a medical treatment facility [39].

8 Mass Patient Decontamination

Decontamination activities conducted for a large number of potentially contaminated patients, which may exceed the typical response capacity of an organization, may require additional resources or personnel, and require that patients be prioritized for the decontamination process. The number of patients that constitutes mass decontamination is dependent on the jurisdiction, responding agency, and capacity. Mass decontamination may occur within any of the decontamination tiers.

9 Self-Care

Actions that a patient can perform for him/herself, including distancing him/herself from the site of release, removing clothing, and wiping visible contamination from skin and clothing in order to reduce his/her own contamination level immediately, without waiting for a formal decontamination process to be set up.

10 Gross Patient Decontamination

Actions likely to be performed by or with the assistance of first responders or first receivers in order to achieve a gross or hasty reduction in contamination, significantly reducing contamination on skin or clothing, as soon as possible after contamination has occurred.

11 Technical Patient Decontamination

Planned and systematic actions, likely to be performed under the guidance of or with the assistance of first responders or first receivers, to achieve contamination reduction to a level that is as low as possible.

12 Summary

Weapons of mass destruction presents a threat to civilization by both hostile states and non-state actors, including terrorists. Numerous legislative efforts have attempted to halt the proliferation of WMD which works for nations who intend on following the law. The danger exists with non-state actors, rogue nations and terrorists, anyone of whom wouldn't think twice on using them. It is important for

nations and international law enforcement agencies to keep tabs on these rogue nations and terrorists. The threat is too great and the cost is just too high if these weapons fall into the wrong hands. Global proliferation of weapons of mass destruction (WMD) presents a clear and present danger to global health security and unlike conventional weapons that confine themselves to a defined and targeted area, WMD's cross international boundaries and borders. From the sarin attacks in 1994 and 1995 in Japan and 2001 anthrax attacks to the Syrian chemical attack on innocent civilians and VX nerve agent assignation in Malaysia, weapons of mass destruction are a sad reality in today's society. As we have learned in this chapter, the driving motivation of terrorism is to strike fear and kill or injure innocent civilians to achieve their twisted goals. WMD's pose a much larger threat than conventional weapons and could potentially kill thousands and result in many more thousand casualties.

WMD's include chemical agents, biological pathogens, radiological agents, and nuclear weapons, each of which require special protective measures for responders and decontamination for victims. Chemical agents include Lung Damaging Agents (Chlorine (CL) and Phosgene (CG)), Blood Agents (Cyanogens), Blister Agents (Mustard (H), Lewisite (L), and Phosgene Oxime (CX)), and Nerve Agents (Tabun (GA), Sarin (GB), Soman (GD), and VX). Biological agents are those that contain viruses and/or bacterial pathogens or poisonous substances that have been engineered to cause severe illness or death in human beings, animals and vegetation. In their natural state, these pathogens or substances are not normally fatal to living beings and must be amplified or weaponized to become a threat. In addition, biological weapons also require a delivery mechanism. The Centers for Disease Control (CDC) categorizes biological threats into three distinct categories based on lethality, with each category containing specific biological agents. Category A contains the most lethal agents that pose the greatest threat, as they are easily disseminated and have the highest mortality rates [14]. Category A agents include Anthrax- *Bacillus anthracis*, Botulism- Clostridium botulinum, Plague- Yersinia pestis, Smallpox- Variola virus, Tularemia- Francisella tularensis, and Viral Hemorrhagic Fever Viruses (which includes the Ebola Virus) [15]. Category B agents have a low to moderate morbidity and are less threatening to the general public. Category B agents include Bacterial, Rickettsial, and Protozoal agents (Brucellosis, Glanders, Melioidosis, Q Fever, Psittacosis, Typhus Fever, Cholera, and Cryptosporidiosi); Toxins (Staphylococcus Enterotoxin B, C. Perfringens Epsilon Toxin, and Ricin Toxin); and, Viral agents (Viral Encephalitides, including Venezuelan, Western, and Eastern Equine Encephalitis) [14, 15]. The final category is Category C, which are those pathogens that can be engineered for mass dissemination because they are readily available, have a general ease of production, and their potential for high mortality rates [14]. These include emerging viral pathogens, including Nipah Virus, Hantavirus, which also includes Hantavirus Pulmonary syndrome and Hantavirus Hemorrhagic Fever Syndrome. These pathogens have a higher mortality than Cat B Agents.

The radiological threat are those posed by the spread of radioactive materials in the atmosphere. Radiological dispersal devices (RDDs) may be explosive-driven—a dirty bomb—or use nonexplosive means like a crop duster airplane. Radioactive material may be dispersed indoors to contaminate a building, though the scenario most commonly discussed involves detonation of a dirty bomb outdoors. The nuclear threat is the greatest of all threats The concern the world faces is what happens when a terrorist group obtains a nuclear weapon. One thing is for certain, we are in an age where terrorism is almost common place, with terrorists always seeking different ways to achieve mass casualties. The United States and United Nations have worked hard to eliminate the threat of the spread of WMD, but even with the best intentions, it is difficult to maintain enforcement with rogue states and terrorists. It is critically important that all public health providers maintain vigilance and become aware of the WMD threat.

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