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Radiological, chemical and biological terrorism

Abstract

Terrorism involves the use or threat of violence and aims to instill fear not only in the immediate victims but also in the general public. The extent to which it relies on fear distinguishes terrorism from conventional warfare. Terrorism has become a matter of international concern. Terrorists make use of 'Weapons of mass destruction'. A weapon of mass destruction is a nuclear, radiological, chemical, biological or other device designed to harm large numbers of people. Weapons of mass destruction (WMD) constitute a class of weapons with the potential to have massive destructive effects, killing millions of civilians, endangering the natural environment and changing the lives of future generations with catastrophic consequences. These include: Chemical weapons can cause death or serious injury to persons by poisonous chemicals. Biological weapons spread disease organisms or poisons to harm or kill people, animals or plants. Radiological weapons which release radioactivity to maim and kill humans, animals and plants. Nuclear devices can be used to disperse all the three. The general awareness, covering all aspects about these weapons of mass destruction in one compilation, is needed by law enforcement agencies, criminal justice organizations, forensic science professionals, medical fraternity and the general public.

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Introduction

In recent years, terrorism has conquered the whole world. This is a critical question that every nation must face. The perception of the threat of terrorism has increased considerably in the current social, economic and political scenario of the world. Terrorism has been defined as "the systematic use of violence to create a climate of general fear in the population and thus achieve a specific political goal".[1] It is usually seen as a means to destabilize or overthrow existing political institutions. There are several reasons for the phenomenal growth of terrorism, including growing religious fundamentalism, failure of nationalist goals, disgruntled political leadership, economic deprivation, desperation of violent right-wing groups, clashes of ideologies, racial discrimination and increasing globalization, etc.

Events such as 9/11(USA), 26/11(India) and many others have shown that all countries must prepare for attacks that defy traditional ethical standards and can kill or maim thousands of civilians without warning. Conventional weapons may not be used in these attacks. Three types of unconventional weapons of mass destruction, i.e., radiological, chemical and biological weapons, can cause serious health effects and/or death to large populations if used effectively. In addition to radiological weapons, chemical and biological weapons have been highly valued by terrorist groups around the world due to their evil appeal, which has made the current situation very critical. Japan and Germany are known to have used chemical weapons during World War II, and other countries such as the United Kingdom, the United States, France, and Russia had stockpiles of chemical weapons.

After the World War II and during the Cold War, the Soviet Union and the United States secretly researched chemical and biological weapons, and both may have stockpiled these weapons, originally developed by different countries for their militaries during the war. When these weapons of mass destruction are used to attack the enemy, it affects not only the soldiers but also the civilian population. Under strong criticism and pressure, the United Nations took initiatives to ban these weapons of mass destruction through several international treaties. However, it is feared that many countries continue to secretly manufacture, store and research these weapons. Soldiers have masks and protective gear to protect against chemical weapons. They are also vaccinated against potential bioweapons. However, the civilian population under attack is usually defenseless. After the Gulf War, it was discovered that Iraq had a large supply of these weapons of mass destruction.

This widely publicized disclosure was on the one hand a harsh wake-up call for all nations and, on the other hand, unfortunately attracted the attention of terrorist groups who became aware of these weapons of mass destruction and got much interested in them. This attraction was logical because these weapons had several advantages over conventional weapons. These weapons are cheap and easy to make without advanced technology. These weapons of mass destruction are best suited for covert use.

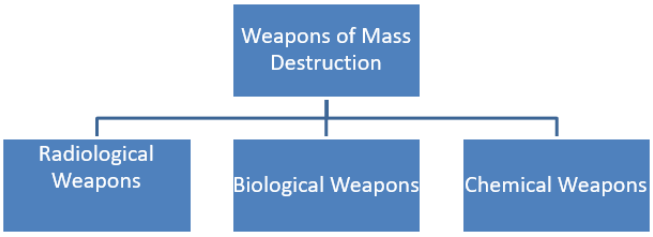
The effects of their release will last for several hours or even days, giving the terrorists enough time to escape. The effects of chemical and radiological agents are usually recognized within minutes or hours of release, while it may take a few days to a week before the effects of a biological attack are seen as symptoms. Once a biological attack is identified, it may take several days to confirm the type of biological agent.

In 1984, an outbreak of salmonellosis in restaurants in the state of Oregon affected 751 people as a result of intentional contamination.[2]

Similarly, 45 people became ill with *Shigella dysenteriae* in another intentional food contamination in the state of Texas in 1996.[3] In March 1995, the apocalyptic sect Aum Shinrikyo killed 12 people and injured more than 100 people by releasing sarin gas in the busy Tokyo subway.[4] This group had previously tried bioweapons such as anthrax and botulinum toxin without success. After the attacks of September 11, there were several attacks of anthrax in the United States, which killed 11 people.[5]

Weapons of mass destruction can be divided into three categories, viz. radiological, chemical and biological weapons. Of the three, the possibility of using radiological weapons is low. Existing chemical weapons can be easily detected and appropriate countermeasures can be taken using available analytical technology. Bioweapons, other than poisons, present a much more serious problem because they act slowly over days and take longer to detect. Although toxins are of biological origin, they can be detected by readily available advanced analytical methods. Terrorists can use chemical and biological weapons anytime, anywhere, by spraying, mixing in food and water supplies, with devastating consequences. Biological weapons are far more destructive than any other WMD.

The controversy surrounding the recent coronavirus as a precursor to a bioweapon is well known. In December 2019, a pneumonia cluster of unknown origin was identified in Wuhan, China. On January 12, 2020, Chinese authorities isolated a new coronavirus called severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) from isolated cluster cases. Since then, the disease caused by SARS-CoV-2 is called coronavirus disease 2019 (COVID-19). Articles have been published suspecting that the virus is part of the Chinese biological weapons program at the Wuhan Institute of Virology, which escaped from the infecting laboratory. The coronavirus (COVID-19), called SARS-CoV-2, is a new coronavirus that has not been previously identified in humans. Some other sources said that the coronavirus can mutate into more virulent strains, and that the coronavirus can easily be modified to function as a bioweapon through genetic engineering. The trail of destruction and death caused by COVID has raised doubts about whether the rapid spread of this pandemic is a deliberate attempt to test an experimental bioweapon to destroy the infrastructure and economy of countries. These issues are of interest to the public of entire world. Rogue states secretly test such bioweapons, adding to their already known list, causing serious concern.[6-8]



Radiological weapons

Natural radiation is everywhere, but its activity level is too low to pose a serious threat. However, some artificial radiation sources have a higher activity level suitable for use as a crude radiation weapon, such as a "dirty bomb". Sources of radioactive materials include medical devices and drugs; industrial instruments such as soil moisture meters; food irradiators; state and university research laboratory equipment and research nuclear reactors. Less accessible sources that can cause catastrophic radiation contamination include commercial nuclear power and national nuclear weapons. A single event involving these sources can contaminate and destroy a city or region. Thus, radiological weapons can be divided into two categories. The first category is radiological weapons, called "dirty bombs", which could be very easily used by terrorists. The second category is conventional nuclear bombs, but they are properly shielded. If those real nuclear devices secretly produced by some rogue countries fall into the hands of terrorists, it could be a serious problem.

A radiation incident, such as a radiation dispersal device, also known as a "dirty bomb", can take the form of a fine powder or a solid explosive. It is basically a normal bomb with radioactive material attached to the explosives. It is not considered a true nuclear device. A "Dirty Bomb" explosion is not a nuclear explosion, although its effects on humans are very similar. Early symptoms of people exposed to high doses of radiation from a real nuclear device include reddening of the skin, hair loss, generalized nausea, vomiting, headaches, weakened immune systems, and radiation sickness, which can be fatal. Depending on the scenario, these acute radiation symptoms may not be seen in a "dirty bomb" explosion because the high level of radiation may not travel very far. General guidelines indicate that a radiological event has occurred if the radiation dose rate is 0.01 rem/hour or greater. However, short-term exposure to doses of about 10 rems/hour for a few hours may not cause significant health effects; however, first responders are generally advised not to enter these areas, except for possible very short-term rescue operations. These "dirty bombs" are thought to be the first choice of many terrorists because they are relatively easy to build or produce without the high level of expertise in acquiring the necessary components and materials compared to nuclear bombs.[9]

Nuclear weapons have a devastating and long-term impact on the lives of humans and animals and their living environment. They are one of the most difficult types of weapons to make because the critical nuclear elements, plutonium and/or highly enriched uranium, are difficult to obtain and process, even if they are very expensive. These weapons are delivered as ballistic missile warheads or dropped bombs. On August 6, 1945, Allied forces dropped the first such atomic bomb, nicknamed "Little Boy", on Hiroshima, Japan, which had a devastating effect within a radius of about 2 km, killing 1,40,000 to 2,00,000 people. On August 9, 1945, another larger atomic bomb nicknamed "The Fat Man" was dropped on Nagasaki, Japan, killing 70,000 people. But it could not cause more destruction than the first bomb, as the allies expected, due to the strange topography of the area, wind direction, etc. After these attacks, nuclear devices came

under strict control and several international treaties were signed under the auspices of the United Nations. Thanks to these controls, these nuclear facilities, owned by a handful of countries (US, Russia, UK, France, China, India and Pakistan), are tightly guarded and inaccessible. Some countries are suspected of having/had secret nuclear bombs (Iraq, Libya, Iran, North Korea and Israel).[10]

Terrorists can cause accidents in nuclear power plants, isotope treatment machines in hospitals and vehicles used to transport nuclear waste. Due to the capabilities of major terrorist groups and their enormous financial resources and the political support of certain countries, there is always a looming fear that these groups could get their hands on nuclear weapons and use them anytime and anywhere. An actual nuclear weapon can be quite small in size and can easily fit into a large car or truck. This has led many experts to fear that terrorists could simply drive a nuclear warhead into a major city and detonate either by suicide or by remote control. Terrorists may be able to contaminate the water or food distribution system with radioactive materials to commit acts of mass destruction. A recent example is that former Russian spy Alexander Litvinenko (who fled to Britain) was murdered on November 23, 2006 by sprinkling his tea with polonium.[11]

Many of the terms used to describe radioactive sources are unique to radiation physics and chemistry. The amount of radioactive material is measured in Curie units. Smaller amounts are millicuries (1/1000 curies) or microbeams (1 millionth of curies). The radiation dose received by a person is called rem, which is also divided into millirems and microrems. Typical annual background radiation doses are approximately 0.3 rem, while for a single medical X-ray it can be up to 1 rem depending on the specific procedure. Radiological agents decay at a predictable rate over time. The time it takes for half of a radioactive element to decay is called its half-life. Each individual radioactive element has a specific half-life. If the half-life is very short, only a few seconds or minutes, the radioactivity can be reduced to a safe level in a few hours. Radiation radiates in all directions and bounces off surfaces, making it difficult to create a good shield. Radiological agents can emit one or more types of radiation called alpha, beta, gamma radiation (like X-rays), or neutrons. Alpha radiation requires the least shielding, while gamma and neutron radiation require the thickest shielding. As an external threat, gamma and neutron radiation are the most dangerous. However, if inhaled or swallowed, alpha and beta radiation can damage local organs. Beta radiation can burn the skin like sunburn, but beta burns can have much greater long-term cancer effects than sunburn. Radiological substances cannot be detected by human senses; they cannot be seen, smelled, tasted or felt. However, radiation can be easily and quickly detected with suitable instruments such as a GM counter. There are three basic rules for protection against external radiation. They are:

I. Reduce the time one is exposed,

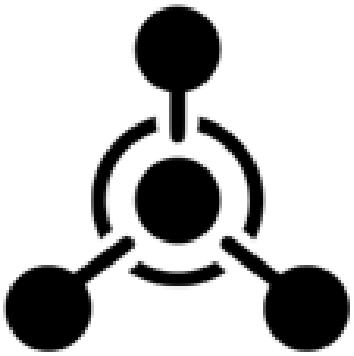
II. By staying as far away as possible from the source of radiation, and

III. By using the thickest possible shielding between the individual and the radiation source.

These rules do not protect one from radioactive gases or ingested radioactive food. Food consumption controls can prevent ingestion. Special filters or a self-contained breathing apparatus can protect from inhalation.

The general dose recommendations for protection, evacuation and movement of the population are much lower than for rescue workers, because people living in a contaminated area are exposed to higher than normal radiation levels for a long time and continuously. These longer-term doses are calculated over a 24-hour or year-long period, and people exposed to these levels can die from the blast, just as with a conventional bomb. Consequences of lower radiation exposure include long-term increases in certain cancers. If excessive radiation is measured, radiation abatement action must be initiated. The affected area must be mapped to determine the extent of radiation contamination and to determine the limits of the area to be isolated and contained. Containment involves stopping all traffic that could spread the contamination and preventing it from gravity spreading into sewers. Estimated doses should be used when making decisions about evacuation or protection of the public. Short-term treatment may include wound care to prevent infection, as radiation can damage the immune system. Some drugs can be used if the radioactive material is accurately identified.[12]

Chemical weapons



Chemical weapons use the toxic properties of chemicals. They can be solid, liquid or gas. However, most chemical weapons are gas-based. Some may be liquids that are sprayed as aerosols using an inert gas such as nitrogen. Thousands of chemicals can be weaponized and delivered using conventional or unconventional methods. Chemical weapons are cheap to produce. Chemical weapons can cause disorientation, dizziness, nausea, blindness, serious injury, skin withering, difficult breathing, incapacitation, immobilization and death. Some chemical weapons are persistent because the chemicals released remain on surfaces for more than 24 hours without volatilizing or breaking down. They can even last from days to weeks. Some others are impermanent, evaporating or breaking down quickly.

The first chemical weapon used in World War I was "mustard gas". Both sides used it. It caused massive bleeding and took about five weeks to die of poisoning. It is estimated that it affected a million soldiers and killed 40,000 of them. The most dangerous chemical weapon known is VX, which attacks the nervous system. VX was created in Great Britain, which then traded it to the United States for a nuclear weapons program. The main effects of VX are seizures, coma and possible death. VX can only be stockpiled by the United States, Russia, and France, and would probably never be used as a nuclear counterattack. During World War II, both Germany and Japan used chemical weapons. After World War II, the threat of chemical weapons was reduced due to the post-cold war nuclear threat. However, many countries continued to secretly conduct chemical weapons research. Chemical weapons have been used in recent years in Yemen, Afghanistan, Iraq, Chad and Iran. Although the armies of several

countries developed and used these chemical weapons exclusively for warfare, they attracted the attention of terrorist groups as a cheap and effective source of destruction. Terrorists have seen that chemical weapons are cheap to produce, can have multiple means of delivery, have physical and psychological effects, and can be carried and used covertly. Chemical weapons are sometimes called "the poor man's nuclear weapon." Some of the disadvantages of chemical weapons are that some agents require complex chemical processing, their effects are often unpredictable, their effects may not be limited to the target area, and of course they come with international taboos and controls. Chemical weapons can be lethal or non-lethal. Chemical weapons have several classifications. According to one popular classification, these agents can be classified as hemostatics, skin-damaging or blistering agents (hydrostatics), nerve agents, pulmonary or asphyxiating agents, incapacitating agents, and riot control agents. Non-lethal agents include incapacitating agents and riot control agents. Chemicals can

enter through pulmonary inhalation, oral ingestion, injection through a puncture wound, and absorption through the skin.[13]

Blood agents disrupt the oxygen transport mechanism at the cellular level and rapidly cause death. They are not persistent, but are quickly fatal if inhaled. They initially cause headaches, nausea and dizziness because they prevent the use of oxygen at the cellular level. Cyanide chloride (CK), hydrogen cyanide (AC), arsine, carbon monoxide and hydrogen sulfide are examples of blood agents. Syria and Iraq used HCN against Hamas in 1980 and Halba in 1988. However, HCN is not currently considered suitable because it polymerizes quickly.

Blister agents are often persistent. These are blisters or skin lesions that destroy the skin and tissues. They affect the eyes, lungs and skin, causing large blisters. On contact, these substances destroy the skin. Skin irritation is felt within minutes or hours, depending on the substance. Translucent agents are usually oil droplets that can penetrate normal clothing. If they get into the eyes, they can cause blindness. Inhalation can cause life-threatening respiratory damage. Common examples of blistering agents include lewisite (L) and mustards (HD, H, HT, HL, and HQ), nitrogen oxides, phosgene oxime, and phenyldichloroarsine (PD), which are common in chemical warfare agents. On July 12, 1917, the Germans shelled the British with mustard in Ypres, Belgium. The initial effect was just a sneeze; eye irritation, vomiting and blisters developed within a few hours.

In case of nerve agents the duration varies from a few hours to a few weeks. These are G-series organophosphorus compounds that are potent cholinesterase inhibitors. They disrupt the body's nervous system by interfering with the acetyl cholinesterase process. Organophosphorus pesticides are similar in structure but less toxic. They can quickly disrupt the nervous system, causing seizures, and if the dose is high enough, they can cause paralysis and death. Reactions usually occur within minutes of inhalation or several hours after skin contact. Sarin (GB), used by Aum Shinrikyo in the Tokyo subway, is an example of a non-persistent nerve agent because it is very volatile. Cyclosarin (GF) and the deadly VX are examples of persistent nerve agents that are not volatile. Tabun (GA) is another example of a non-persistent nerve agent that is relatively less toxic. In the same category, Soman (GD) has medium volatility and is resistant to usage. The V series nerve agents include VE, VG, VM and VX, which are more toxic than the G series. 10-15 mg or less than a drop in contact with the skin can kill a person. They are also very durable. The Germans discovered these nerve agents before World War II. Tabun and Sarin went in weapon mode but were not used. Aerosols have very rapid effects on people, including collapse, difficulty in breathing and failure, convulsions and paralysis, leading to death. At lower doses, they cause confusion, blurred vision, difficulty in breathing, drooling, vomiting, diarrhea, weakness, tremors, and incoordination. Iraq is believed to have used these agents against Iran in 1984.

Choking or pulmonary agents are usually impermanent. These substances cause blood vessels in the lungs to swell and fluid to build up until the victim suffocates or drowns in his own fluid. Odor or lung irritation warns of the presence of substances most dangerous if inhaled. Reactions can be immediate or delayed, with symptoms appearing within seconds or delayed up to three hours after exposure. Gases such as chlorine and phosgene are pulmonary or suffocating agents. Chlorine gas is used in industry and water treatment and is stored and transported in bulk. During World War I, Germany released 22,160 tons of chlorine gas against the Allied forces on April 19, 1915 near Ypres, Belgium, killing 5,000 and wounding 10,000. The Germans attacked the enemy again on December 19, 1915, using phosgene contained in artillery shells. As if for revenge, the allies used both chlorine and phosgene in June 1916. It is estimated that the British released more than 1,500 tons of phosgene in the destruction of people, flora, insects, and animals. An example of this type of poisoning is the July 2010 chlorine leak from lying cylinders at a Mumbai shipyard, which affected a large number of people. In addition to chlorine and phosgene, other suffocating agents such as diphosgene, chloropicrin, ethyl dichloroarsine (DICK) and perfluoroisobutylene (PFIB) were used.

Incapacitating agents, affect over duration of time, ranging from hours to days, without endangering life or causing permanent injury. The person recovers slowly even without any medical attention. These include Agent 15 (BZ), belladonna, ergot and lysergic acid diethylamide (LSD).

Riot control agents (harassing agents) and **vomiting agents** are chemical weapon agents used to fight civil unrest as a non-lethal means of dispersing riotous crowds. These include lacrimals, sternutators, and emetics. Tear gas irritates the eyes and mucous membranes of the nose and mouth, causing extreme discomfort. Human rights leaders have questioned the use of these substances on ethical grounds. Examples of these substances are ethyl bromoacetate, chloroacetone,

xylyl bromide, acrolein, bromobenzyl cyanide (CA or Camite), chloro acetophenone (CN), O-chloro benzylidene malononitrile (CS) and pepper spray. They cause various symptoms such as skin and respiratory irritation, eye irritation, tearing, sneezing, vomiting, temporary disorientation and dizziness etc. They are rarely fatal. Terrorists may use any of the above chemical weapons depending on the situation and circumstances. They can be used for mass killings of civilians or for isolated attacks.

The most common routes of exposure through which humans can be exposed are inhalation, ingestion and skin contact. All types of chemical agents can cause significant symptoms if inhaled, as only nerve agents are likely to be effective if ingested. Skin contact is the most common injury caused by blisters, but nerve agents, asphyxiants, and riot control agents can also cause skin or eye irritation. These routes of exposure indicate that emergency responders need full-body protective suits in addition to respirators to protect against these chemical agents. In the event of a chemical attack, agents are typically released as vapors, liquid droplets or solid aerosols of small particles, all of which can be inhaled as well as contact the skin and eyes.

Illinois Poison Centre has published in 2008 exhaustive list of antidotes for poisons including radiological, chemical and biological weapons. Comprehensive charts giving the structures, symptoms and detection methods of the common chemical weapons falling under the above categories are given below:

Agents	Category	Symptoms	Identification	Protection	Antidote
Tabun(GA), Sarin (GB), Soman (GD), Cyclosarin (GF) & VX	Nerve Blood	Sweating, difficulty in breathing, nausea, vomiting, blurred or dim vision, convulsion, paralysis, death	M256,M18A2 M19,M0M9 papers M0A1 alarm, GC, GC-MS M25G,M18A2 M19 papers, GC, GC-MS	Protective masks and protective clothing Protective mask	Atropine, Pralidoxime Chloride and diazepam IV sodium nitrite and sodium thiosulphate
Hydrogen cyanide (AC) Cyanogen chloride (CK) Mustard (H) Mustard (HD) Nitrogen mustard (HN) Lewisite (L) Mustard- lewisite mixture (HL) Phosgene oxime (CX)	Blister Choking	Rapid breathing, convulsions, coma, death No early symptoms. Burning eyes, respiratory tract damage, skin blistering Powerful irritant of eyes, nose, respiratory tract and skin	M256, M18A2, M19, MIIM9 papers GC, GC-MS GC, GC-MS	Protective mask and protective clothing Protective mask	No antidote British antilewisite No antidote

Characteristics of some chemical agents.[14,15]

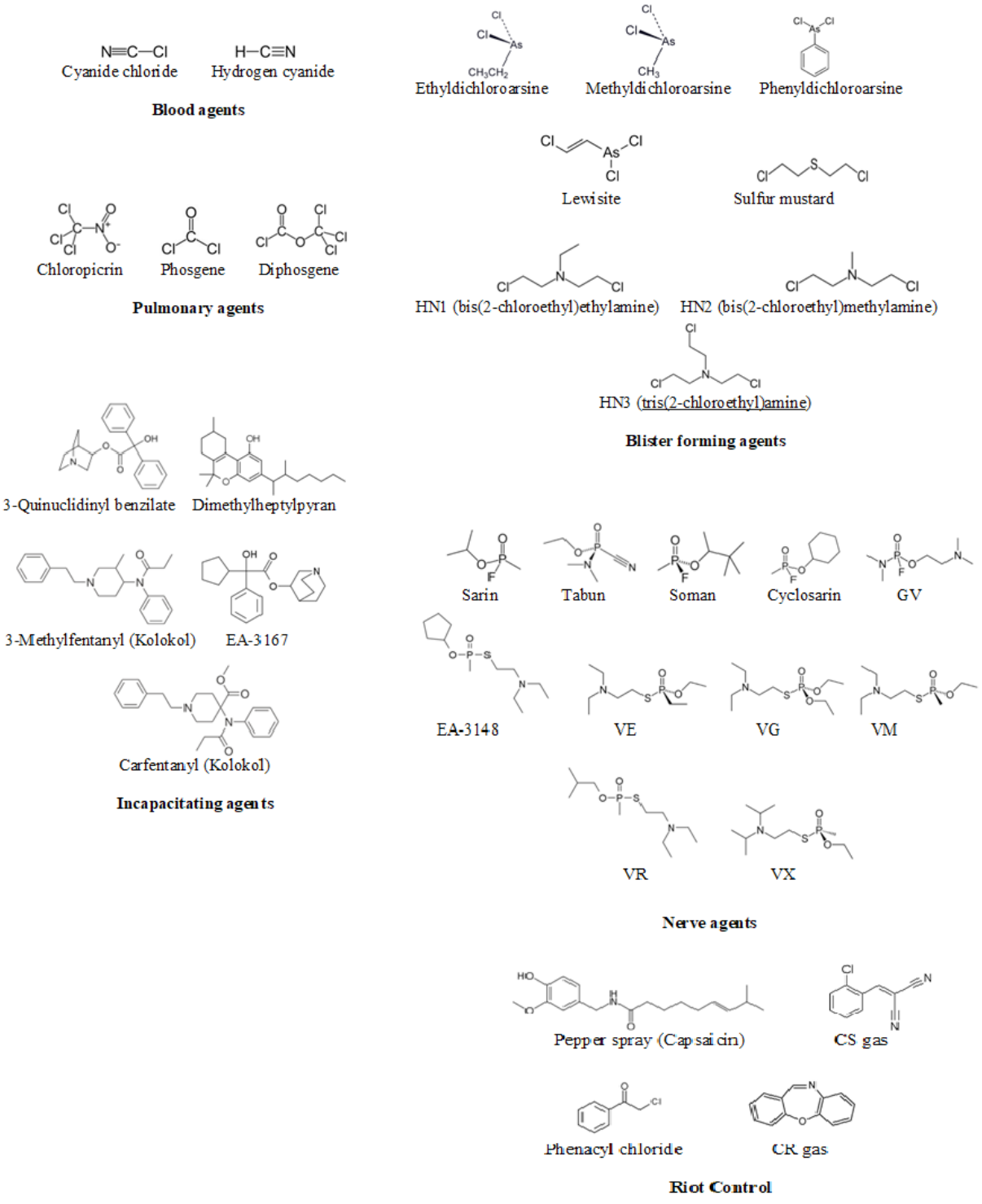
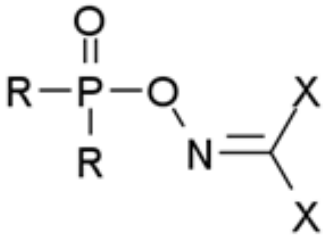
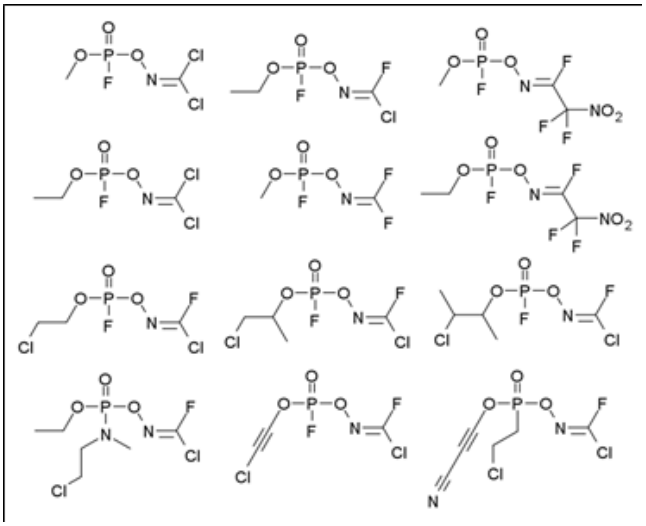


Figure 1 Chemical warfare agents.

Some organophosphorus agents which are claimed to be more potent (five to eight times) than VX, known as 'Novichok' agents have been investigated as pesticide research in Russia, shrouded in secrecy. These compounds belong to organophosphate acetylcholiesterase inhibitors group and perhaps could be dispersed in the form of fine powder. Due to increase in the concentration of acetylcholinesterase at neuromuscular junctions, involuntary contractions of all muscles take place resulting into respiratory and cardiac arrest, finally leading to death. Some structures reported in the literature are reproduced below.[16]



General formula of Novichoke compounds



Some structures of 'Novichok' Agents

The intelligence agencies and other departments should keep a watch over the activities of the suspects who have potential to prepare, procure and stock chemical weapons. Production, purchase and movement of precursor chemicals which could be used in the synthesis or preparation of chemical weapons should be continuously and systematically monitored.

The methods of detection of these chemical agents are available which vary. Some can be seen, some can be smelled, some can give a taste and most of them can be felt through burning sensation and a feeling of choking. Certain kits and papers have been developed to detect these chemical agents. The kits have glass tubes filled with adsorbing material and a chemical reagent which specifically reacts with the particular chemical agent producing a colour change. The papers are impregnated with chemical reagents which specifically react with particular chemical agents producing a colour change. All these agents can be more specifically detected and quantified by using sophisticated instrumentation like gas chromatography and mass spectrometry. Recently Surface Enhanced Resonance Raman Spectroscopy (SERRS) has been successfully employed to detect these chemical agents. Some sensors based on nano technology are also being developed.

The quick response to an attack by chemical weapons include calling Hazmat team, identifying chemical agent, isolating and containing the affected persons, evacuating, providing shelter, providing medical treatment and cleaning up the contaminated area.

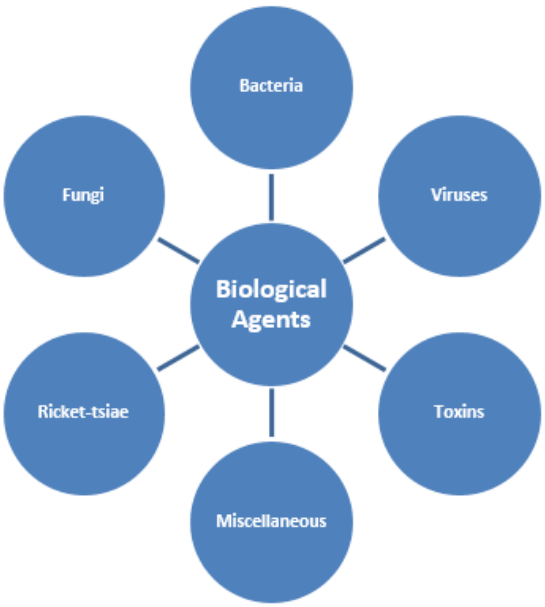
Armies are generally prepared to face a chemical weapon attack through protective clothing, masks, creams, antidotes and drugs. In the event of threat perception to civilian population all these measures are to be made available to them with the help of specially trained personnel and medical practitioners. Further if such an attack is anticipated continuous mobile monitoring of the atmosphere has to be carried out by special vehicles (Fox vehicles) fitted with sophisticated instruments like GC-MS

Biological weapons

Biological weapons use living organisms or their toxic components. For use as a bioweapon, an effective dosing device is also required. Both traditional and non-traditional shipping methods can be used. There are six main types of biological weapons or bioweapons. These are bacteria, viruses, rickettsiae, fungi, toxins and various substances.[17,18]

Bacteria are unicellular organisms. They can reproduce in the host, but usually bacteria do not reproduce well in the open environment. In contrast, viral agents live in cells and can only reproduce in the host. Bacteria such as anthrax, brucellosis, melioidosis, tularemia and plague can be used as bioweapons.

Viruses used in bioweapons include smallpox, dengue, yellow fever, Ebola, Hanta, Lassa fever, Marburg, Rift Valley fever (flu), equine Venezuelan encephalitis, chikungunya, etc. A cold is an example of a virus. Specific antibiotics and antiviral medications are available to prevent or kill certain bacterial agents and prevent viruses. Viruses are also controlled by vaccines, which help the body's immune system to recognize and fight invading viruses. However, effective treatments are not available for all viruses. Also, vaccines are ineffective if viruses mutate or terrorists deliberately use different strains.



The organisms of **Rickettsiae** such as Q fever, Rickettsia (e.g. RMSF, epidemic typhus) have potential to be used as bioweapons.

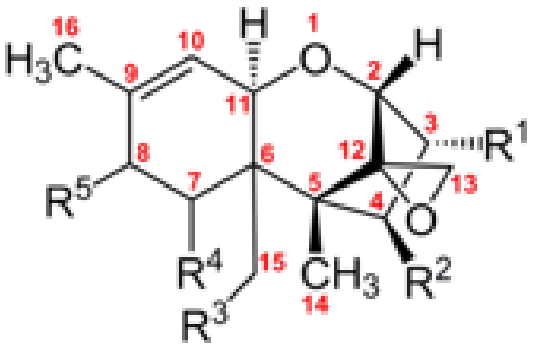
Fungi like Histoplasma cryptococcus can be used as a bioweapon. The afflotoxins produced by fungi are potent bioweapon toxins. Afflotoxins are known to be public health problems because of the contamination of foods and grains. Out of the several afflotoxins AFB is most toxic. These are very stable and resistant to decontamination. The toxicity of afflotoxins is 2mg / Kg. Skin is not affected. In chronic doses it affects lungs and causes liver cancer. Acute oral doses cause vomiting, seizures, fever, respiratory distress, liver failure, coma and death. It is understood that Iraqis put afflotoxin in the Skud missiles to target as bioweapon.

Tricothecene mycotoxins also known as 'Yellow rain' are fungal toxins which are quite stable and resist decontamination. Trcothecene toxin (T-2) can be lethal when inhaled or ingested. It is damaging to skin and eyes in nano to mcgs. Even at low levels it induces vomiting and affects the nervous system. Acute exposure produces rashes, joint pain, fatigue, fever, chills, hypotension, confusion, somnolesence, memory loss, hallucinations, dyspnea, diarrhea and recurrent infections. Laboratory tests indicate low white cell counts, low platelet levels and decreased coagulation factors.

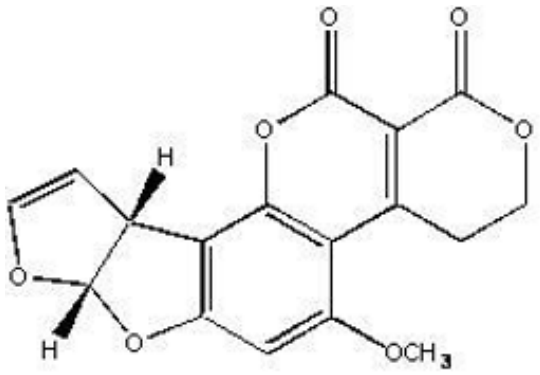
Bio toxins are toxic chemicals that are produced by biological organisms, such as bacteria, or plants. Ricin and botulinum are examples of biotoxins. Some of the biotoxins can be treated with suitable antidotes.

Ricin Also known as Agent W, is a protein extracted from castor seeds. Its toxicity has been known since ancient times in India and China. Although it was not used in World War II, it was developed by Great Britain and the United States as a weapons emplacement during that time. It is said to be a powerful weapon, as effective as the nerve agent sarin. Ricin is not very stable. It will break in a few days. Hours after exposure, it causes eye inflammation, severe pulmonary edema, and death from respiratory failure. When injected, it causes fever, high white blood cell count, seizures and multi-organ failure. It is highly immunogenic. On September 7, 1978, a man stabbed Bulgarian dissident Georgi Markov in the leg with a dart gun built into an umbrella in a public place in London. The gun pressed a small pellet containing ricin into Markov's leg. Markov died four days later.

Various agents include animal and plant pathogens (e.g. foot and mouth disease, West Nile virus, wheat rust and powdery mildew), which can also be used as bioweapons. Herbicides can sometimes be effective bioweapons. Certain factors are taken into account when choosing an agent as an effective bioweapon, such as ease of availability, infectivity, rapid epidemic progression, lethality, suitability for infectious spread, and lack of effective treatment or prevention (through resistant strains).



Tricothecene mycotoxin



Aflotoxines

Species	Formula	CAS N°	MW[amu]
B1	C17H12O6	[1162-65-8]	312.3
B2	C17H14O6	[7220-81-7]	314.3
G1	C17H12O7	[1165-39-5]	328.3
G2	C17H14O7	[724198-7]	330.3
M1	C17H12O7	[6795-23-9]	328.3
M2	C17H14	[6885-57-0]	330.3

Some common biological agents & their characteristics

Microorganism	Found in	Host	Infected through	Symptoms
Anthrax (Basillus anthracis)	Soil	Humans & domestic animals	Open wounds & inhalation	Flue like, Pulmonary, Septicemia
Clostridium botulinum	Soil	Humans	Food, water & inhalation	Extreme weakness, diplopia, vertigo,slurred speech & breathlessness
Clostridium perfringens	Soil, human & animal intestines	Humans & domestic animals	Open wounds	Diarrhea, abdominal cramps, gangrene
Ricin(Protein toxin)	Castor seeds	-	Food, drink, water, injection, inhalation	Abdominal cramps, bloody diarrhea, vomiting, fever, cough pulmonary edema
Smallpox Variola virus	Eradicated, Humans Cell line Laboratory Stocks		Body fluids, inhalation	Fever, vomit- ing, rash, bumpy boils on skin

The advantages of bioweapons are multiple methods of distribution, wide applicability, indiscriminateness, cause disease, death, panic, can spread widely and permanently. They are logistically superior because the weapons are cheap and easy to store, versatile, difficult to defend against, do not damage infrastructure and are easy to hide. Because of these advantages, bioweapons are sometimes called the "poor man's nuclear weapon."

All biological substances are produced in biological farms. Cultivating, purifying and efficiently distributing sufficient quantities of biological material in a way that is harmful to many require technical skill and time. Advances in biotechnology increase the possibility of making the properties of biomaterial less dangerous,

but this requires expensive research and development, so that the use of biotechnological agents is generally considered less likely. To increase effectiveness and confusion, an attack may involve a mixture of several different biological agents, or a mixture of chemical or radiological agents. While many chemical agents have readily available antidotes, some do not and treatment options are limited.

A useful chart giving the characteristics of common biological agents downloaded from 'Blue Book'[19] is reproduced below:

Characteristics of Biological Agents

Disease	Degree of person-to-person transmission	Infective Dose (Aerosol/ LD50)[1]	Incubation period[2]	Duration of illness	Case fatality rate (CFR)	Persistence of organism outside heat	Vaccine efficacy (aerosol exposure)
Anthrax	None	8,000 – 50,000 spores	1-6 d	3-5 d (usually fatal if untreated)	High	Very Stable – Spores remain visible for > 40 Yrs in Soil	2 dose efficacy against up to 1000 LD50 in Monkeys
Brucellosis	None	10-100 organisms	5 -60 d (usually 1-2 mos)	Wks to mos	< 5% untreated	Very Stable	No Vaccine
Glanders	Low	Unknown, Potentially Low	10 -14 d via aerosol	Death in 7-10 d in septicemic form (untreated)	> 50%	Very Stable	No Vaccine
Melioidosis	Low	Unknown, Potentially Low	1 -21 d (upto yrs)	Death in 2-3 d with septicemic form (untreated)	19 -50% for severe disease	Very Stable; survives indefinitely in warm moist soil or stagnant water	No Vaccine
Plague	Moderate (for pneumonic form)	500-1500 Organisms	1-7 d (usually 2-3 d)	1-6 d (usually fatal)	High unless treated within 12-24 hrs	For up to 1 yr in soil 270 d in live tissue	No Vaccine
Tularemia	None	10-50 Organisms	1 – 21 d (average 3- 6 d)	≥ 2 wks	Moderate if untreated	For mos in moist soil or other media	80% protection against 1-10 LD50
Q Fever	Rare	1-10 Organisms	7 -41 d	2 -14 d	Very Low	For mos on wood & sand	94% protection against 3500 LD50 in Guinea pigs
Small Pox	High	Assumed Low (10-100) organisms	7-17 d (average 12 d)	4 wks	High to Moderate	Very stable	Protects against large doses in Primates
Venezuelan Equine Encephalitis	Rare	10-100 organisms	2-6 d	Days to wks	Low	Relatively unstable	TC 83 protects against 30-500 LD50 in hamsters
Viral Hemorrhagic Fevers	Moderate	1-10 organisms	4-21 d	Death between 7 -16 d	High to moderate (depends on agent)	Relatively unstable – (depends on agent)	No Vaccine
Botulism	None	0.001 μ gm/ kg is LD50 for type A (parenteral), 0.003 μg/kg (aerosol)	12 h to 5 d	Death in 24 – 72 hrs; lasts mos if not lethal	High without respiratory support	For wks in non-moving water & food if shaded from UV light	3 dose efficacy 100% against 25-250 LD50 in primates
Staph Enterotoxin B	None	0.03 μg/ person (80kg) incapacitation	3-12 h after inhalation	Hours	< 1%	Unknown; Resistant to freezing	No Vaccine
Rincin	None	3-5 μg/kg is LD50 in Mice	18-24 h	Days – death within 10 – 12 days for ingestion	High	Stable	No Vaccine
T-2 Mycotoxins	None	Moderate	2-4 h	Days to mos	Moderate	For yrs at room temp	No Vaccine

[1]In this table, "Infective Dose" refers to bacteria and viruses, while "LD50" refers to toxins

[2]In this table, "In Period" implies "Latent Period" where toxins are indicated

These bio-agents can be used maliciously to create widespread fear in the form of disease, death and panic, and cause negative social and economic consequences. Like other hazards, biomaterials can cause illness if inhaled, ingested or in contact with the skin. However, unlike other agents, biological agents can also be transmitted between humans and between humans and animals. Biomaterials can incubate and multiply in the body for days to weeks before symptoms appear and a person knows they are sick.

Vaccines are not available against some bio-agents, so infected people must be quarantined. Once in the environment, some biological agents may be inactive but remain active for weeks or years, depending on both the specific agent and the environmental conditions. The form of delivery or method of dispersion affects both the distribution and response of the substance. Attacks can be overt or covert. In an open attack, the method of delivery is obvious, such as releasing an airplane or a bomb. Although the use of a bio-agent may not be immediately known, testing can quickly confirm the presence of microorganisms. However, it may take several days to determine the identity of the biological agent. Detection of a bio-toxin, like any chemical, is much faster.

In the case of a covert attack, the delay in detecting the bio-agent can be even longer, as the attack cannot be recognized until after people are clearly ill, which can take days. Stealth attacks can involve contamination of a building or subway system, food, water or other surfaces. For infectious pathogens, the presence of an infected individual in a large population can effectively spread the biological agent. However, with most diseases, people are clearly sick and bedridden in the most contagious stage. An attack by an unknown infectious agent with a delay of several days in the detection of symptoms can allow the transmission of infected individuals and the spread of the pathogen. In the worst case, an epidemic may occur before a biological attack is detected.

Biomaterials are detected by infectious symptoms and time-consuming tests. These tools cannot identify the organism. The ability of an organism to cause harm is not certain until it is determined. Tests to detect bio-agents typically take days because they require the organism to be grown in culture before it can be detected. Recent experience with anthrax in Washington has shown that cleanup can be long and expensive. Methods such as HEPA vacuum, use of liquid and foam decontamination agents, emulsions and fumigants all play a role depending on the specific agents. Recently, new methods for the rapid identification of biomaterials have been reported. These are the "Sandwich Immunoassay" in which fluorescent dye-labeled antibodies targeting a specific pathogen are attached to silver and gold nanowires, Bio-aerosol Single Particle Recognition Equipment (BiosparQ), BioPen is an approved form of ELISA (takes only 20 minutes), and Elisa systems with fiber optics.

Identifying and reporting indicators of biological matter is critical to identifying and mitigating the impact of an attack. A biological attack is detectable before the specific agent is clearly identified. Possible signs of a biological attack include many patients presenting to hospital emergency rooms with similar symptoms. These may include unusual symptoms for the patient's age or a type of infection that is not common in the area. An unusual number of dead wildlife may also indicate the release of biomaterial. The combination of location, severity and timing of outbreaks is a good indicator of a biological attack. Communicating such observations to local medical authorities or advanced medical research organizations is very important for early detection and response.

Bio-agents cannot be detected by human senses, although large amounts of mist or powder may be seen, which may be early signs of bio-agents (e.g. powder in envelopes). There are tools that can quickly detect the growth of biological organisms. Identifying the biological agent is essential for a proper emergency response, but it can take several days. Medical facilities should be advised to be alert for any symptoms and report cases to the Department of Public Health or advanced medical research organizations before confirming identification of the pathogen. Determining the source and area of spread of the pathogen is essential to developing the best possible response, which usually involves isolating and isolating the affected area and population.

Drug treatment and vaccine administration are essential but can be delayed by factors such as delays in pathogen identification and associated delays in determining pathogen spread. The final steps in responding to biological threats include cleaning up contaminated areas and, if necessary, providing ongoing medical care to those at risk. Successful decontamination is most difficult for biomaterials that persist for long periods of time in an exposed environment, the best example of which is anthrax spores. Because disease-causing doses are very small, even removing 99.99% of the released substance may not be enough to prevent the damage.

Forensic pathologists, physicians and medical professionals are the first professionals to come in contact with people affected by a bioterrorist attack. These professionals should have first-hand knowledge of the different types of organisms used in a bioterrorist attack, their symptoms and treatments, etc., although exposure to them may be a small possibility for them. With the development of genetic engineering and life sciences, it is possible to create such microorganisms that have all the necessary properties to be used as a bioweapon. Such biotechnological products would be highly infectious and pathogenic resistant strains for which no vaccine or therapy is available.

In these circumstances, the medical profession must be vigilant and be at the forefront of condemning the use of diabolical biomedical research to develop bioweapons with such devastating potential. As the bioweapons have a high effectiveness compared to radiological and chemical weapons. Government counterintelligence agencies may be involved in gathering information about potential bioweapons production, but medical professionals and ordinary citizens have an important role to play in containing this threat. They must be vigilant and watch out for unusual activity in their environment that leads to the development, production or proliferation of bioweapons. For example, any individual or group activity involving unauthorized handling of chemicals, microorganisms, microbiological equipment, fermenters, brewing equipment, protective equipment, etc. there is reason to suspect. Unusual operation, reminiscent of a temporary laboratory in basements, garages, farmhouses, etc., with continuous air conditioning or ventilation equipment, unusual or fermenting odors may be due to covert attempts to recover background microorganisms. All these findings and observations must be reported immediately to the relevant authorities.

The urban population should be made aware of this issue. The government and local bodies must be attentive to solve this problem quickly and effectively. A rapid response team must be available 24/7 in the protective equipment storage area. Nursing staff must be well trained to handle bioweapon attack cases. Hospitals must have adequate stocks of antidotes, as well as the necessary drugs and other means for symptomatic treatment. Obviously, all this would require a large financial investment and good planning. Adequate allocations can be made to various government departments such as defense, home and medical departments.

There have also been significant measures taken to tackle the problem of weapons of mass destruction through international treaties. They include:

The **Nuclear Non-Proliferation Treaty (NPT) of 1970** under which all non nuclear weapon states have committed not to acquire nuclear weapons and to accept International Atomic Energy Agency monitoring of their nuclear activities in exchange for commitments by the permanent members of the UN Security Council (US, Russia, Britain, France and China) to eventual nuclear disarmament. Israel, India, Pakistan and North Korea are outside the treaty.[20]

The **Biological Weapons Convention (BWC) of 1972** under which, as of July 2008, 162 out of 192 UN member states have agreed to ban biological weapons. The BWC however has no arrangement for verification.[21]

The **Chemical Weapons Convention (CWC) of 1993**, under which, as of May 2009 188 countries accept inspection by the Organization for Prohibition of Chemical Weapons (OPCW) of facilities that could produce or for which there are reasonable grounds to suspect of possession or production of chemical weapons. Four countries (Iraq, Libya, Russia and USA) are destroying their chemical weapons stocks and three (Albania, South Korea and India) have done so.[22]

The convention on the Prohibition of the Development, Production, Stockpiling and Use of Chemical Weapons and on their Destruction (The Chemical Weapons Convention) was established on April 29, 1997.[23] Organization for the Provision of Chemical weapons (OPCW) was also established to achieve the objectives of CWC. CWC can inspect and collect samples for analysis. Several laboratories have been recognized world wide to carry out this work. The Indian institute of Chemical technology (CSIR), Hyderabad, India is one of the recognized laboratories under CWC. SOP's and ROP's (recommended operating procedures) are available. Chemicals falling under CWC are listed in three schedules:

Schedule I: Chemical developed, produced, stock piled or used as CW and their immediate precursors.

Schedule II: Toxic chemicals and their precursors not produced or used much

Schedule III: Old chemicals such as HCN and phosgene and precursors as Phosphorus tri chloride widely used in modern chemical Industries

Monitoring soil, water and air for CW is carried out regularly using sophisticated analytical methods like gas chromatography, derivatized gas chromatography, capillary electrophoresis, GC coupled with mass spectrometry etc.

De-weaponization programme is far from satisfactory as for biological weapons there is no provision for inspection and verification. Clandestinely, many countries might be producing and stocking both the chemical and biological weapons, over which there is no check.

Conclusion

In the current world scenario of terrorism the minimum knowledge base which is essentially required to handle the situation by law enforcement agencies, forensic profession, medical professionals and administration is provided in the article. Background information and data is included to make the approach comprehensive and useful. It strengthens all the personnel concerned to prevent and combat the situation to mitigate the suffering and save precious lives.

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Conflicts of interest

The author declares there is no conflict of interest.

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