THE CENTRE FOR EXCELLENCE IN EMERGENCY PREPAREDNESS

Ontario

## What is CBRN?

CBRN are weaponized or non-weaponized **C**hemical, **B**iological, **R**adiological and **N**uclear materials that can cause great harm and pose significant threats in the hands of terrorists. Weaponized materials can be delivered using conventional bombs (e.g., pipe bombs), improved explosive materials (e.g., fuel oil-fertilizer mixture) and enhanced blast weapons (e.g., dirty bombs). Non-weaponized materials are traditionally referred to as Dangerous Goods (DG) or Hazardous Materials (HAZMAT) and can include contaminated food, livestock and crops.

## What is a CBRN incident

An ***accidental*** CBRN incident is an event caused by human error or natural or technological reasons, such as spills, accidental releases or leakages. These accidental incidents are usually referred to as DG or HAZMAT accidents. Outbreaks of infectious diseases, such as SARS, or pandemic influenza are examples of naturally occurring biological incidents.

An ***intentional*** CBRN incident includes:

- criminal acts such as the deliberate dumping or release of hazardous materials to avoid regulatory requirements
- the malicious, but non-politically motivated poisoning of one or more individuals
- terrorist acts (as defined in the Criminal Code of Canada and the Security Offences Act) that involve serious violence to persons or property for a political, religious or ideological purpose and/or that are a matter of national interest

The response to an intentional CBRN incident may be similar to an accidental CBRN incident; however, intentional CBRN incidents differ because there are unique implications relating to federal/provincial/territorial responsibilities, public safety, public confidence, national security and international relations.

CBRN incidents may include all or some of the following characteristics:

- potential for mass casualties
- potential for loss of life
- potential for long term effects
- creation of an extremely hazardous environment
- relative ease and cheapness of production
- initial ambiguity and/or delay in determining the type of material involved
- potential use of a combination of CBRN materials each presenting different response requirements
- narrow time frame in which to administer life saving interventions/treatments;
- need for immediate medical treatment for mass casualties
- need for immediately available specialised pharmaceuticals
- need for specialised detection equipment
- need for timely, efficient and effective mass decontamination systems

- need for organised, trained and equipped health service personnel to immediately augment local Fire-HAZMAT teams
- need for pre-coordination within health services to establish medical treatment protocols, to stock pharmaceuticals and to determine treatment requirements
- need to establish coordinated incident management/response procedures for such incidents;
- need to ensure early warning systems for hospitals
- need to establish early those who are affected and those at risk
- need for active case finding versus passive case finding
- need to work closely with Police on site and at health care facilities, as they perform their legal duties in relation to victim identification/registration and evidence gathering
- need for a pro-active media policy to ensure the community is informed and thus its anxiety allayed.

Countermeasures include:
- Technical equipment such as respirators that can detect chemical agents and masks that prevent exposure
- Medical therapy and, for some agents, prophylaxis
- Organizational strategies, such as specially developed intelligence systems, standard operating procedures, and training
- Instruments of international law.

## What are biological weapons?

**Biological weapons** are weapons that achieve their intended effects by infecting people with disease-causing microorganisms and other replicative entities, including viruses, infectious nucleic acids and prions. The chief characteristic of biological agents is their ability to multiply in a host over time. The disease they may cause is the result of the interaction between the biological agent, the host (including the host's genetic constitution, nutritional status and the immunological status of the host's population) and the environment (e.g., sanitation, temperature, water quality, population density).

Biological agents are commonly classified according to their taxonomy (e.g., fungi, bacteria, viruses). This classification is important because of its implications for detection, identification, prophylaxis and treatment. Biological agents can also be characterized by other features, such as infectivity, virulence, lethality, pathogenicity, incubation period, contagiousness and mechanisms of transmission, and stability -- all of which affect their potential to be used as weapons. The following definition of these terms are based on those of J M Last, *A dictionary of epidemiology*, fourth edition, Oxford University Press, 2001.
- The **infectivity** of an agent is its capability to enter, survive and multiply in a host, and may be expressed as the proportion of persons exposed to a given dose who become infected.
- **Virulence** is the relative severity of the disease caused by a microorganism (i.e., the ratio of clinical cases to the number of infected hosts). Different strains of the same microorganism may cause diseases of different severity. For example, infection due to *Brucella melitensis* is usually more severe than infection due to *B. suis* or to *B. abortus*.
- **Lethality** is the ability of an agent to cause death in an infected population. The case-fatality rate (i.e., the proportion of patients clinically recognized as having a specified disease who die as a result of that illness within a specified time) provides useful information on the clinical management of cases.
- **Pathogenicity** is the capacity of a microorganism to cause disease, and is measured by the ratio of the number of clinical cases to the number of exposed persons.

- The **incubation period** is the time between exposure to an infective agent and the first appearance of the signs and symptoms of disease. The incubation period can be affected by many variables, such as the initial dose, virulence, route of entry, rate of replication, and the immunological status of the host.
- For those infections that are contagious, a measure of their **contagiousness** is the number of secondary cases following exposure to a primary case in relation to the total number of exposed susceptible secondary contacts. The mechanisms of transmission involved may be direct (i.e., direct contact between an infected and an uninfected person) or indirect. (i.e., through inanimate material that has become contaminated with the agent, such as soil, blood, bedding, clothes, surgical instruments, water, food or milk). Infections may also be through airborne droplets (i.e., through coughing or sneezing) or through vectors, such as biting insects. The distinction between types of transmission is important in selecting control measures. For example, direct transmission can be interrupted by appropriate handling of infected persons, while interrupting indirect transmission requires other approaches, such as adequate ventilation, chlorination of water, or vector control.
- **Stability** is the ability of the agent to survive the influence of environmental factors such as air pollution, sunlight and extreme temperatures or humidity.

## What are chemical weapons?

**Chemical weapons** are those that are effective because of their toxicity: that is, their chemical action can cause death, permanent harm or temporary incapacity. Weapons that use chemicals as propellants, explosives, incendiaries or obscurants are not chemical weapons, even though the chemicals in them may also have toxic effects. Only weapons whose main goal is to have toxic effects are considered chemical weapons. Some toxic chemicals, such as phosgene, hydrogen cyanide and tear gas, may be used for both civil and peaceful, and hostile purposes. When they are used for hostile purposes, they are considered chemical weapons.

A common way to classify chemical agents is according to the degree of effect (e.g., harassing, incapacitating or lethal).

- A **harassing agent** disables exposed people for as long as they remain exposed. They are acutely aware of discomfort, but usually able to remove themselves from exposure to it unless they are otherwise constrained. They usually recover fully a short time after exposure ends, and do not require medical treatment.
- An **incapacitating agent** also disables, but people exposed to it may not be aware of their predicament (e.g., certain psychotropic agents), or may be unable to function or move away from the exposed environment. The effect may be prolonged, but recovery may not require specialized medical aid.
- A **lethal agent** causes death for those exposed.

This approach to classifying chemical agents is not particularly precise because the effects of chemical agents will depend on the dose received, and on the health and other factors that affect how susceptible people are to the agent. For example, tear gas is usually a harassing agent, but it can be lethal if a person is exposed to a large quantity in a small closed space. On the other hand, nerve agents are usually lethal, but may only incapacitate people who are exposed to a low concentration for a short time. If it is not possible to totally protect people from the chemical weapons, protective measures should try to reduce their effect . For example, the use of pretreatment and antidotes in a nerve gas victim is unlikely to provide a complete “cure”, but may reduce what would have been a lethal effect to an incapacitating one.

Another form of classifying chemical agents is based on their effects on the body:

- **Nerve agents** gain access to the body usually through the skin or lungs, and cause systemic effects.
- **Respiratory agents** are inhaled and either cause damage to the lungs, or are absorbed there and cause systemic effects.
- **Blister agents** are absorbed through the skin, either damaging it (e.g., mustard gas) or gaining access to the body to cause systemic effects (e.g. nerve agents), or both.

A further classification is based on the duration of the hazard:
- **Persistent agents** remain in the area where they are applied for long periods (sometimes up to a few weeks). They are generally substances of low volatility that contaminate surfaces and have the potential to damage the skin if they come into contact with it. A secondary danger is inhalation of any vapours that may be released. Persistent agents may consequently be used to create obstacles, contaminate strategic places or equipment, deny access to an area, or cause casualties. Protective footwear and/or dermal protective clothing will often be required in contaminated areas, usually with respiratory protection. Mustard gas and VX are persistent agents.
- **Non-persistent agents** are volatile substances that evaporate or disperse quickly, and may be used to cause casualties in an area that the group using the weapons wants to occupy soon after. Surfaces are generally not contaminated. The primary danger is from inhalation, secondary from skin exposure. Respirators are the main form of protection required. Protective clothing may not be necessary if concentrations are below skin toxicity levels. Hydrogen cyanide and phosgene are typical non-persistent agents.

Chemical agents are often grouped according to their effect on the body**,** based on the primary organ system affected by exposure. Typical classes include:
- **nerve** agents or “gases” (e.g., sarin, VX, VR)
- **blood** gases or systemic agents (e.g., hydrogen cyanide)
- **vesicants** or skinblistering agents (e.g., mustard gas, lewisite)
- **lung** irritants, asphyxiants or choking agents (e.g., chlorine, phosgene).

**Comparison of Features of Chemical and Biological Attacks**

| Indicator | Chemical Attack | Biological Attack |
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| Epidemiological features | Large numbers of patients with very similar symptoms seeking care virtually simultaneously (especially with respiratory, ocular, cutaneous or neurological symptoms, such as nausea, headache, eye pain or irritation, disorientation, difficulty with breathing, convulsions and even sudden death)<br>Clusters of patients arriving from a single locality<br>Definite pattern of symptoms clearly evident | Rapidly increasing disease incidence (over hours or days) in a normally healthy population<br>Unusual increase in people seeking care, especially with fever, respiratory, or gastrointestinal complaints<br>Endemic disease rapidly emerging at an unusual time or in an unusual pattern<br>Large numbers of patients with rapidly fatal illness (agent dependent)<br>Patients with a relatively uncommon disease that has bioterrorism potential (e.g., pulmonary anthrax, tularemia, plague) |
| Animal indicators | Dead or dying animals<br>Absence of insects normally present | Sick or dying animals or fish<br>Unusual swarms of insects |
| Devices | Unusual liquid spray or vapour<br>Suspicious devices or packages<br>Droplets, oily film<br>Unexplained odour<br>Low clouds or fog unrelated to weather | Suspicious devices or packages |

*Source*: adapted from WHO references 4.08 and 4.09.

## Some Historical Examples of Use of CBRN Agents

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| Early use | Use of biological agents from Hannibal throwing pots of 'serpents of every kind' onto enemy ships in 184 BC to the reported catapulting of plaque victims into the town of Caffa by the attacking Tatars in 1346. Smallpox was reportedly used as a weapon in colonization of both North and South America in the 15-1700's. |
| 1915 | Modern use of CBRN weapons started in Europe – WWI. German army releases 180 tonnes of liquid chlorine into a breeze that would carry a cloud of asphyxiating vapour towards enemy lines: as many as 15,000 French, Algerian and Canadian soldiers were casualties and one-third of them died |
| 1923-26 | Morocco -chemical weapons used |
| 1930 | Libyan Arab Jamahiriya -chemical weapons used |
| 1934 | Sinkiang- chemical weapons used |
| 1935-40 | Ethiopia- chemical weapons used |
| 1937-42 | China- chemical weapons used |
| 1957 | Accusations by Eastern European press that Britain used biological weapons in Oman |
| 1961 | China accuses the United States of starting a cholera epidemic in Hong Kong |
| 1969 | Egypt accuses 'imperialist agressors' of using cholera in Iraq |
| 1961-75 | Viet Nam- chemical weapons used (agent Orange); suspected use of Tricothecene Mycotoxins ("Yellow rain") |
| 1963-67 | Yemen- chemical weapons used |
| 1978 | Bulgarian exile Georgi Markov assassinated in London using ricin |
| 1979 | *Bacillus anthracis* accidentally released from a Soviet military research facility in Sverdlovsk (66 people believed to have been killed) |
| 1980-88 | Use of mustard gas and nerve gas in the Islamic Republic of Iran/Iraq war |
| 1988 | Use of mustard and nerve gas by the government of Iraq against the people of Halabja |
| 1984 | Rajneshee Cult in The Dalles, Oregon sicken over 750 people by contaminating salad bars at 8 local restaurants with Salmonella. The cult was trying to influence a local election by making people too sick to vote. They did this by manually contaminating food, e.g. salad bars, with cultures of *Salmonella enterica* serotype Typhimurium, a common causative organism for food poisoning. The pathogen was obtained from materials purchased by the Rajneesh Medical Corporation for their (state-licensed) medical laboratory. Over 750 people were affected. The cult fell apart and members turned informant to expose the effort. |
| 1994 | Matsumoto, Japan. Terrorist group, Aum Shinrikyo, uses nerve agent, sarin and improvised dissemination system (i.e., heater, fan, drip system) to attack an apartment building killing 7 and injuring 300; group also uses VX to murder an opponent |
| 1995 | Tokyo, Japan. Aum Shinrikyo launched a coordinated attack on the subway using the nerve agent, sarin, in pierced bags, killing 12 people and causing 5,000 to seek care |
| 1996 | Pastries contaminated with Shigella by disgruntled lab worker in Dallas sicken several coworkers |
| 2001 | A series of letters containing an extremely high quality preparation of anthrax spores were mailed to a number of politicians and media personalities. None of the targets appeared to have been affected but 22 people developed serious illness (11 cutaneous and 11 inhalational anthrax) and 5 people died. |

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| 2004 | Ukrainian presidential candidate Viktor Yushchenko poisoned with dioxins |
| 2006 | Former Russian spy Alexander Litvinenko killed by ingestion of polonium-210 |

When considering strategies for preparedness against CBRN incidents, the possibility of a low-probability catastrophic outcome must be weighed against public health hazards of higher probability but smaller magnitude. It would be irresponsible to be complacent about the possible effects of deliberately released biological or chemical agents, but it would also be prudent to not overestimate them. Given the emotional shock of an alleged biological or chemical threat, jurisdictions must at least consider how to address such dangers, should they occur, as part of preparing for threats to public health and well-being.

## Milestones in Global Efforts to Control CBRN

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| 1925 | Geneva Protocol prohibits use of chemical and biological weapons |
| 1947 | UN Security Council document defines weapons of mass destruction were defined as "atomic explosive weapons, radioactive material weapons, lethal chemical and biological weapons, and any weapons developed in the future which have characteristics comparable in destructive effect to those of the atomic bomb or other weapons mentioned above" (2.03). |
| 1969 | United States publicly renounces use of bioweapons |
| 1970 | Conference of the Committee on Disarmament, a multilateral conference on disarmament held in Geneva, decides to consider biological and chemical weapons separately |
| | World Health Organization (WHO) publishes *Health aspects of chemical and biological weapons* |
| 1972 | Convention on the Prohibition of the Development, Production and Stockpiling of Biological and Toxin Weapons and on their Destruction (Biological and Toxin Weapons) Convention convened |
| 1975 | Biological and Toxin Weapons Convention (BWC) comes into force |
| 1990s | Ad hoc group formed to negotiate a protocol to strengthen the BWC, particularly through mechanisms to ensure compliance. Protocol has still not been agreed |
| 1997 | Chemical Weapons Convention comes into force |
| | Organization for the Prohibition of Chemical Weapons (OPCW) starts supervising the destruction of chemical wseapons stocks, including those belonging to the Russian Federation and the United States, and monitoring the world's chemical industries to prevent future misuse |
| 2004 | WHO publishes Public Health response to biological and chemical weapons: WHO guidance (a revised version of its 1970 report) |