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Chemical Weapons: Lethal Weapons of Uncivilized World!

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ABSTRACT

The threat of chemical weapons (CW) of mass destruction has intensified to a great extent that it has assumed an inevitable part of the daily news papers. The effect of CWs is devastating to the mankind as well as the environment. The biggest concern now is the disposal of CWs which is even more dangerous than the deployment itself. Many years after their use human beings and the environment are still bearing the brunt of devastation. Beyond chemical warfare now the biggest threat facing the mankind at present is utilization of chemical weapons against civilian population which should be stopped immediately at any cost by all the nations. The release of sarin in Matsumoto in Japan in 1994 by extremist Aum Shinnrikyo against civilian became a greatest threat to the nation which experienced the worst attack by nuclear weapons. In this context we would like to discuss about the history of chemical warfare, the health hazards, detection, treatment, and the present status of chemical weapons in the recent scenario.

Keywords: Chemical Weapons, Chemical Weapons Convention, nerve agents, antidotes, decontamination

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INTRODUCTION

The threat of CW has become one of the major global concerns nowadays due to the health hazard and environmental devastation it poses. The advanced and sophisticated scientific discoveries, knowledge and resources are being deliberately misdirected towards human hatred and power. Despite the persistent efforts of the international regulatory bodies like Chemical Weapons Convention (CWC) in eradicating the chemical weapons from the face of the earth, there was not much progress made to eradicate them completely. This article tries to enlighten the ill effects of CW on human beings and also about the preventive aspects as well as the treatment [1].

A chemical used in warfare to kill, injure or incapacitate an enemy is called a chemical warfare agent. Chemical warfare is the intentional use of toxic chemicals to kill or confuse man.

"Chemical Weapons" mean the following, together or separately [2]:

- Toxic chemicals and their precursors, except where intended for purposes not prohibited under this convention, as long as the types and quantities are consistent with such purposes;
- Munitions and devices, specifically designed to cause death or other harm through the toxic properties of those toxic chemicals specified in subparagraph (a), which would be released as a result of the employment of such munitions and devices;
- Any equipment specifically designed for use directly in connection with the employment of munitions and devices specified in subparagraph (b).

"Old Chemical Weapons" [2] means:

- Chemical weapons which were produced before 1925; or
  - Chemical weapons produced in the period between 1925 and 1946 that have deteriorated
- To such extent that they can no longer be used as chemical weapons.

Abandoned Chemical Weapons [2] means: Chemical weapons, including old chemical weapons, abandoned by a State after 1 January 1925 on the territory of another State without the consent of the latter.

This article highlights the history, available chemical weapons and their effects on human health, preventive aspects, and treatment modalities.

HISTORY OF CHEMICAL WARFARE (CW)

CW's were first used on a large scale against mankind was during World War I which made a havoc on the health of the human beings and the environment [3]. In late 1914, the Prussian chemist Fritz Haber who went to drive the enemy from his trenches delivered clouds of chlorine gas from pressurized cylinders. By the end of the war, exposures with

chlorine, phosgene, mustard gas, and other toxic agents had inflicted approximately one million casualties, about 90,000 of them fatal [4].

Despite the negotiation in 1925 of the Geneva Protocol banning the use of chemical weapons in warfare, their use continued during the war period. In 1936, Gerhard Schrader, a German industrial chemist produced pesticides at the I. G. Farben company, accidentally discovered a new group of super toxic nerve poisons that affect the nervous system, leading to convulsions and death by respiratory arrest [5]. The German Army deliberately developed these compounds into the dreaded G-series nerve agents, including tabun, sarin, and soman. In the early 1950s, industrial chemists at Imperial Chemical Industries in Britain developed a new pesticide called amiton that was very toxic for agricultural use and was abandoned. But amiton was transferred to the British chemical warfare establishment at Porton Down and later developed into the first V-series nerve agents, which easily penetrate the skin and lethal in minimal dose, a drop of VX weighing 10 milligrams can kill an adult man in seconds [6]. During the Cold War between United States and Soviet Union, they produced and stockpiled tons and tons of nerve agents as a preparedness for the impending war [7].

CW's also proliferated to several developing countries and was used on the battlefield in the Yemen Civil War (1963-67) and the Iran-Iraq War (1980-88). Saddam Hussein first started the use of mustard gas in 1983 against Iran. When his chemical usage did not produce international condemnation Saddam initiated the use of nerve agents in March 1984 during the battle of Majnoon Island. The Iranian forces were vulnerable to chemical attack because the Basij militia did not wear gas masks and the traditional troops refused to shave their beards to make an airtight seal. After the war Saddam Hussein used chemical weapons to terrorize native Kurdish population in northern Iraq. In an inhumane attack on March 16-17, 1988, the Iraqi Air Force dropped bombs containing mustard gas and nerve agents on the Kurdish town of Halabja, killing an estimated 5,000 civilians, many of them women and children [8]. Terrorist groups such as Aum Shinrikyo in Japan and al-Qaeda in Afghanistan have also attempted to acquire and use CW's, so far with limited success [9].

For many terrorist organizations, chemical weapons may be an ideal choice for attack as they are cheap, has a long shelf life, easy to transport, difficult to detect and effects such as mortality and morbidity are instant. The first attack of chemical agents by terrorists against a civilian population was on 20th March 1995 where "Aum Shinrikyo', a rebellion group based in Japan released "sarin" into the Tokyo subway system, killing twelve and injuring over 5000 people [10]. The CW's have nothing to do with conventional weapons which cause physical destruction not only of humans but of equipment and facilities. However, the use of chemical and biological weapons in war is prohibited by the Geneva Protocol of 1925 and the Biological weapons convention of 1992 [11].

Recent scenario

In recent times all news papers quote the threat posed by Syria in using the chemical weapons. "The Syrian regime acknowledged for the first time that it possessed stockpiles of chemical and biological weapons and said it will only use them in case of a foreign attack

and never against its own citizens". This was the news recently appeared in the news paper in India [12].

Of 188 signatory nations to the Chemical Weapons Convention, state parties listed have also declared stockpiles, agreed to monitored disposal, and verification, and in some cases, used CW in conflict. Both military targets and civilian populations have been affected. As of 2012, only four nations are confirmed of having CW's: the United States, Russia, North Korea and Syria.

Public opinion brought about to endorse the complete elimination of this class of weapons. The research community must undertake research with utmost social responsibility and national security [13]. Progress is being made to fulfill its eradication through international law and the cooperation by the community. We hope that a day will come that all of us will be free from the most dreadful weapons.

Recent fears

Recent fears surrounding the possible use of CW's stockpiles by regime rulers in Libya and Syria, or their seizure by regional terrorists, underscore the continued danger of CW's proliferation and the need to take stronger measures to oppose it. The use of a significant quantity of a chemical agent in a concentrated area can be extremely deadly. The effects of exposure to chemical agents occur rapidly and are usually extremely virulent; CW's are also effective tools of psychological warfare. Moreover, under certain conditions, even a minor CW's attack could cause widespread panic, leading to economic loss that would transform limited attacks into major incidents" [14].

"So-called tear gas, often considered a crowd-control method with no lasting harmful effects, can cause permanent injuries, miscarriages, and even fatalities, if it is not used according to strict guidelines, as used by Bahrain's security forces," says Richard Sollom, lead author of last week's report on tear gas by Physicians for Human Rights.

Chemical weapon classes

- CW's are inert agents that come in four categories: Chocking, blister, blood and nerve [15].
- The agents are organized into several categories according to the manner in which they affect the human body. The names and number of categories varies slightly from source to source, but in general, types of chemical warfare agents are as follows:

Class agent

Nerve

The following are the important nerve agents produced to deploy in chemical warfare. Cyclosarin (GF), sarin (GB), soman (GD), tabun (GA),VX (Methylphosphonothioic

acid S-(2-(bis(1-methylethyl)amino)ethyl) O-ethyl ester),VR, some insecticides, and Novichok agents.

- Mechanism of action of these agents are that it inactivates enzyme acetyl cholinesterase, preventing the breakdown of the neurotransmitter acetylcholine in the victim's synapses and causing both muscarinic and nicotinic effects. The signs and symptoms are miosis (pinpoint pupils), blurred/dim vision, headache, nausea, vomiting, diarrhoea, copious secretions/sweating muscle twitching/ fasciculation's, dyspnea, seizures, loss of consciousness.
- Rate of reaction : Vapors: seconds to minutes, Skin: 2 to 18 hours
- VX is persistent and a contact hazard; other agents are non-persistent and present mostly inhalation hazard.

Asphyxiants / Blood

The toxic agents are arsines, cyanogen chloride, and hydrogen cyanide.

- Mechanism of action: Arsine causes intravascular hemolysis that may lead to renal failure. Whereas, in cyanogen chloride/hydrogen cyanide, cyanide directly prevents cells from using oxygen. The cells then use anaerobic respiration, creating excess lactic acid and metabolic acidosis.
- Signs and symptoms: Possible cherry-red skin, possible cyanosis, confusion, nausea, patients may gasp for air, seizures prior to death, metabolic acidosis.
- Rate of reaction: Immediate on inhalation.

Vesicant / Blister

The agents which produce vesicant and blisters over skin are sulfur mustard (HD, H), nitrogen mustard (HN-1, HN-2, HN-3), lewisite (L), phosgene, and oxime (CX).

- Mechanism of action: Agents are acid-forming compounds that damages skin and respiratory system, resulting burns and respiratory problems.
- Signs and symptoms: Severe skin, eye and mucosal pain and irritation, skin erythema with large fluid blisters that heal slowly and may become infected, tearing, conjunctivitis, corneal damage, and mild respiratory distress to marked airway damage.
- Rate of reaction for mustard vapors: 4 to 6 hours, eyes and lungs affected more rapidly; Skin: 2 to 48 hours. Lewisite: Immediate.

Choking / Pulmonary

The following are the Chocking agents which chokes the respiratory system, chlorine, hydrogen chloride, nitrogen oxides, and phosgene.

- Mechanism of action: Similar mechanism to blister agents in that the compounds are acids or acid-forming, but action is more pronounced in respiratory system, flooding it and resulting in suffocation. Survivors often suffer chronic breathing problems.

- Signs and symptoms: Airway irritation, eye and skin irritation, dyspnea, cough, sore throat, chest tightness, wheezing, and bronchospasm.
- Rate of reaction: Immediate to 3 hours, non persistent and produces inhalation hazard.

Lachrymatory agent

- These are commonly used agents to produce intense eye irritation, tear gas, and pepper spray.
- Mechanism of action: It causes severe stinging of the eyes and temporary blindness.
- Signs and symptoms: It causes powerful eye irritation
- Rate of reaction: Immediate, non persistent and produces inhalation hazard.

Incapacitating

Important incapacitating agent is BZ (3-Quinuclidinyl benzilate).

- Mechanism of action: Causes atropine-like inhibition of acetylcholine in subject. Causes peripheral nervous system effects that are the opposite of those seen in nerve agent poisoning.
- Signs and symptoms: May appear as mass drug intoxication with erratic behaviors, shared realistic and distinct hallucinations, disrobing and confusion, hyperthermia, ataxia (lack of coordination), mydriasis (dilated pupils), dry mouth and skin.
- Rate of reaction: Inhaled- 30 minutes to 20 hours;
- Skin: Up to 36 hours after skin exposure to BZ. Duration is typically 72 to 96 hours. Extremely persistent in soil and water and on most surfaces; contact hazard.

Non-living biological proteins

The following are the proteins, ricin, abrin, and cytotoxic proteins.

- Mechanism of action: It Inhibits protein synthesis.
- Signs and symptoms: Latent period of 4-8 hours, followed by flu-like signs and symptoms. Progress within 18-24 hours to inhalation: nausea, cough, dyspnea, and pulmonary edema
- Ingestion: Gastrointestinal hemorrhage with emesis and bloody diarrhea; eventual liver and kidney failure.
- Rate of reaction: Rate of reaction is 4-24 hours. Exposure by inhalation or injection causes more pronounced signs and symptoms than exposure by ingestion. The agents degrade quickly in environment.

Preventive measures

In International level in 1998 WHO established an expert group to review and monitor the health aspects of chemical and biological weapons [16].

There are four main cornerstones in the protection against chemical weapons, all of which are largely dependent upon each other to provide optimum effect. These four are:

- Physical protection: body protection, respiratory protection, and collective protection.
- Medical protection: pretreatment, and therapy.
- Detection: alarm, monitoring, verification, identification, and all-clear.
- Decontamination: individual decontamination, and equipment decontamination.

Medical protection

Under this the detection and confirmation of chemical weapon attack is very important to avoid unnecessary panic among the public. To accomplish those faster and quick methods of detection must be available. There are two methods available for quick detection of CW's.

- New technology for detecting CW's in seconds by using nano-silver particles, by Engineering and Physical Sciences Research Council (EPSRC) [17].
- Shocking Pink: An inexpensive test for chemical weapon attacks.
  Paper sensors change color from blue to pink within 30 seconds of exposure to trace amounts of the toxic gas [18].

Researchers were able to detect the presence of a nerve agent related to sarin gas at a low concentration of 160 parts per billion using a litmus-like paper sensor designed to change color from blue to pink within 30 seconds of exposure to trace amounts of the toxic gas.

Apart from this there must be training in how to behave in an environment and also how to use the protective equipments. There may be practical difficulty in wearing the protective equipment and performing the regular duties. Extreme weather conditions are not suitable for wearing the protective equipments. These are the practical difficulties in implementing physical protection.

Civilian Protection

Civilian protective masks of simple design are used to transfer civilians from one place to another. For younger children protective jackets are used which gives protection for respiratory organs and protection against liquid chemicals. Children less than 12 years are given protective carry-cot. Further, a collective protection is given by installing filters in the shelters which selectively filters chemicals.

Warning systems consists of sirens in urban areas and warning telecasted in TV and radios.

The civil defense can organize special petrol in affected areas to prevent from further exposure and help in shifting the people to safer areas.

Decontamination

The aim of decontamination is to rapidly and effectively render harmless or remove poisonous substances both on personnel and equipment. High decontamination capacity is one of the factors which may reduce the effect of an attack with CW agents [19].

All decontamination is based on one or more of the following principles:

- To destroy CW agents by chemically modifying them (destruction).
- To physically remove CW agents by absorption, washing or evaporation.
- To physically screen-off the CW agent so that it causes no damage.

Most CW agents can be destroyed by means of suitable chemicals. Some of the examples of decontaminants are:

- Sodium hydroxide dissolved in organic solvent breaks down most substances but should not be used in decontaminating skin.
- Chloramine solutions which are often used to decontaminate personnel. These have good effect against mustard agent and V-agents but are ineffective against nerve agents of G-type (sarin, soman, and tabun).
- A water solution of soda rapidly renders nerve agents of G-type harmless but when used in connection with V-agents, it produces a final product which is almost as toxic as the original substance. It is necessary to know which CW agent has been used and according to that suitable decontaminants are chosen.

Decontamination Methods

CW agents can be washed and rinsed away, dried up, sucked up by absorbent substances, or removed by heat treatment. Water, with or without additives of detergents, soda, soap, etc., can be used, as well as organic solvents such as fuel, paraffin and carburetor spirit. Emulsified solvents in water can be used to dissolve and wash-off CW agents from various contaminated surfaces [19].

Individual Decontamination

The most important decontamination measure naturally concerns the individual. If it is suspected that skin has been exposed to liquid CW agents, then it must be decontaminated immediately (within a minute). All experience confirms that the most important factor is time; the means used in decontamination are of minor importance. Good results can be obtained with such widely differing means as talcum powder, flour, soap and water, or special decontaminants [18].

In complete decontamination, clothes and personal belongings must also be decontaminated. If clothes have been exposed to liquid contamination, then extreme care must be taken when undressing to avoid transferring CW agents to the skin. There may be particular problems when caring for injured since it may be necessary to remove their clothes by cutting them off. This must be done in such a way that the patient is not further

injured through skin contact with CW agents. During subsequent treatment it is essential to ensure that the entire patient is decontaminated to avoid the risk of exposing the medical staff to the CW agents.

Antidotes and Treatment of Chemical warfare agents

To avoid death, administration must occur within minutes of substantial exposure together with immediate decontamination. Continuous observation and repeated administration of antidotes are necessary as symptoms warrant. Available antidotes do not necessarily prevent respiratory failure or incapacitation. The toxicity of the antidotes themselves and the individualized nature of medical care preclude recommending that auto injectors be distributed to the general public.

Organophosphate nerve agent poisoning [20]

Antidote

Atropine

Anticholinergic alkaloid used to block parasympathetic nerve stimulation. In massive doses used to treat AchE poisoning and to manage some psychiatric disorder.

Action: Relieves smooth muscle spasm in lung and gastrointestinal tract, and reduces secretions in lungs. Dose: 2-4mg or more by I.M. or I.V depending upon the response. Full atropinisation maintained at 2mg every 3 to 8 minutes for several hours.

Child: Initial dose 0.05mg/kg, maintenance dose 0.02 to 0.05/kg. For all provide atropine until signs of atropinization occur. Use until signs of improvements occur, then tapper the dose.

Over dosage symptoms and treatment: Dryness of mucous membranes, lungs, skin hot and dry, high fever, tachycardia, and restlessness.

Management: Physostigmin 0.5-1mg oral/parenteral can be given.

2-PAM-Cl (Protopam chloride; 2-pyridine aldoxime methyl chloride; and pralidoxime)

Used to treat poisoning due to organophosphate insecticides and nervegases. Anticholinesterase antagonist, useful when given along with atropine.

Dose: Adult; 1-2grams in 100ml saline 15-30mts for initial dose.Second dose after one hour if symptoms persists.

Children initial dose is 15-25mg/kg followed by second dose if symptoms persist.
Infants: Try 15mg /kg.

Less effective if time elapsed or aging occurs.

Overdosage: Rapid dangerous rise in blood pressure, tachycardia, blurred vision, and dizziness.

Usually well tolerated with careful administration.

Vesicant Agent Therapy

The blister agents, mustard and lewisite, are very toxic. But, are not acutely lethal at extremely low doses, which is characteristic of nerve agent toxicity. Rather, they were designed as effective incapacitating agents.

Sulfur Mustard

Treatment of sulfur mustard poisoning in humans has focused on rapid decontamination followed by symptomatic therapy [21]. Discussions in U.S. Army manuals of therapy for various chemical warfare agents correctly emphasize that instantaneous removal of mustard from body surfaces is the best form of treatment [22]. The recommended way to accomplish this is by washing with dilute household bleach (0.5% HTH) or copious amounts of soap and water.

Lewisite [23]

It is life saving in acute poisoning of arsenicals (except arsine). And solutions of organic Hg compounds. Action by displacing the metal from its combination with sulfhydryl groups of enzyme protein.

Dose: IM into buttocks, dose 0.5ml 25 lb body weight up to maximum of 4ml repeat in 4,8, 12 hrs, for severe cases interval shortened to 2hrs.

Overdose symptoms: Rise in systolic and diastolic BP with tachycardia, nausea, headache, burning sensation of lips and mouth, feeling of constriction of throat, chest, hands, conjunctivitis, salivation, abdominal pain, and tremors.

Management of overdose: Symptoms usually subside in 30-90 minutes; I. M. use of 1:100 solution of epinephrine HCl 0.1-0.5ml or oral ephedrine sulfate (25-50mg). This may be given to revert the effects of arsenicals.

CONCLUSION

In spite of the successful implementation of the CWC in recent years, CW's remain a global concern and great threat to human beings. This requires greater attention from policymakers, rulers, environmentalists and the general public. The CW threat is multipronged with military weapons, incapacitating agents, and toxic industrial chemicals. Nowadays with the globalization, fast industrialization CW may spread to nearby likeminded countries like a fire if not checked early. In a crisis or war CW may be used as a defense or threat by the possessing countries.

The important CW's used are the nerve gases, asphyxiants, vesicants, chocking agents, lachrymatory agents and incapacitating agents. The appropriate treatments with antidotes are available which should be administered in time. Newer drug delivery systems like inhalers, auto injections in the form of prefilled syringes may be produced in large quantities and kept ready for emergency use. Public must be educated about the actions of the common CWs and ways to protect the ill effects.

All the countries must join as the member of CWC and adhere to the guidelines laid down by CWC. Periodical inspection must be carried out in all the countries with the representatives of CWC. Global monitoring must be strengthened and warning should be issued to the erring country. There must be mutual trust and transparency among the members of CWC. Domestic preparedness may be strengthened to face any eventuality. With proper protective equipment, training, and decontamination measures, the primary effects of chemical weapons can be overcome. There is no role for CW in a civilized world hence we all should join together to eradicate the lethal weapon of the uncivilized world and save our planet.

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