

The designation “nerve gas” or “nerve agent” is used for organophosphorus compounds that inhibit tissue cholinesterase. It is an allusion to the mode of action of these substances, namely the disruption of nerve impulse transmission.

At the present time, two families of nerve gases are important for military purposes, namely the G agents, which are alkyl esters of methylphosphonofluoridic acid or of dialkylphosphoramidocyanidic acid, and the V agents, which are mainly alkyl esters of S-dialkylaminoethyl methylphosphonothiolic acid.

G agents (e.g. sarin, tabun and soman) are primarily designed to act via inhalation, while V agents (eg. VX) act primarily through skin penetration and by inhalation of aerosol. Chemically and toxicologically, the nerve gases are similar to many of the commercial organophosphate pesticides and, while information on severe nerve gas poisoning in humans is rather limited, there are extensive data on human exposure to some of these pesticides.

Nerve agents are mostly odourless and colourless to yellow-brown liquids at ambient temperature, and are soluble in water except V agents. Nerve agents are heavier than air and will tend to accumulate in low-lying areas.

Exposure

- Sarin, tabun and VX may be absorbed quickly and easily. When dispersed as a vapor or aerosol, or absorbed on dust, they are readily absorbed through the respiratory tract and conjunctivae. Absorption is most rapid and complete through the respiratory tract. Aerosols and liquids are absorbed through skin. Vapors may be absorbed through skin if at very high concentrations.
- Sarin and tabun mixes easily with water (whereas VX does not mix with water as easily as other nerve agents), so it could be used to poison water or food. Following release of sarin and tabun into water, people can be exposed by touching or drinking water that contains G agents.
- Nerve agents may be released into water and used to contaminate food and are toxic by ingestion. □
- Liquid droplets or even vapor may persist in a victim's clothes after minutes to hours of exposure which may lead to cross-contamination of others.
- VX is primarily a liquid exposure hazard.

Latency period

The effect of exposure to sarin depends on the amount of the agent, route and duration of the exposure. The symptoms will appear within a few seconds after inhalation exposure to the vapor form and from a few minutes to 18 hours after exposure to the liquid form.

Main clinical signs and symptoms

Following local exposure

- Rhinorrhoea and hyperaemia of nasal mucosa membrane
- Miosis, (pin-point pupils), sometimes unequal
- Hyperaemia of conjunctivae
- Excessive sweating at site of exposure
- Frontal headache, eye pain on focusing, slight dimness of vision, occasional nausea and vomiting
- Tightness of chest, sometimes with prolonged wheezing, expiration suggestive of bronchoconstriction or increased secretion and cough
- Fasciculations at site of exposure to liquid

Following systemic absorption

- Tightness in chest, with prolonged wheezing expiration suggestive of bronchoconstriction or increased secretion; dyspnoea, slight pain in chest; increased bronchial secretion; cough; pulmonary oedema; cyanosis
- Anorexia; nausea; vomiting; abdominal cramps; epigastric and substernal tightness with "heartburn" and eructation; diarrhoea; tenesmus; involuntary defecation
- Increased/excessive sweating
- Increased/excessive salivation
- Increased/excessive lacrimation
- Bradycardia
- Slight miosis, occasionally unequal
- Blurring of vision
- Frequency; involuntary urination
- Easy fatigue; mild weakness; muscular twitching; fasciculations; cramps; generalized weakness, including muscles of respiration, with dyspnoea and cyanosis

Principles of medical management

- Remove the victim from contaminated area
- Give antidotes (atropine and oximes) to symptomatic cases
- Give supportive therapy (e.g. oxygen)

Prophylaxis/treatment

- While prophylaxis is possible, involving the administration of a reversible anticholinesterase agent, in practice this is not likely to be available to civilians.
- Atropine sulfate blocks the muscarinic effects of acetylcholine that cause bronchorrhoea, hypersalivation, bronchoconstriction and bradycardia, thereby reducing these effects. It also partially counteracts the convulsive effects and respiratory depression in the central nervous

system. Dosing regimens vary, however, a suggested regimen is to give a loading dose of between 1 and 5 mg i.v. every 30 minutes until full atropinization, and maintenance doses of between 0.5 and 2 mg/hour. Titration of atropine in the individual patient must be carried out on the basis of the most relevant effects for a favourable clinical outcome, i.e. a decrease in bronchial constriction and secretions as judged by auscultation and blood gas analysis. Changes in heart rate are less important but easier to follow, and a mild tachycardia of 80 beats or more per minute should be maintained.

- Besides atropine, a centrally acting anticonvulsant should be administered, diazepam being the drug of choice. It is used to both prevent and treat convulsions. In addition to diazepam, lorazepam, midazolam and pentobarbital have been used to treat soman-induced seizures. Seizure control declines markedly if there is any delay in treatment; 40 minutes after exposure, control is minimal. Most clinically effective antiepileptic drugs may be incapable of terminating nerve agent-induced seizures.

- An oxime should also be given, such as pralidoxime, obidoxime or HI-6. Oximes are acetylcholinesterase reactivators and should be given as soon as possible after exposure.

Stability/neutralization

Tabun, sarin and soman are quite volatile and are considered to have low environmental persistence, whereas thickened soman and VX may persist in the environment for days, depending on temperature and other environmental conditions; generally persistence is prolonged at low temperatures.

Decontamination procedures for skin, equipment and materiel have been developed by most armies, using neutralizing, active chemicals, such as chloramine solutions, or neutral adsorbing powders, e.g. fuller's earth.

How to protect yourself

Recovery from nerve gases or agents exposure is possible with treatment, but the antidotes available must be used quickly to be effective. Therefore, the best thing to do is avoid exposure:

- Leave the area where the nerve agents were released and get to fresh air. Quickly moving to an area where fresh air is available is highly effective in reducing the possibility of death from exposure to nerve gas vapor.

- If the nerve agents were released outdoors, move away from the area where they were released. Go to the highest ground possible, because these nerve agents are heavier than air and will sink to low-lying areas.

- If the nerve agents are released indoors, get out of the building.

- If people think they may have been exposed, they should remove their clothing, rapidly

wash their entire body with soap and water, and get medical care as quickly as possible.

Removing and disposing of clothing

- Quickly take off clothing that has liquid or vapors of nerve agent on it. Any clothing that has to be pulled over the head should be cut off the body instead of pulled over the head. If possible, seal the clothing in a plastic bag. Then seal the first plastic bag in a second plastic bag. Removing and sealing the clothing in this way will help protect people from any chemicals that might be on their clothes.
- If clothes were placed in plastic bags, inform the Ministry of Health or local health department or emergency personnel upon their arrival. Do not handle the plastic bags.
- If helping other people remove their clothing, try to avoid touching any contaminated areas, and remove the clothing as quickly as possible.

Washing the body

- As quickly as possible, wash any liquid or vapor from the skin with large amounts of soap and water. Washing with soap and water will help protect people from any chemicals on their bodies.
- Rinse the eyes with plain water for 10 to 15 minutes if they are burning or if vision is blurred.
- If these nerve agents have been swallowed, do not induce vomiting or give fluids to drink.
- Seek medical attention immediately.

Protection

Chemical protective clothing containing activated carbon layer and a full-face gas mask with an appropriate filter should be used.

References

[Medical Management of Chemical Casualties Handbook, 4th ed 2007. US Army Medical Research Institute of Chemical Defense \[pdf 102Mb\]](#)

[Medical Management Guidelines for Nerve Agents \[pdf 289.5kb\]](#)

[Public health response to biological and chemical weapons—WHO guidance \(2004\)](#)

[Quick Reference Guides \(Sarin, Soman, Tabun, VX\) \(2011\) US National Response Team](#)

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