

Florida Poison Information Center/Jacksonville
At Shands Jacksonville
University of Florida Health Science Center
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G Nerve Agents

Mechanism of Action

The chemical warfare agents tabun (GA), sarin (GB), soman (GD), and GF are nerve agents in the acetylcholinesterase inhibitor group. These agents affect transmission of nerve impulses in the nervous system by irreversibly binding to the enzyme acetylcholinesterase inhibiting its activity, and causing an accumulation of acetylcholine. They have a very rapid onset, and can manifest severe toxic effects, including death from just a few drops.

Physical Properties

Tabun, sarin, and soman are esters of phosphoric acid. The G nerve gases and VX exist under temperate conditions as clear, colorless liquids with high boiling points. They are soluble in water solvents and fat. When mixed with water a hydrolysis reaction creates a less toxic compound than the parent molecule. These agents are more volatile compounds than VX, evaporating from the skin more rapidly and limiting skin penetration. Sarin has volatility similar to water and is the most volatile of the nerve agents. The decreasing order of volatility among nerve agents are: sarin > soman > tabun > GF > VX. The less volatile a nerve agent the more persistent it is on terrain and material. These properties make the G nerve agents lethal by inhalation, and to a lesser degree, percutaneous exposure.

Clinical Effects

Symptoms are dependent upon the route, concentration, and duration of exposure. Effects are caused by excess acetylcholine at both muscarinic and nicotinic receptors, resulting in a "cholinergic syndrome." Onset of symptoms can occur anywhere from 10 minutes to 18 hours after exposure. Initial symptoms are usually localized to the contact site, followed by gastrointestinal symptoms and then other systemic manifestations.

Low to moderate doses- Patients may have an asymptomatic period of 20 to 30 minutes after skin exposure. Mild signs and symptoms include localized sweating and muscle twitching in the contaminated area, stomach cramps and nausea, increased salivation and drooling, unexplained runny nose, miosis, visual impairment (limited night and short range vision) and pain or headache around the eyes. Patients may also complain of chest tightness, difficulty breathing, and fatigue. Moderate exposures cause increasing severity of mild symptoms and may progress to weakness, muscle fasciculations, slurred speech and hallucinations.

High doses- symptoms will be very rapid and severe. With higher doses, severe dyspnea and cough secondary to bronchoconstriction and increased secretions are likely. Pinpoint pupils, severe vomiting and involuntary urination/defecation can be seen with rapid progression to convulsions, coma and respiratory failure. Respiratory muscle paralysis or suffocation usually causes death.

Medical Management

Decontamination - Rescuers need to wear full protective garments and gloves (Class B or above). Remove any clothing that has been exposed. The potential for secondary contamination is extremely HIGH before decontamination, and LOW if decontamination is thorough.

Skin- When skin contact has occurred, the area should be washed well with soap and water.

Eyes- Exposed eyes should be irrigated with copious water or saline for 15-20 minutes.

Airway and ventilatory support may be required. If intubation is required, depolarizing neuromuscular blockade with succinylcholine should be avoided.

Antidotes

Atropine- as an anticholinergic agent, it blocks excess acetylcholine at peripheral muscarinic sites. Atropine will not reverse the nicotinic effects.

Pralidoxime (2-PAM)- breaks the toxin-acetylcholinesterase bond to restore normal activity of the enzyme. Pralidoxime will be most effective if given within 24 hours after the exposure, since the agent-acetylcholinesterase bond undergoes "aging", and thus becomes irreversible.

Diazepam-is administered as needed for seizure activity. Other benzodiazepines may be substituted.

Field Antidotes

- These 3 agents are available in intramuscular autoinjectors and may be utilized at the exposure site and in mass casualty incidents. The MARK I kit contains 2mg of atropine and 600mg of pralidoxime and the CANA kit contains 10 mg of diazepam. CANA kits are not to be self-administered. A person does not need the injections if they are well enough to give it to him/herself.

Assessment of Cholinesterase Concentrations

If available, it may be appropriate to obtain red blood cell cholinesterase levels. A significant depression of enzyme activity may be useful in documenting exposure. However, there is a wide range of normal, and levels may still fall within a normal range in spite of significant inhibition. The amount of enzyme inhibition may not correlate with the degree of toxicity. Knowing that acetylcholinesterase regenerates at approximately 1% each day, a post-exposure level may provide a rough estimate as to how long a patient will require ventilatory support or rehabilitation.

References

1. Holstege CP, et al. Chemical Warfare: Nerve Agent Poisoning. Critical Care Clinics. 1997.
2. Medical Management of Chemicals Casualties Handbook. United States Army. 1995.

3. Sidell FR, Borak J. Chemical Warfare Agents: II Nerve Agents. *Annals of Emergency Medicine* 1992;21:865-71.



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