

NERVE AGENTS

(e.g., Sarin, Soman, Tabun, VX)

Background:

Nerve agents inhibit acetylcholinesterase. When inhibition of acetylcholinesterase occurs, there is a build up of acetylcholine, a neurotransmitter found at the neuromuscular junction and pre-ganglionic synapses in the sympathetic and parasympathetic nervous system. This leads to classic muscarinic, nicotinic and central effects. Muscarinic effects (DUMBBELS) include diarrhea, urination, miosis, bradycardia, bronchorrhea, emesis, lacrimation and salivation. Nicotinic effects (M T W H F) include mydriasis, tachycardia, weakness, hypertension and fasciculations. Central effects may include anxiety, agitation, confusion, seizures and coma. Nerve agent poisoning can occur from ingestion, inhalational or dermal exposure. All suspected or confirmed cases of nerve agent poisoning must be reported to the local department of public health and the Illinois Department of Public Health (IDPH).

Onset of Action:

- 1) Vapor or gas exposure: Seconds to minutes
- 2) Dermal liquid exposure: Minutes to hours

Signs/Symptoms:

- 1) Motor: Ranges from diffuse muscle cramping and fasciculations (early) to flaccid paralysis (late)
- 2) Pulmonary: Rales, wheezing, poor inspiration from muscle weakness
- 3) Cardiac: Bradycardia or tachycardia and hypotension or hypertension may be seen
- 4) GI: Nausea, vomiting, diarrhea, abdominal cramping
- 5) GU: Urinary incontinence
- 6) Skin: Diaphoresis
- 7) HEENT: Miosis or rarely mydriasis, tearing of eyes, excessive salivation
- 8) CNS: Confusion, agitation, seizures, coma


Laboratory and Diagnostic Testing:

Diagnostic tests may include CBC, Chem-7, continuous pulse oximetry, ABG, CXR and an RBC cholinesterase level.

Treatment:

Decontamination:

Generally, gas/vapor exposures only need removal of clothes and jewelry. Seal all articles in impervious plastic bags and save for the authorities. Patients exposed to gas/vapor do not always need dermal decontamination as secondary decontamination is negligible once the clothing is removed. Sarin, Soman and Tabun can be in gaseous form. VX has a high boiling point and, therefore, dispersal occurs in a mist form, not a gaseous form; all VX exposures are technically liquid exposures and **MUST** have universal, thorough decontamination.

- 1) Dermal exposure: Remove all clothes and jewelry. Wash patient with copious amounts of mild soap or bleach and water as per hospital guidelines.  *Soap and water may be preferable for infants and small children.* Use chemical resistant gloves (e.g., neoprene) if possible.
- 2) Ingestion: May consider lavage and charcoal, but copious emesis usually makes gastric decontamination unnecessary and charcoal difficult to administer.

(continued, next page)

If you suspect a poisoning exposure from any bioterrorism agent, immediately contact your local county health department, and the Illinois Poison Center at 1-800-222-1222.

3) If a cluster of patients has cholinergic signs from an **unknown** exposure, assume it is a dermal liquid exposure or VX, and thoroughly decontaminate all patients. If it is a **known** exposure to a **gaseous** form of nerve agent, consider abbreviated decontamination by removing clothing only, or using a shorter decontamination period.

Antidotal Therapy:

Atropine will reverse the muscarinic symptoms of nerve agents. Pralidoxime (2-PAM), will reverse the nicotinic symptoms as well as prevent irreversible binding of the nerve agent to the acetylcholinesterase enzyme.

AGE	MILD-MOD	SEVERE	OTHER TREATMENTS
	(localized sweating, fasciculations, nausea, emesis, weakness, dyspnea)	(unconsciousness, convulsions, apnea, flaccid paralysis)	
INFANT (0-2 yrs)	ATROPINE: 0.05 mg/kg IM/IVP 2-PAM: 15 mg/kg IV slowly over 20 – 30 min	ATROPINE: 0.1 mg/kg IM/IVP 2-PAM: 15 mg/kg IV slowly over 20 – 30 min	Ventilation and suctioning PRN Repeat ATROPINE: 1 mg IM/IVP Q 5 – 10 min until tracheobronchial secretions have cleared Repeat 2-PAM: Q6 hrs may be necessary DIAZEPAM: 0.05 – 0.3 mg/kg IV over 3 min (max 5 mg/dose), consider PR
CHILD (2-10 yrs) 20+ kg	ATROPINE: 1 mg IM/IVP 2-PAM: 15 mg/kg IV slowly over 20 – 30 min	ATROPINE: 2 mg IM/IVP 2-PAM: 15 mg/kg IV slowly over 20 – 30 min	Ventilation and suctioning PRN Repeat ATROPINE: 2 mg IM/IVP Q 5 – 10 min until tracheobronchial secretions have cleared Repeat 2-PAM: Q6 hrs may be necessary DIAZEPAM: 0.05 – 0.3 mg/kg IV over 3 min (max 10 mg/dose), repeat Q 15-30 min
ADOLESCENT (> 10 yrs) 40+ kg	ATROPINE: 2 mg IM/IVP 2-PAM: 15 mg/kg IV (up to 1 gm) slowly over 20 – 30 min	ATROPINE: 4 mg IM/IVP 2-PAM: 15 mg/kg IV (up to 1gm) slowly over 20 – 30 min, consider 600mg IM (auto-inj)	Ventilation and suctioning PRN Repeat ATROPINE: 2 mg IM/IVP Q 5 – 10 min until tracheobronchial secretions have cleared Repeat 2-PAM: 1gm IV or 600mg IM in 1 hr; Q6hr prn DIAZEPAM: 5 – 10 mg IM/IV over 3 min
ADULT	ATROPINE: 2-4 mg IM/IVP 2-PAM: 15 mg/kg IV (up to 1 gm) slowly over 20 – 30 min	ATROPINE: 6 mg IM/IVP 2-PAM: 15 mg/kg IV (up to 1gm) slowly over 20 – 30 min, consider 600mg IM (auto-inj)	Ventilation and suctioning PRN Repeat ATROPINE: 2 mg IM/IVP Q 5 – 10 min until tracheobronchial secretions have cleared Repeat 2-PAM: 1gm IV or 600mg IM in 1 hr; Q6hr prn DIAZEPAM: 5 – 10 mg IM/IV over 3 min
ELDERLY, FRAIL	ATROPINE: 1 mg IM/IVP 2-PAM: 5-10 mg/kg IV (up to 1 gm) slowly over 20 – 30 min	ATROPINE: 2 mg IM/IVP 2-PAM: 5-10 mg IV (up to 1 gm) slowly over 20 – 30 min, consider 600mg IM (auto-inj)	Ventilation and suctioning PRN Repeat ATROPINE: 2 mg IM/IVP Q 5 – 10 min until tracheobronchial secretions have cleared Repeat 2-PAM: 1gm IV or 600mg IM in 1 hr; Q6hr prn DIAZEPAM: 5 – 10 mg IM/IV over 3 min

(continued, next page)

(Adapted from ATSDR GUIDELINES and Rotenberg, PEDIATRICS)

If you suspect a poisoning exposure from any bioterrorism agent, immediately contact your local county health department, and the Illinois Poison Center at 1-800-222-1222.

NERVE AGENTS, p.3

If IV medications are unavailable and Mark Kits are available, may use Mark 1 kits:

- 1) Mark Kits: Each kit contains 600 mg of 2-PAM and 2 mg of atropine
 - a) Initial bolus:
 - a. One Mark 1 kit for mild symptoms (ambulating, miosis, eye pain, blurred vision, rhinorrhea, mild dyspnea, sweating at exposure site-if dermal exposure)
 - b. Two Mark 1 kits for moderate symptoms such as unable to ambulate, nausea, vomiting, wheezing, dyspnea or large scale fasciculations
 - c. Three Mark 1 kits for severe symptoms such as extremis, loss of consciousness, flaccid paralysis, seizures, cardiac or respiratory arrest
 - b) Maintenance: 1 Mark kit injection every hour for three hours

Note: Tachycardia is not a contraindication to utilization of atropine in these poisonings.

Supportive Care:

- 1) Seizures: Control seizures with benzodiazepines (diazepam or lorazepam). Consider phenobarbital for intractable seizures.
- 2) Airway: Support airway with standard measures. Atropine and bronchodilators for wheezing and bronchospasm.
- 3) Hypotension: Standard supportive measures with IVF boluses and pressors if needed.