Section: ALS Protocols
Subject: ORGANOPHOSPHATES AND MILITARY NERVE AGENTS
Section #: 345.16
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Approved By: Michael Lozano, Jr., M.D., HCFR Medical Director

1. General:
    a. Nerve agents are the most toxic of the known chemical warfare agents.
        i. They are chemically similar to organophosphate pesticides.
        ii. Both exert their biological effects by inhibiting the neurotransmitter acetylcholinesterase.
            1. The result is a buildup of acetylcholinesterase in the nervous system of the body.
            2. This excess of neurotransmitter produces over stimulation and hyperactivity in muscles, glands, and brain tissues.
    b. The three (3) main routes of intoxication are:
        i. Inhalation (lungs).
        ii. Absorption (dermis, eyes, mucous membranes)
        iii. Ingestion (alimentary canal)
    c. Rapidly fatal systemic effects may occur.
    d. Most organophosphates are volatile liquids that produce vapor with relative ease.
    e. Caution:
        i. Persons whose skin or clothing is contaminated with nerve agent or pesticides can contaminate rescuers by direct contact or through the off-gassing of vapor.
        ii. Persons whose skin is exposed only to nerve agent vapor have no direct risk of secondary contamination; however, their clothing can trap vapor and this CAN affect the rescuer.

2. Signs and Symptoms:
    a. The signs and symptoms of organophosphate/nerve agent exposure differ between the central and peripheral nervous systems.
        i. In the peripheral nervous system the net effect depends upon the number of receptor sites (either nicotinic or muscarinic) that are affected.
            1. The muscarinic receptor effects can be summarized by the mnemonics "SLUDGE" or "DUMBELS".
            2. The nicotinic receptor effects can be summarized by the mnemonic "MTWHF".

Peripheral Nervous System Effects of Organophosphates / Nerve Agents		
Muscarinic		Nicotinic
Salivation	Diarrhea	Mydriasis (pupil dilation)
Lacrimation	Urination	Tachycardia
Urination	Miosis (pupil constriction)	Weakness
Defecation	Bradycardia / Bronchorrhea / Bronchspasm	Hypertension / Hyperglycemia
Gastric irritation	Emesis	Fasciculations
Emesis	Lacrimation	
	Salivation / Secretion / Sweating	

ii. The central nervous system effects can be recalled by the mnemonic "C3" (Confusion, Convulsions, and Coma).

b. The initial effects seen in a victim differ depending on whether exposure was to a vapor or to a liquid and what the route of exposure was.
   i. Inhalation (pulmonary): Absorption by inhalation begins within seconds. Rhinorrhea and tightness in the throat or chest begin within seconds to minutes after vapor exposure. Nerve agent vapors are heavier than air. Odor does not provide adequate warning of detection.
   ii. Topical (skin and mucus membranes): Nerve agent liquids are readily absorbed from the skin and eyes.
      1. Vapors are not absorbed through the skin except at very high concentrations.
      2. As little as one drop of VX on the skin can be fatal and 1.0 – 10 mL of GA, GB, or GD can be fatal.
   iii. Ingestion (gastrointestinal): Organophosphates / Nerve Agents are readily absorbed from the GI tract.
      1. Ingestion of nerve agents is expected to be relatively rare compared to inhalation or absorption.

3. Treatment:
   a. Rapidly remove the patient from the contaminated area.
   b. Using soap and water (or water alone if no soap is available) to perform field expedient decontamination in accordance with the HCFR Decontamination Plan.
   c. Standard ALS and BLS should be initiated as per HCFR protocol after the patient has been decontaminated.
   d. Atropine and pralidoxime chloride (2-PAM) are antidotes for nerve agent toxicity; however, pralidoxime must be administered within minutes to a few hours following exposure (depending on the specific agent) to be effective. Treatment consists of supportive measures and repeated administration of antidotes.
   e. If the military autoinjectors are available, they provide the best way to administer the antidotes.
      i. The Mark 1 (NAAK) Kit contains two autoinjectors. One delivers 2.0 mg atropine and the other 600 mg 2-PAM.
      ii. The ATNAA (Antidote Treatment – Nerve Agent, Auto-Injector) Kit consists of a single needle autoinjector. It delivers 2.1 mg of atropine and 600 mg of 2-PAM.
   f. Specific treatment for organophosphate/nerve agent exposure depends upon the symptoms present, the degree of disability, and the route of exposure.
      i. Inhalation exposure:
         1. Mild: Patient is ambulatory, miosis, eye pain, dim or blurred vision, conjunctival injection, rhinorrhea, mild dyspnea.
         2. Moderate: Usually seated or prostrate on the ground, moderate to marked dyspnea, coughing, wheezing, nausea, vomiting, fasciculations, muscle weakness
         3. Severe: The patient is in extremis, manifested by loss of consciousness, seizures, flaccid paralysis, respiratory arrest, or cardiopulmonary arrest.

ii. Topical (dermal) exposure:
    1. Mild: Patient is ambulatory, there is localized sweating at the exposure site, fine muscle fasciculations are seen at the exposure site,
        a. NB: Miosis is not an early sign after dermal exposure.
    2. Moderate: The patient is seated or prostrate, nausea, muscle fasciculations, muscle weakness,
        a. NB: There will be no respiratory signs or symptoms unless there has been concurrent inhalational exposure.
    3. Severe: The patient is in extremis, manifested by loss of consciousness, seizures, flaccid paralysis, respiratory arrest, or cardiopulmonary arrest.

4. QA Points:
    a. By knowing the anatomic location of nicotinic and muscarinic receptors, you will better understand the symptoms produced, and the importance of combination therapy with both atropine and 2-PAM (pralidoxime)*.
    b. Autoinjectors must never be used as a prophylaxis for exposure because in and of themselves, they can be incapacitating.

System	Peripheral Nervous System				Neuroendocrine	Central Nervous System
Location	Autonomic Ganglia		Neuromuscular junction	Parasympathetic junctions (e.g. glands, smooth muscle, etc.)	Adrenal medulla	Brain and spinal cord
	Sympathetic	Parasympathetic				
Receptor	Nicotinic	Nicotinic	Nicotinic	Muscarinic	Nicotinic	Muscarinic and Nicotinic

* Adapted from Univeristy of Arizona Emergency Medicine Research Center, and American Academy of Clinical Toxicology. AHLS: Advanced HAZMAT Life Support. (3rd edition) 2003.

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Treatment Guidelines for Organophosphate / Nerve Agent Exposure†				
Patient Age	Initial Medications, Doses, and Routes of Administration[1]			Additional Therapy
	Mild Symptoms	Moderate Symptoms	Severe Symptoms	
Adults (18-65 yr)	Atropine 2.0 mg IM 2-PAM 600 mg IM[2]	Atropine 4.0 mg IM 2-PAM 1200 mg IM[3]	Atropine 6.0 mg IM 2-PAM 1800 mg IM[4]	Assisted ventilation should be started after antidote administration for severe cases. Repeat **atropine** dose q 5 – 10 min until symptoms have remitted, secretions diminish, or airway resistance decreases.
Adults (> 65 yr)	Atropine 1.0 mg IM 2-PAM 10 mg / kg IM (max dose 600 mg)		Atropine 4.0 mg IM 2-PAM 25 mg/kg IM (max dose 1500 mg)	
Pediatric (11-17 yr)	Atropine 2.0 mg IM 2-PAM 15 mg / kg IM (max dose 900 mg)		Atropine 4.0 mg IM 2-PAM 25 mg/kg IM (max dose 1500 mg)	
Pediatric (2-10 yr)	Atropine 1 mg IM 2-PAM 15 mg/kg IM (max dose 900 mg)		Atropine 2 mg IM 2-PAM 25 mg/kg IM (max dose 1500 mg)	
Pediatric (< 2 yr)	Atropine 0.05 mg/kg IM 2-PAM 15 mg/kg IM (max dose 900 mg)		Atropine 0.1 mg/kg IM 2-PAM 25 mg/kg IM (max dose 1500 mg)	

1. IM is the preferred route when the number of patients exceeds the number of paramedics available.
2. May treat HCFR and other public safety personnel who fall into this category with the contents of one (1) Mark I Antidote kit or one (1).ATNAA kit
3. May treat HCFR and other public safety personnel who fall into this category with the contents of two (2) Mark I Antidote kits or two (2).ATNAA kits
4. May treat HCFR and other public safety personnel who fall into this category with the contents of three (3) Mark I Antidote kits or three (3).ATNAA kits.
5. Monitor closely for the cardiac effects of atropine and the hypertensive effects of 2-PAM.

† Adapted from Managing Hazardous Material Incidents (MHMI). Volumes III. Agency for Toxic Substances and Disease Registry (ATSDR). 2001. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service and Univeristy of Arizona Emergency Medicine Research Center, and American Academy of Clinical Toxicology. AHLS: Advanced HAZMAT Life Support. (3rd edition) 2003.

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Mass CASUALTY TRIAGE GUIDELINES FOR ORGANOPHOSPHATE EXPOSURE‡		
Category (Priority)	Effects	Clinical Signs
Immediate (RED)	Unconscious talking but not walking; severe or moderate to severe effects in two or more body systems (e.g. respiratory, GI, muscular, CNS)	Seizing or post-ictal; respiratory distress or apneic; recent cardiac arrest
Delayed (YELLOW)	Recovering from agent exposure or antidote	Diminished secretions, improved respirations
Minimal (GREEN)	Walking and talking	Miosis, rhinorrhea, mild to moderate dyspnea
Expectant (BLACK)	Unconscious	Cardiopulmonary arrest of long duration

1. Immediate: casualties who require lifesaving care within a short time, when that care is available and is of short duration. This care may be a procedure that can be done within minutes at an emergency treatment station (e.g. relief of an airway obstruction, administering antidotes).

2. Delayed: casualties with severe injuries who are in need of major or prolonged surgery or other care and who will require hospitalization, but delay of this care will not adversely affect the outcome of the injury (e.g. fixation of a stable fracture).

3. Minimal: casualties who have minor injuries, can be helped by non-physician medical personnel, and will not likely require hospitalization

4. Expectant: casualties with severe life threatening injuries who would not survive even with optimal medical care or casualties whose injuries are so severe that their chance of survival does not justify expenditure of limited resources. As circumstances permit, casualties in this category may be reexamined and possibly be re-triaged to a higher category.

‡ Managing Hazardous Material Incidents (MHMI). Volumes III. Agency for Toxic Substances and Disease Registry (ATSDR). 2001. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.