Chapter 96
Approach to Organophosphate Poisoning in the ICU

96.1 Introduction

Organophosphate (OP) poisoning is a global health concern, particularly in rural areas of Asia and Africa, where pesticide use is prevalent. According to the World Health Organization (WHO), an estimated three million cases of pesticide poisoning occur annually, resulting in over 250,000 deaths. In developing countries, intentional self-poisoning is more common, whereas occupational exposure prevails in developed nations.

OP compounds inhibit acetylcholinesterase, leading to an accumulation of acetylcholine and overstimulation of nicotinic and muscarinic receptors. This biochemical mechanism results in a cholinergic crisis characterized by symptoms such as miosis, salivation, bronchorrhea, seizures, and neuromuscular dysfunction. Understanding the pathophysiology, timely diagnosis, and management strategies is critical for improving outcomes in the intensive care unit (ICU) [1–3]. [Ref: Algorithm 96.1].

Epidemiology

- Global Incidence: OP poisoning accounts for a significant proportion of pesticide-related morbidity and mortality worldwide. Rural agricultural communities in Asia and Africa experience the highest prevalence due to the accessibility of pesticides and limited regulations.
- Exposure Types:
- Occupational Exposure: Common in agricultural workers handling pesticides without adequate protective measures.
- Intentional Exposure: Suicide attempts through ingestion are a major issue in developing countries.
- Accidental Exposure: More frequent in children and nonagricultural settings in developed countries.

S. B. Mishra et al., *Mastering ICU Care*,
https://doi.org/10.1007/978-981-95-0179-3_96

Pathophysiology
OP compounds inhibit acetylcholinesterase by phosphorylating the serine hydroxyl group at the active site of the enzyme. This inhibition leads to:

- Accumulation of Acetylcholine: Excess acetylcholine overstimulates nicotinic and muscarinic receptors.
- Muscarinic Effects: Bronchorrhea, bronchospasm, bradycardia, miosis, salivation, lacrimation, urination, diarrhea.
- Nicotinic Effects: Muscle fasciculations, weakness, paralysis, tachycardia, hypertension.
- Enzyme Aging: Over time, the phosphorylated enzyme undergoes "aging," making reactivation by oximes like pralidoxime ineffective. This underscores the importance of timely oxime therapy, ideally within 6 h of exposure.

Diagnostic Tools
- Clinical Scoring Systems:
- Peradeniya Organophosphorus Poisoning (POP) Scale: Assesses severity based on pupil size, respiratory rate, heart rate, fasciculations, level of consciousness, and seizures.
- Laboratory Tests:
- Cholinesterase Assays: Measure plasma (butyrylcholinesterase) and red blood cell (acetylcholinesterase) activity.
- Limitations: Assays may not be readily available or standardized; levels do not always correlate with clinical severity.
- Differential Diagnosis: Rule out other causes of cholinergic symptoms, such as carbamate poisoning or nerve agent exposure.

96.2 Management Nuances

Step 1: Initial Assessment and Resuscitation
1. Suspect OP Poisoning:
   - Obtain history of exposure and identify clinical signs.
   - Early recognition is crucial for initiating life-saving interventions.
2. Airway Management:
   - Ensure airway patency; intubate if necessary due to excessive secretions or decreased consciousness.
   - Be prepared for difficult intubation due to bronchorrhea and laryngospasm.
3. Breathing:
   - Provide high-flow oxygen.
   - Use bronchodilators for bronchospasm.

4. Circulation:

   - Establish IV access.
   - Manage hypotension with isotonic fluids; vasopressors if unresponsive.

Step 2: Decontamination and Staff Safety

1. Personal Protective Equipment (PPE):

   - Healthcare providers should wear gloves, gowns, and masks to prevent secondary contamination.
   - Use decontamination facilities when available.

2. Remove Contaminated Clothing:

   - Cut off clothing to avoid further dermal absorption and reduce secondary exposure.

3. Skin Decontamination

   - Wash skin thoroughly with soap and water.
   - Avoid aggressive scrubbing to prevent skin damage.

4. Gastric Decontamination

   - Gastric Lavage: Consider within 1 hour of ingestion if airway is protected.
   - Activated Charcoal: Administer if the patient is alert or airway is secured.

Step 3: Advanced Therapies

1. Atropine:

   - Dosage: Start with 2–5 mg IV bolus; repeat every 5 min until muscarinic symptoms resolve (clear lung sounds, adequate oxygenation, dry mucous membranes).
   - Maintenance: Continuous infusion based on recurrence of symptoms.
   - Rationale: Competitive antagonist at muscarinic receptors, reversing muscarinic overstimulation.

2. Oxime Therapy (Pralidoxime):

   - Dosage:
   - Loading Dose: 1–2 g IV over 15–30 min.
   - Maintenance: 0.5–1 g/hour infusion.
   - Duration: Continue until clinical recovery, which may take several days.
   - Rationale: Reactivates acetylcholinesterase by removing the phosphate group before “aging” occurs.
   - Effective Agents: Pralidoxime is commonly used; obidoxime and asoxime are alternatives in certain regions.

3. Diazepam/Midazolam:

   - Indications: Seizure control, agitation, neuroprotection.
   - Dosage: Diazepam 5–10 mg IV; repeat as necessary.
   - Rationale: Benzodiazepines enhance GABAergic activity, providing anticonvulsant effects.

4. Magnesium Sulfate:
    - Emerging Evidence: May provide neuroprotection by blocking NMDA receptors and reducing acetylcholine release.
    - Dosage: 1–2 g IV over 15 min; monitor for hypotension and respiratory depression.
5. Butyrylcholinesterase Replacement Therapy:
    - Experimental Therapy: Administering exogenous butyrylcholinesterase to scavenge OP compounds.
    - Organophosphorus Hydrolases: Enzymes under investigation that degrade OP compounds.

Step 4: Monitoring and Management of Complications

1. Vital Signs and Respiratory Function:
    - Continuous monitoring of heart rate, blood pressure, respiratory rate, and oxygen saturation.
    - Frequent arterial blood gas analysis.
2. Neuromuscular Status:
    - Assess for Signs of Intermediate Syndrome (IMS):
    - Occurs 24–96 h post-exposure.
    - Characterized by proximal muscle weakness, cranial nerve palsies, and respiratory failure.
    - Management of IMS:
    - Prolonged ventilatory support.
    - Continued atropine and oxime therapy.
    - Physical therapy to prevent muscle atrophy.
3. Delayed Neuropathy:
    - Organophosphate-Induced Delayed Neuropathy (OPIDN):
    - Occurs 1–3 weeks after exposure.
    - Presents with distal motor-sensory polyneuropathy.
    - Management:
    - Supportive care.
    - Rehabilitation services.
4. Cholinesterase Levels:
    - Monitor plasma and RBC cholinesterase levels to assess treatment efficacy.
    - Recognize that clinical improvement may lag behind laboratory normalization.

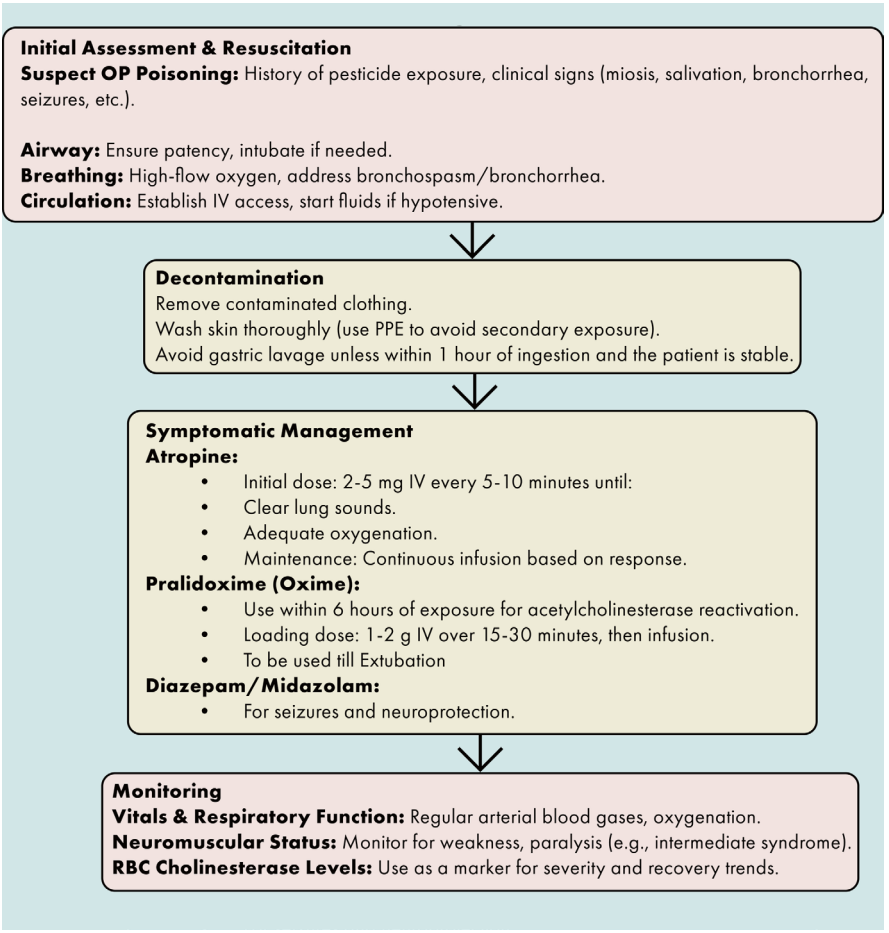
Step 5: Public Health and Interdisciplinary Collaboration

1. Regulatory Measures:
   - Pesticide Regulations: Advocacy for stricter controls and access restrictions can reduce incidence.
   - Public Awareness: Education on safe handling practices in agricultural settings.
2. Interdisciplinary Approach:
   - Collaboration among toxicologists, intensivists, emergency medicine specialists, and mental health professionals.
   - Implement protocols for mass casualty events involving nerve agents, as per national and WHO guidelines.

96.3 Conclusion

Managing organophosphate poisoning in the ICU requires a comprehensive approach that includes prompt recognition, decontamination, targeted pharmacologic therapy, and vigilant monitoring for complications. Advanced therapies like oxime administration and emerging treatments such as magnesium sulfate and butyrylcholinesterase replacement hold promise for improving outcomes. Public health initiatives and interdisciplinary collaboration are essential in reducing the incidence and improving the management of OP poisoning. By adhering to established guidelines and incorporating new evidence-based practices, healthcare providers can enhance patient care and outcomes in this critical area.

Algorithm 96.1: Approach to organophosphate poisoning in the ICU



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