Organophosphorus Compound Poisoning

Forensic Medicine - KUHS MBBS Exam Notes

1. Identification of Probable Poison

The probable poison is Organophosphorus Compound poisoning (OPC poisoning).

The case suggests OPC poisoning because of:

1. Farmer by occupation
2. Vomiting
3. Salivation
4. Sweating
5. Pinpoint pupils / miosis
6. Bradycardia
7. Urinary incontinence
8. Kerosene-like smell in breath due to petroleum solvent used in many insecticide preparations

Therefore, this is a case of acute organophosphorus insecticide poisoning.

2. Common Examples of OPCs

Common OPC insecticides include:

1. Parathion
2. Malathion
3. Diazinon
4. Chlorpyrifos
5. Dichlorvos
6. Fenthion
7. Monocrotophos

3. Mechanism of Action

A. Inhibition of Cholinesterase

OPCs inhibit:

1. Acetylcholinesterase / true cholinesterase
2. Pseudocholinesterase / plasma cholinesterase

They inhibit the enzyme by phosphorylation.

B. Accumulation of Acetylcholine

Due to inhibition of cholinesterase, acetylcholine is not broken down.

This causes accumulation of acetylcholine at:

1. Muscarinic receptors
2. Nicotinic receptors
3. Central nervous system

C. Cholinergic Overstimulation

Excess acetylcholine causes continuous stimulation of:

1. Parasympathetic system
2. Autonomic ganglia

3. Neuromuscular junction
4. Brain

This produces the classical features of cholinergic crisis.

D. Aging

The phosphorylated enzyme complex may become permanently fixed by a process called aging.

After aging, the enzyme cannot be reactivated by oximes.

Therefore, oximes must be given early.

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4. Clinical Features

Clinical features are divided into:

1. Muscarinic effects
2. Nicotinic effects
3. CNS effects
4. Delayed effects

A. Muscarinic Features

These are remembered by SLUDGE / DUMBELS.

SLUDGE

1. S - Salivation, sweating
2. L - Lacrimation
3. U - Urination
4. D - Defecation / diarrhoea
5. G - Gastrointestinal cramps
6. E - Emesis / vomiting

Other Muscarinic Features

1. Miosis / pinpoint pupils
2. Blurred vision
3. Bronchorrhoea
4. Bronchospasm
5. Dyspnoea
6. Pulmonary oedema
7. Bradycardia
8. Hypotension
9. Increased secretions

These muscarinic features are mainly treated by atropine.

B. Nicotinic Features

Nicotinic features occur due to action at neuromuscular junction and autonomic ganglia.

Features include:

1. Muscle fasciculations
2. Muscle cramps
3. Muscle weakness
4. Areflexia
5. Flaccid paralysis

6. Respiratory muscle paralysis
7. Diaphragmatic paralysis

Autonomic ganglionic effects may cause:

1. Tachycardia
2. Hypertension
3. Mydriasis

These nicotinic features are mainly treated by oximes and ventilatory support.

C. CNS Features

CNS features include:

1. Anxiety
2. Restlessness
3. Headache
4. Confusion
5. Tremors
6. Ataxia
7. Slurred speech
8. Delirium
9. Convulsions
10. Coma

Death may occur due to:

1. Respiratory centre depression
2. Respiratory muscle paralysis
3. Bronchorrhoea and bronchospasm

D. Delayed Effects

1. Intermediate Syndrome

Occurs 24-96 hours after acute poisoning.

Features:

1. Neck muscle weakness
2. Proximal limb weakness
3. Cranial nerve palsies
4. Respiratory muscle weakness

It may lead to respiratory failure.

2. Organophosphate-Induced Delayed Neuropathy

Occurs after 1-3 weeks.

Features:

1. Peripheral neuropathy
2. Weakness
3. Paraesthesia
4. Paralysis, especially of lower limbs

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5. Diagnosis

Diagnosis is mainly clinical, supported by laboratory tests.

A. History

Important history includes:

1. Farmer / agricultural worker
2. Exposure to insecticide
3. Ingestion, inhalation or skin exposure
4. Suicidal attempt or accidental exposure
5. Kerosene / petroleum smell

B. Clinical Examination

Classical triad:

1. Pinpoint pupils
2. Excess secretions
3. Bradycardia / respiratory difficulty

Other features:

1. Salivation
2. Sweating
3. Vomiting
4. Urinary incontinence
5. Muscle fasciculations
6. Altered sensorium

C. Cholinesterase Estimation

Important test:

1. RBC cholinesterase / true cholinesterase
2. Plasma cholinesterase / pseudocholinesterase

Findings:

1. Levels are decreased
2. Symptoms usually appear when enzyme inhibition is more than 50%
3. RBC cholinesterase correlates better with severity

Note: For enzyme estimation, collect a separate blood sample properly. Do not confuse it with blood preserved for routine chemical analysis.

D. Urine Test

p-Nitrophenol test may be useful in parathion poisoning.

E. Chemical Analysis

The poison can be detected in:

1. Blood
2. Urine
3. Gastric lavage
4. Vomitus
5. Stomach contents

Methods:

1. Gas-liquid chromatography
2. HPLC
3. GC-MS

6. Treatment of OPC Poisoning

Treatment should be started immediately. Do not wait for laboratory confirmation.

Main principles:

1. Resuscitation
2. Decontamination
3. Atropine
4. Oximes
5. Supportive treatment

A. Resuscitation

1. Maintain ABC

1. Airway
2. Breathing
3. Circulation

2. Airway and Breathing

1. Clear secretions by suction
2. Give oxygen
3. Intubate if needed
4. Give mechanical ventilation if respiratory failure occurs

Respiratory failure is commonly due to:

1. Bronchorrhoea
2. Bronchospasm
3. Respiratory muscle paralysis
4. CNS depression

B. Decontamination

1. Remove Contaminated Clothing

Remove all contaminated clothes.

2. Skin Decontamination

Wash skin thoroughly with:

1. Soap
2. Water

This prevents further absorption through skin.

3. Gastric Lavage

If poison is ingested recently, gastric lavage may be done only after:

1. Airway protection
2. Prevention of aspiration
3. Stabilisation of the patient

Textbook method:

Gastric lavage with 1:5000 potassium permanganate solution may be mentioned, followed by activated charcoal.

Important exam-safe point:

Because many OPC preparations contain kerosene / hydrocarbon solvent, gastric lavage should be done carefully and only when the airway is protected.

4. Activated Charcoal

Give activated charcoal to reduce further absorption, if indicated.

C. Atropine

1. Nature

Atropine is the physiological antidote for OPC poisoning.

2. Mechanism

Atropine blocks muscarinic receptors.

It reverses:

1. Salivation
2. Bronchorrhoea
3. Bronchospasm
4. Bradycardia
5. Hypotension
6. Excess secretions

Atropine does not reverse nicotinic effects like:

1. Muscle weakness
2. Fasciculations
3. Paralysis

3. Dose

Adult dose:

2-4 mg IV or 2-5 mg IV, repeated every 5 minutes until atropinisation.

In severe poisoning, large doses may be required.

4. Signs of Atropinisation

Most reliable endpoint:

Drying of bronchial secretions and clear chest.

Other signs:

1. Dry mouth
2. Pulse rate improves
3. Blood pressure improves
4. Bronchospasm relieved
5. Pupils may dilate
6. Skin becomes dry and warm

Do not depend only on pupil dilatation for atropinisation.

5. Maintenance

After atropinisation, atropine should be continued by:

1. Repeated doses, or
2. Continuous infusion

Dose is adjusted according to bronchial secretions, pulse, BP and respiration.

D. Oximes

1. Examples

1. Pralidoxime / 2-PAM
2. Obidoxime
3. Diacetyl monoxime / DAM

2. Mechanism

Oximes reactivate acetylcholinesterase by removing the phosphate group from the enzyme.

They are useful especially for nicotinic effects, such as:

1. Muscle weakness
2. Fasciculations
3. Respiratory muscle paralysis

They must be given early, before aging occurs.

3. Dose of Pralidoxime

Adult dose:

1-2 g IV slowly in normal saline over 15-30 minutes.

It may be followed by:

1. Repeat doses, or
2. Continuous infusion

4. Important Note

Oximes are useful in OPC poisoning.

In pure carbamate poisoning, oximes are usually not required, but in doubtful insecticide poisoning they may be used if OPC cannot be excluded.

E. Diazepam

Diazepam is given for:

1. Convulsions
2. Agitation
3. CNS manifestations
4. Severe muscle fasciculations

F. Supportive Treatment

1. IV fluids
2. Correction of electrolyte imbalance
3. Treatment of pulmonary oedema
4. Antibiotics, if aspiration pneumonia occurs
5. ICU monitoring
6. Ventilatory support
7. Monitor for intermediate syndrome

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7. Postmortem Findings

Postmortem findings are generally those of asphyxia and poisoning.

A. External Findings

1. Kerosene-like smell from mouth and nostrils

2. Frothy discharge from mouth and nose
3. Cyanosis of lips and nails
4. Constricted pupils may be seen
5. Postmortem staining may be deep
6. Clothes may smell of insecticide / kerosene
7. Evidence of vomiting may be present

B. Internal Findings

1. Stomach and Intestine

1. Stomach contents may have kerosene-like smell
2. Gastric mucosa may be congested
3. Mucosa may be inflamed
4. There may be haemorrhagic erosions
5. Small intestine may be congested

2. Respiratory Tract

1. Larynx, trachea and bronchi may be congested
2. Air passages may contain frothy fluid
3. Lungs may be congested and oedematous

3. Other Organs

1. Brain - congested and oedematous
2. Liver - congested
3. Kidneys - congested
4. Heart - may show congestion
5. Blood may be dark and fluid

4. Cause of Death

Death is usually due to:

1. Respiratory failure
2. Asphyxia
3. Pulmonary oedema
4. Respiratory muscle paralysis
5. Cardiac arrhythmia

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8. Samples to be Preserved

The following samples should be preserved and sent to Forensic Science Laboratory.

Bottle 1

Stomach with contents and about 30 cm of upper small intestine with contents.

Bottle 2

Liver 300-500 g with gallbladder and one half of each kidney.

Bottle 3

Blood 10 mL.

Preservative:

Sodium fluoride + potassium oxalate

Bottle 4

Urine 10-100 mL, if available.

Bottle 5

Vomitus / gastric lavage, if available.

Bottle 6

Clothes, if contaminated with poison.

Bottle 7

Suspected poison container / insecticide bottle, if available.

Bottle 8

Sample of preservative used as control.

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9. Preservatives

For solid viscera:

Saturated solution of common salt is preferred.

For blood:

Sodium fluoride and potassium oxalate.

Important:

Rectified spirit should not be used because OPC preparations may contain petroleum / kerosene-like solvents, and it may interfere with chemical analysis.

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10. Medico-Legal Importance

1. Suicidal Poisoning

OPCs are commonly used for suicidal poisoning, especially in rural agricultural areas, because they are:

1. Cheap
2. Easily available
3. Highly toxic
4. Commonly used as insecticides

2. Accidental Poisoning

Accidental poisoning may occur in:

1. Farmers
2. Sprayers
3. Manufacturers
4. Packers
5. Children accidentally exposed to insecticides

Routes of exposure:

1. Ingestion
2. Inhalation
3. Skin absorption

3. Occupational Poisoning

Seen in agricultural workers due to:

1. Lack of protective clothing
2. Spraying without mask

3. Skin contamination
4. Inhalation of spray mist

4. Homicidal Poisoning

Homicidal poisoning is rare because OPCs often have:

1. Strong smell
2. Bitter taste
3. Rapid onset of symptoms

5. Delayed Complications

Patients should be observed because of risk of:

1. Intermediate syndrome
2. Delayed neuropathy
3. Respiratory failure
4. Aspiration pneumonia

6. Legal Duties

1. Treat as medico-legal case
2. Inform police
3. Preserve stomach contents, viscera, blood and urine
4. Preserve container and clothing
5. Send samples for chemical analysis
6. Record proper history and clinical findings

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11. Opinion in the Given Case

The farmer has features of acute organophosphorus compound poisoning.

The most important supporting findings are:

1. Pinpoint pupils
2. Salivation
3. Sweating
4. Vomiting
5. Bradycardia
6. Urinary incontinence
7. Kerosene-like smell
8. Agricultural exposure

The immediate management is:

ABC + decontamination + atropine + oxime + ventilatory support.

Exam Recall Box

- OPC = cholinesterase inhibitor -> acetylcholine excess.
- Muscarinic: SLUDGE / DUMBELS - salivation, urination, miosis, bronchorrhoea, emesis.
- Nicotinic: fasciculations, weakness, paralysis.
- CNS: confusion, convulsions, coma.
- Diagnosis: low RBC cholinesterase.
- Treatment: ABC + wash + atropine + pralidoxime + diazepam.
- Atropine endpoint: dry bronchial secretions / clear chest.
- Oxime: give early before aging.
- PM smell: kerosene-like insecticide smell.
- Preservative: saturated common salt for viscera, NaF + potassium oxalate for blood.

Final exam line: OPC poisoning is diagnosed clinically and managed immediately with ABC, atropine, oxime and ventilatory support.