

Principles of Management of Acute Poisoning
or
General Principles of Poison Management

Clinical toxicology

- Clinical toxicology is a branch of toxicology that deals with the diagnosis and treatment of human poisoning.
- It deals with the measurement and interpretation of concentrations of drugs and other toxic substances in human biological fluids for the purpose of patient care.

Principles of Management of Acute Poisoning

- Acute poisoning **is exposure to a poison on one occasion or during a short period of time**. Symptoms develop in close relation to the exposure.
- The care given to victims of poisoning is usually determined by the symptomatology produced.
- Generally speaking, aggressive treatment measures are not necessary if the patient is asymptomatic.
- It must be remembered that one of the most important aspects in managing such patients is **“knowing what to do, and in what order to do it”**
- **The aim of acute poisoning management is;**
 - to assess the patient's condition and stabilize it
 - to identify the poison
 - to institute the appropriate treatment

Principles of Management of Acute Poisoning

The management of a patient with acute poisoning consists of;

1. Emergency management
2. Clinical evaluation
3. Decontamination of the patient
4. Antidotes
5. Enhanced elimination of absorbed poison
6. Supportive therapy
7. Observation and disposition
8. After-care

1. Emergency management

- This refers to the **resuscitation and stabilisation**.
- This is achieved by maintenance of an open airway, adequate ventilation and oxygenation and ensuring adequacy of the hemodynamic state.
- For an unconscious patient, careful evaluation of the Airway, Breathing and Circulation (**ABC**) should be followed by active measures to not only secure these, but also to reverse the unconscious state, if possible.
- It would also be pertinent to look for obvious associated trauma.

1a. Airway management

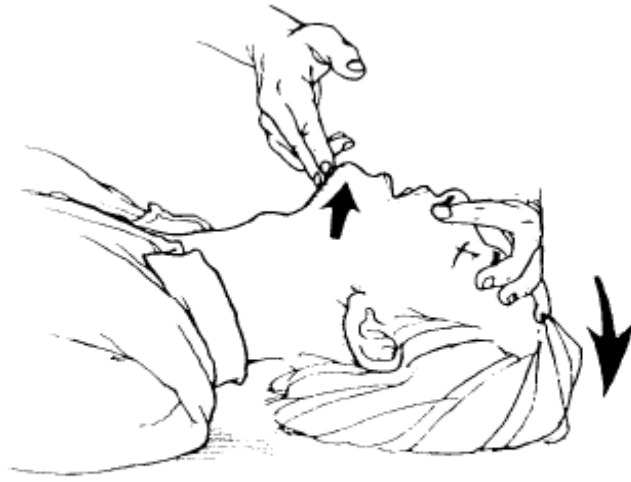
- Majority of preventable deaths following trauma occurs as a result of airway obstruction
- Obstruction may occur at any point within the airway, from **upper airway to the bronchi**.
- Potential causes of obstruction;
 - Tongue
 - Soft tissue swelling
 - Vomiting
 - Blood
 - Secretions

Recognition of airway obstruction

- Look for chest/abdominal movement
- Listen at mouth and nose for breath sounds (auscultation) and abnormal noises
 - Snoring - due to obstruction of upper airway by the tongue
 - Gurgling - due to obstruction of upper airway by liquids (blood, vomit)
 - Wheezing - due to narrowing of the lower airways
 - Complete airway obstruction is silent.
- Feel at mouth and nose for expired air
- **Types of airway management**
 - i. Basic airway management and
 - ii. Advanced airway management (Endotracheal intubation)

Basic airway management

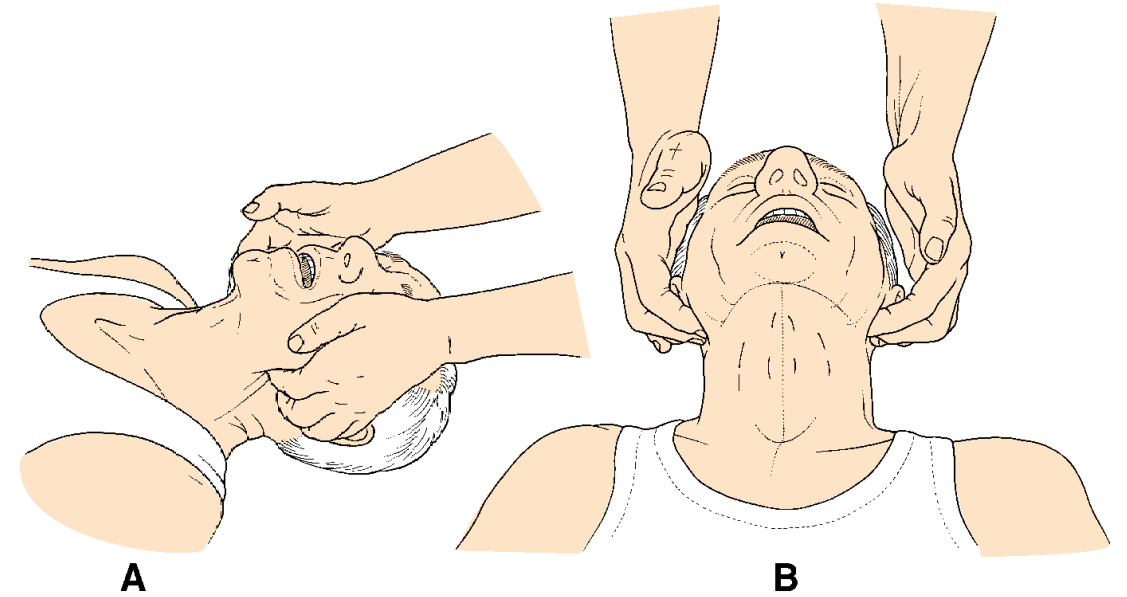
- At a basic level, opening of the airway is achieved through manual movement of the head using various techniques.
 - a) The **head-tilt chin-lift technique** or the **jaw thrust maneuver** would be the initial method of choice.
- However, in the event that neck trauma is suspected, the head tilt should not be employed.
- The **jaw thrust maneuver** is an alternative technique that may be employed in traumatized patients (cervical spine injury).



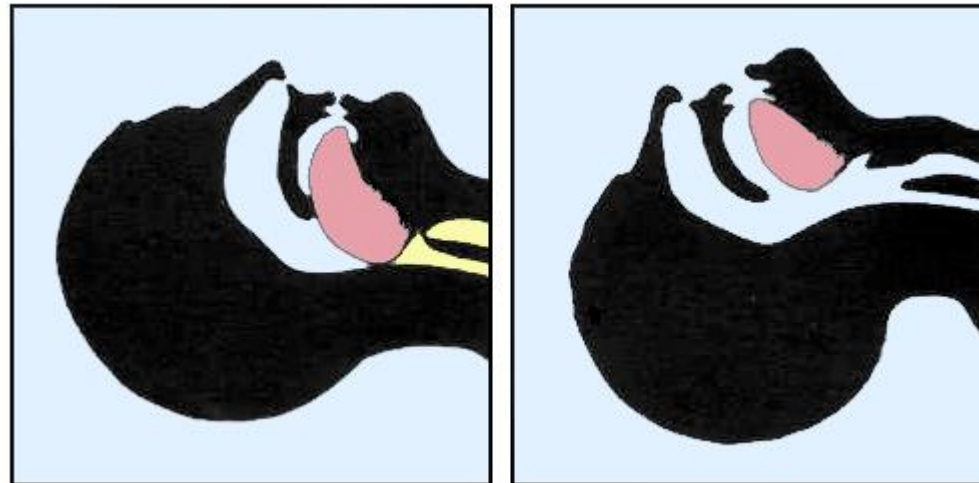
SOURCE: Copyright. American Heart Association. *Instructor's Manual for Basic Life Support*. Dallas: American Heart Association, 1987.

★ *Figure 2-7. Head-tilt/chin-lift.*

The technique opens the airway by moving the tongue away from the back of the throat and the epiglottis away from the opening of the trachea.



Jaw thrust manoeuvre

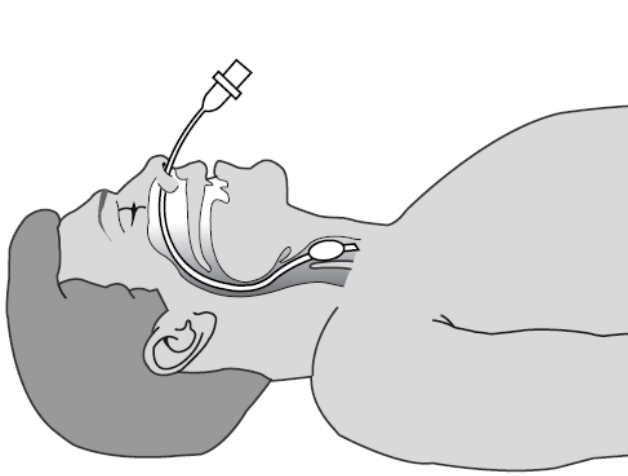


b) The airway can also be maintained with artificial oro-pharyngeal or naso-pharyngeal airway devices.

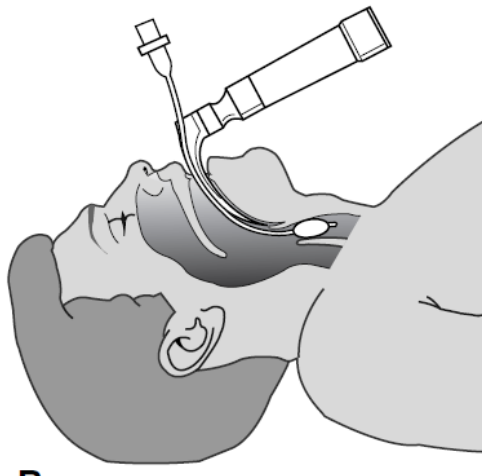
- These are placed in the mouth or nose to lift the tongue and push it forward.
- Prior to this the oral cavity should be inspected and any obvious foreign bodies such as food or broken dentures should be removed.

c) Turning the patient to the recovery (three-quarters prone) position.

- This allows oral secretions and vomitus in the oro-pharynx to drain out of the mouth.

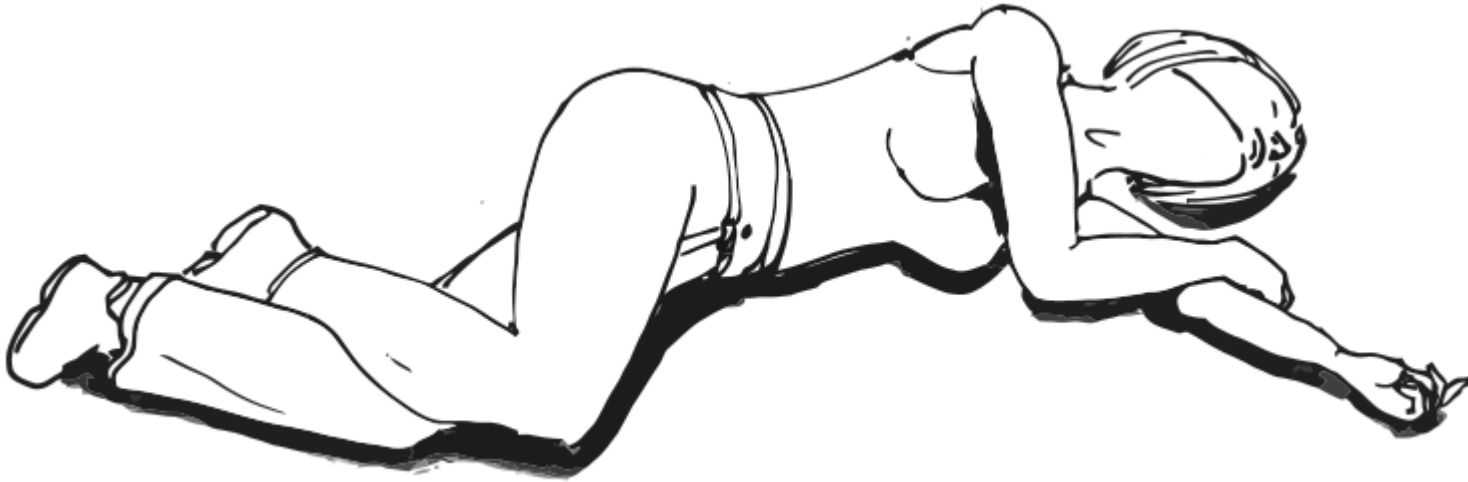


A



B

FIGURE I-3. Two routes for endotracheal intubation. A: Nasotracheal intubation. B: Orotracheal intubation.

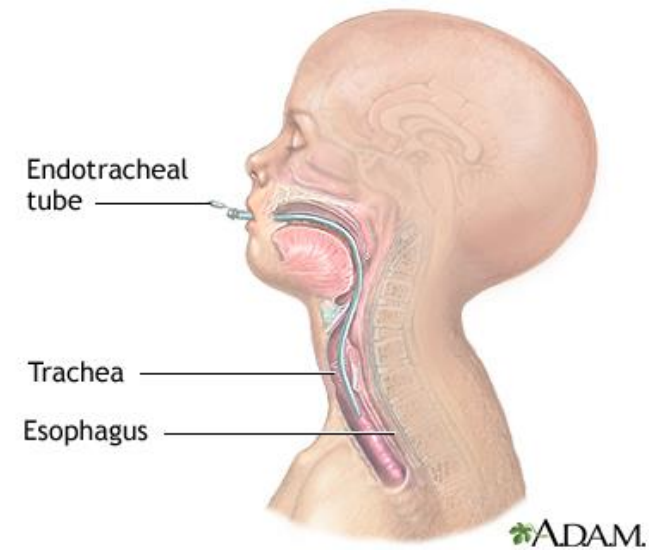


The recovery position: The mouth is downward so that fluid can drain from the patient's airway; the chin is well up to keep the [epiglottis](#) opened. Arms and legs are locked to stabilize the position of the patient

Advanced airway management (Endotracheal intubation)

- In addition to basic airway management, many victims of poisoning requires endotracheal intubation
- Endotracheal intubation is a medical procedure in which a tube is placed into the windpipe (trachea), through the mouth or the nose. In most emergency situations it is placed through the mouth.
- Endotracheal intubation is required;
 - Acute upper airway obstruction (corrosion ingestion/inhalation, envenomation, anaphylaxis)
 - Excess bronchial secretions (pulmonary edema, bronchorrhea)
 - Loss of airway reflex (CNS depressants poisoning)
 - Respiratory failure {Aspiration (Hydrocarbons), Hypoxia (Pulmonary edema)}

- Advantages:
 - Complete airway control
 - Open the airway to give oxygen, medication, or anaesthesia
 - Optimizing both oxygenation and ventilation
 - Protecting the patients from aspiration
 - Providing a route for suctioning of secretions
- Disadvantages:
 - Requires extensive training for proficiency
 - Requires specialized equipment
 - Bypasses physiological function of upper airway (Warm, Filter, Humidify)
 - Possible occurrence of complications; Bleeding, Laryngeal swelling, Laryngospasm, Vocal cord damage, Mucosal necrosis, Barotrauma, Dental trauma, Laryngeal trauma and Esophageal placement, etc

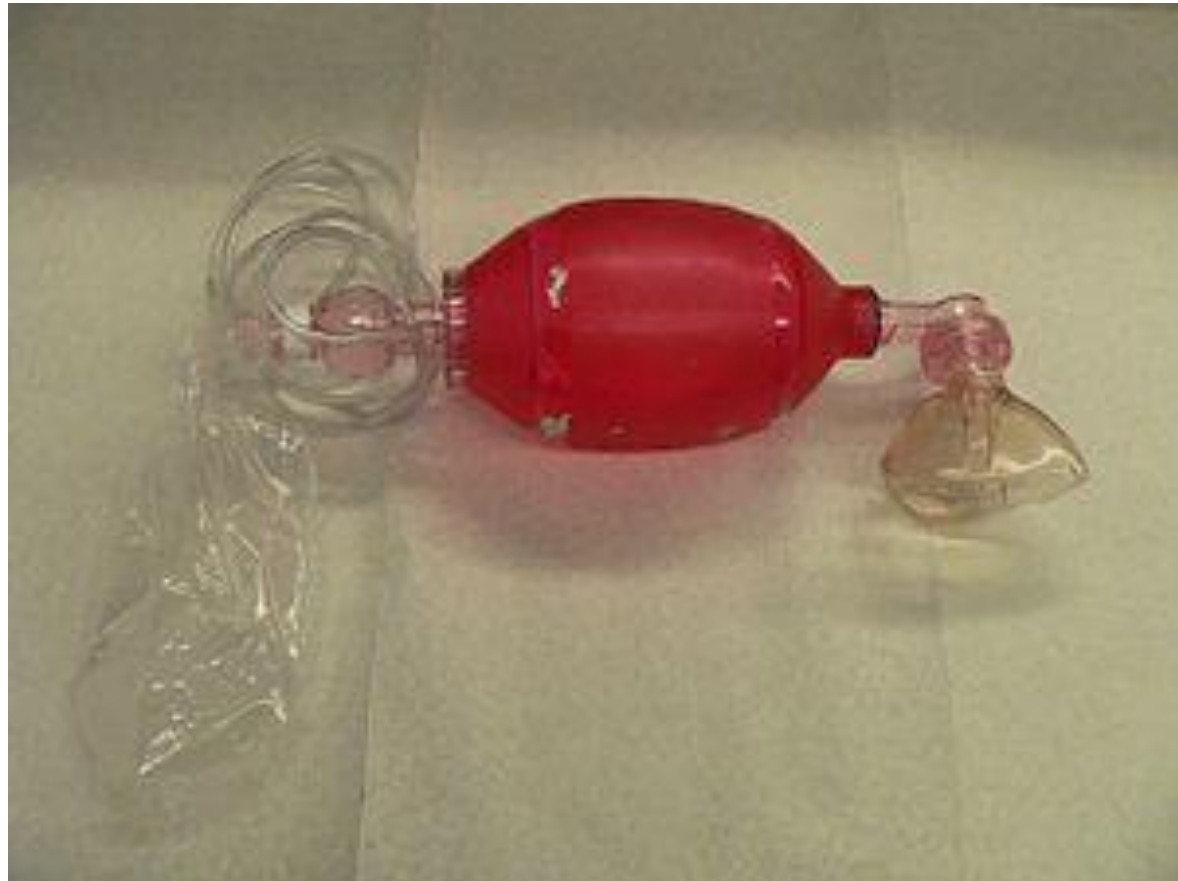


Rapid sequence intubation (RSI)

- The process of intubation in an awake patient is difficult (Coughing, vomiting, tachycardia, hypertension, hypoxia, increased intracranial pressure)
- RSI is a method of rapidly obtaining airway control with minimal physiological disturbance
- It involves a patterned sequence of;
 - **Evaluation** (Presence of foreign bodies, cervical spine stability)
 - **Preparation** (All necessary equipment, i.v. line, size of the endotracheal tube, cardiac monitor and pulse oximetry)
 - **Pre-oxygenation** (4-5 min before, removes N₂ and replaces with O₂, O₂ reservoir allows several minutes of apnea)
 - **Pre-treatment** {Administration of drugs; lidocaine (ICP), atropine (Bradycardia)}
 - **Induction** {Sedatives: Benzodiazepines, Barbiturates; Muscle Relaxants: Succinylcholine, pancuronium bromide}
 - **Intubation** (Insertion of endotracheal tube in to the trachea)
 - **Post intubation management** (Confirmation of the Placement; chest auscultation; Inflation of the cuffed endotracheal tube; anticipation of complications)

1b. Breathing

- Assessment of breathing should include not just whether the patient is breathing , but also if the breathing is slow or fast.
- Slowing of respiration may be a sign of narcotic overdose and assisted ventilation, either via a **bag-valve mask** or **positive pressure ventilation**, may be instituted
- Any patient with abnormal breathing should be provided with 100% oxygen.



Bag valve mask (BVM)/Artificial Manual Breathing Unit (AMBU bag)/Manual resuscitator/self-inflating bag

1c. Circulation

- Poisoned patients often come to emergency dept. with **hypotension** and frank **shock**
- Assessment of circulation should include **heart rate, blood pressure, peripheral circulation** and **hydration status** of the patient.
- Circulatory support is given through **Volume expansion** (Normal saline, Ringer lactate, albumin, whole blood) and **Vasopressor therapy** (Epinephrine, norepinephrine, dopamine and dobutamine)
- To maintain the circulation:-
 - Ideally, the systolic blood pressure (BP) should be kept above 90 mmHg
 - Ephinephrine, norepinephrine, dopamine and dobutamine may be needed to maintain the BP
 - IV fluids (Normal saline, Ringer lactate, albumin, whole blood) may be necessary
 - Central venous pressure (CVP) monitoring may be necessary
 - The patient may require ECG monitoring
 - If in shock, the patient should be maintained in the head -down position

2. Clinical Evaluation

- A clinical evaluation of the patient's condition is achieved by means of the following;
 - Knowing the history,
 - Performing a physical examination and laboratory evaluation
 - An assessment of major toxic signs such as coma, cardiac arrhythmias, metabolic acidosis, gastrointestinal disturbances and seizures.
- Completion of clinical evaluation would allow the patient to be triaged into one of three categories, viz. **mild, moderate or severe.**

2a. History

- The primary aims of taking the history are to:
 - Confirm that poisoning has occurred
 - Identify the substance or substances involved
- If the patient is unconscious or unable to give any form of history, a search of the patient's personal belongings may provide clues (e.g. medicine bottles) to the type of poisoning.

- The following are important to establish when taking the history:
 - Poisoning-related information
 - type of drug or poison ingested
 - dosage and amount
 - time of ingestion
 - Accidental or intentional poisoning
 - presence of suicide intent
 - Current medical history
 - current symptoms
 - treatment received so far
 - Past medical history
 - includes history of past suicide attempts
 - includes history of drug allergy
 - Family history
 - A brief social history

2b. Physical Examination

- In many cases, the physical examination will not reveal significant abnormalities in the initial phase. Physical signs usually manifest later when clinical toxicity develops.
- A full physical examination should be carried out for all patients.
- In addition to a **quick primary survey** in which the conscious state, airway, breathing and circulation are assessed, a **proper secondary survey** is also required.
- Secondary survey consists of a detailed **head to-toe examination**

- In a toxicological patient, particular attention may should be paid to the following:-
 - Consciousness level
 - Odour of breath on the patient
 - Pupil size
 - Rate and depth of respiration
 - Heart rate and blood pressure
 - Dryness of oral mucosa and skin
 - Oral ulcers
 - Evidence of drug abuse e.g. needle marks
 - Evidence of suicidal intent, e.g. cuts on the wrists

- The physical signs can sometimes give a clue to the type of poisoning when the patient himself does not know or is unable to give a history due to impaired consciousness.
- This is because certain symptoms and signs tend to appear in clusters

Gastrointestinal Tract (GIT)

- **Nausea and vomiting**

- This may be seen in overdoses of:
 - Digoxin
 - Opioid analgesics
 - Theophylline derivatives

- **Abdominal pain**

- The possible causes include:
 - Arsenic
 - Corrosive agents
 - Heavy metals
 - Lead
 - Narcotic withdrawal
 - Organophosphates

Pain and ulceration

Pain and ulceration are often caused by **strong acids or alkalis**, which cause tissue destruction

Increased salivation

The possible causes include:

Arsenic
Chlormethiazole
Cholinesterase inhibitors
 e.g. carbamates
 organophosphates
Corrosive fluids
Mercury

Dry mouth

This is often due to anticholinergic drugs.

Other causes include:

- Antihistamines
- Narcotics

Diarrhoea

The possible causes include:

- Arsenic
- Boric acid
- Iron
- Organophosphates

Constipation

The possible causes include:

- Lead
- Narcotics

Respiratory System

Cough and breathlessness

This is often seen in patients who suffer from inhalation of poisonous or irritant gases.

Wheezes and crackles

The most common direct cause of this in a poisoned patient is bronchitis or pneumonitis from:

- Aspiration of chemicals
- Inhalation of irritant gases

Cyanosis

The possible causes include:

- Methaemoglobinaemia
- Respiratory depression due to centrally-acting drugs

It must be remembered that the cause may also be due to the obstruction of the respiratory tract.

Hyperventilation

The possible causes include:

- Carbon monoxide
- Cyanide
- Metabolic acidosis
- Salicylate overdose
- Theophylline

Hypoventilation

The possible causes include:

- Alcohol
- Opioids
- Sedatives / hypnotics

Cardiovascular System (CVS)

Tachycardia

The possible causes include:

- Alcohol
- Amphetamines
- Anticholinergic drugs
- Cocaine
- Salicylates
- Sympathomimetic drugs
- Theophylline
- Tricyclics

Hypotension

In almost any type of severe poisoning, hypotension can occur. As such, this is relatively non-specific as to the type of poisoning.

The more common causes of hypotension include:

- Beta-blockers
- Organophosphates
- Tricyclics

Bradycardia

The possible causes include:

- Beta-blockers
- Cardiac glycosides (e.g. digoxin)
- Cholinesterase inhibitors (e.g. carbamates and organophosphates)
- Opioids
- Sedatives

Arrhythmias

The possible causes include:

- Anticholinergic drugs
- Antimalarial drugs
- Cardiac glycosides
- Chloral hydrate
- Phenothiazines
- Sympathomimetic drugs

Hypertension

This is an uncommon finding in cases of acute poisoning. When it occurs it tends to be associated with an overdose of:

- Monoamine oxidase inhibitors
- Phencyclidine
- Sympathomimetic drugs

Another possible cause is opiate withdrawal.

Central Nervous System (CNS)

Coma or drowsiness

This is very common in poisoning and is usually due to CNS depression. A large number of drugs can cause this, for example:

- Alcohol or other toxic alcohols
- Anticonvulsants
- Antidepressants
- Antihistamines
- Antipsychotics
- Clonidine
- Hypnotics
- Opioid analgesics

However, coma and drowsiness seldom occur in poisoning by:

- Salicylates
- Paracetamol

Ataxia

The possible causes include:

- Alcohol
- Barbiturates
- Bromides
- Hallucinogens
- Heavy metals
- Organic solvents
- Phenytoin

Convulsions or fasciculations

There are a large number of possible causes. These include:

- Alcohol
- Amphetamines
- Anticholinergic drugs
- Antihistamines
- Chlorinated hydrocarbons
- Cyanide
- Isoniazid

Hypotonia and hyporeflexia

The possible causes include:

- Barbiturates
- Benzodiazepines
- Other hypnotics

Hypertonia and hyperreflexia

The possible causes include:

- Anticholinergic drugs
- Monoamine oxidase inhibitors
- Sympathomimetic drugs

Dystonic reactions

Dystonic reactions involving the mouth, eyes and head may be caused by:

- Haloperidol
- Metoclopramide
- Prochlorperazine.
- Trifluoperazine

Delirium and hallucinations

The possible causes include:

- Alcohol
- Anticholinergic drugs
- LSD
- Opioid withdrawal
- Phencyclidine
- Poisonous mushrooms
- Sympathomimetics

Eyes

Loss of Vision

This may be partial or total. The most likely causes are:

- Methanol
- Quinine

Dilated pupils are usually present in poisoning by:

- Amphetamines
- Anticholinergic drugs
- Antihistamines
- Barbiturates
- Cocaine
- Glutethimide
- LSD
- Methanol
- Sympathomimetics
- Tricyclics

Opiate withdrawal can also result in dilated pupils.

Pupils

Small or pinpoint pupils are usually present in poisoning by:

- Cholinesterase inhibitors
- Opioid analgesics
- Phenothiazine

Nystagmus

The possible causes include:

- Barbiturates
- Phenytoin
- Sedatives
- Alcohol

Skin

Reddish skin

The possible causes include:

- Atropine
- Boric acid
- Carbon monoxide
- Cyanide

Moist skin

The possible causes include:

- Organophosphates
- Sympathomimetics

Dry skin

This may be caused by anticholinergic drugs

Needle tracks

These are often present in drug addicts e.g. heroin users.

Clinical Toxidromes

- A toxidrome is a syndrome caused by a dangerous level of toxins in the body
- Certain drugs or classes of drugs are known to cause a cluster of signs and symptoms which may sometimes be fairly typical for that drug or class of drugs.

Cholinergics

- Agitation
- Coma
- Confusion
- Muscle fasciculations
- Seizures
- Weakness
- GIT signs and symptoms
- Defaecation
- Emesis
- Gastric cramping
- Salivation
- Lacrimation
- Odour of garlic
- Profuse sweating
- Urination

Anticholinergics

- Hyperpyrexia
- Cutaneous vasodilatation
- Decreased salivation
- Cycloplegia and mydriasis
- Delirium and hallucinations
- In addition, the patients may have the following problems:
- Decreased GI motility
- Tachycardia
- Urinary retention

Caustic substance ingestion

This tends to be characterised by:

- Dysphagia
- Acute abdominal pain
- Chest pain
- Respiratory distress

Opioids

Poisoning by opioids tends to be characterised by:

- Coma
- Pinpoint pupils
- Respiratory depression

Organophosphates

Poisoning by organophosphates tends to be characterised by:

- | • Muscarinic effects | Nicotinic effects | CNS effects |
|-----------------------------|--------------------------|--------------------|
| - abdominal cramps | - breathlessness | - anxiety |
| - bradycardia | - fasciculation | - ataxia |
| - bronchoconstriction | - muscle fatigue | - coma |
| - bronchorrhoea | - pallor | - confusion |
| - defecation | - paralysis | - convulsions |
| - heart block | - tachycardia | - headache |
| - lacrimation | - tremor | - slurred speech |
| - nausea and vomiting | - twitching | |
| - salivation | - weakness | |
| - sweating | | |
| - urination | | |

2c. Laboratory investigation

- A number of investigations that can be carried out in cases of poisoning for the purpose of identification and to assess the toxic effects of the poison.
- **Identification of agent**
- One or more of the following samples may be sent for toxicology:
 - Blood
 - Urine
 - Gastric aspirate
- Serum digoxin level
- Serum paracetamol level
- Serum phenytoin level
- Serum salicylate level
- Serum theophylline level

- **Effects of agent**

- A number of different investigations may be necessary for evaluating the effects of a poison. Some examples of these are:
 - Full blood count (FBC)
 - Urea and electrolytes (U/E)
 - Liver function test (LFT) e.g. hepatotoxic drugs
 - Prothrombin time / partial thromboplastin time (PT / PTT) e.g. hepatotoxic drugs
 - Arterial blood gas (ABG) e.g. sedative poisoning, salicylates, toxic alcohols
 - Electrocardiogram (ECG)
 - Chest X-ray (CXR) e.g. inhalation of poisonous gas, paraquat poisoning
 - Serum cholinesterase levels e.g. anticholinesterases
 - Electroencephalography (EEG) e.g. some centrally-acting drugs
 - Serum osmolality for toxic alcohols
- These tests should not be done as a matter of routine but should be done only if there is a specific indication for them

3. Decontamination After Poisoning

- The method of decontamination after an episode of poisoning depends on the route of administration of the poison - **gastrointestinal, topical or respiratory**.
- Many methods of decontamination are available.
- The method used would depend on the route of poisoning and known responses of the toxic agent to the effect of the decontaminants.
- Whatever procedure used should be carried out aggressively so as to limit the toxic effects of the poison.

3a. Gastrointestinal Decontamination

- This is used for poisons which have been ingested.
- Decontamination can be achieved by one or more of the following methods:
 - i. Dilution
 - ii. **Emesis**
 - iii. **Gastric lavage**
 - iv. **Catharsis**
 - v. Intestinal lavage
 - vi. **Whole bowel irrigation**
 - vii. Gastrostomy
 - viii. **Oral adsorbents**

i. Dilution

- Water is the best diluent.
- Generally, 100 - 200 ml is administered to children and 200 - 400 ml to adults.
- Dilution with water is useful as:
 - Water helps to reduce the gastric irritation induced by the poison
 - The added bulk allows ipecac-induced emesis to be more effective
- Household products **e.g. cleaning agents**, can be well managed with dilution.

- **Precautions:**

- Excessive fluid may distend the stomach wall. This may cause premature emptying of the stomach contents into the duodenum making it more difficult to remove the poison as well as enhancing the absorption of the poison.

- **Contraindications**

- When the poison ingested is in the solid form e.g. capsules, tablets; this is because dilution will tend to promote dissolution and absorption of the poison
- Unconscious patients
- Patients without a gag reflex

- **Milk**
- Milk can also be used as a diluent.
- It is most often used for ingestion of **caustic or irritant substances**.
- However, it should not be used for phosphorus (Cow's **milk** contains about 1 mg of **phosphorus** per mL).
- Milk may also delay the onset of **Ipecac** emesis and reduce the efficacy of activated **charcoal**.

ii. Emesis

- For many years, emesis has been widely used for treating patients suffering from poisoning
- It is generally more useful if there is sufficient bulk, particularly fluids, in the stomach.
- As such, dilution with water prior to inducing emesis can increase the efficacy of this technique.

Indications

- A potentially toxic dose was ingested
- It is likely that much of the substance is still in the stomach
- Large undissolved tablets or capsules are present (reason: these are generally too large for removal by gastric lavage)
- The ingested substances are not well adsorbed by activated charcoal e.g. enteric-coated or sustained release tablets

Contraindications

- Convulsions
- Corrosive substances
- Impaired consciousness / no gag reflex
- Petroleum distillates
- Severe cardiovascular disease
- Emphysema
- Under 6 months of age
- A poison that causes:
 - a rapid decrease in level of consciousness
 - seizures
 - cardiovascular collapse
 - neuromuscular paralysis

Methods of Inducing Emesis

- Emesis can be induced by a number of different methods. Many are outdated and/or unsafe (copper sulphate, salt water, soap water and mustard water).
- Two currently in use are:
 - **Pharyngeal stimulation**- this is used mainly as a first aid measure and is of limited effectiveness
 - **Ipecacuanha (Ipecac) syrup**- this is the method of choice - it causes emesis through stimulation of chemoreceptors in the CNS

Procedure - Inducing Emesis with Ipecac syrup

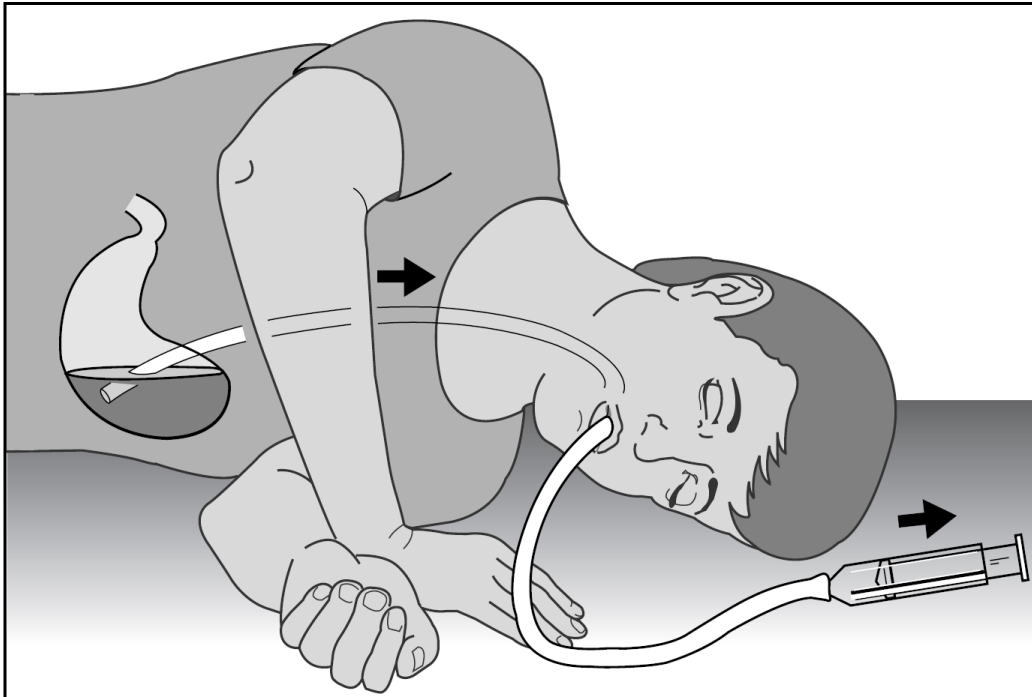
- The recommended doses are:
 - 6 months to 1 year - 10 ml
 - 1 year to 12 years - 15 ml
 - Above 12 years - 30 ml
- If emesis does not occur, gastric lavage should be considered.

Side Effects of Ipecac

- Although Ipecac is generally safe and well tolerated, some patients do suffer from adverse effects. These include:
 - Protracted vomiting
 - Diarrhoea
 - Excessive sweating
 - Fever
 - Lethargy
 - Vomiting may promote passage of toxic material into the small intestine, enhancing absorption.

iii. Gastric lavage

- This is most effective in cases when ingestion of the poison was less than 1 hour before commencing treatment, although a larger time frame is allowed for slow-release formulations or drugs which slow gastric emptying



Indications

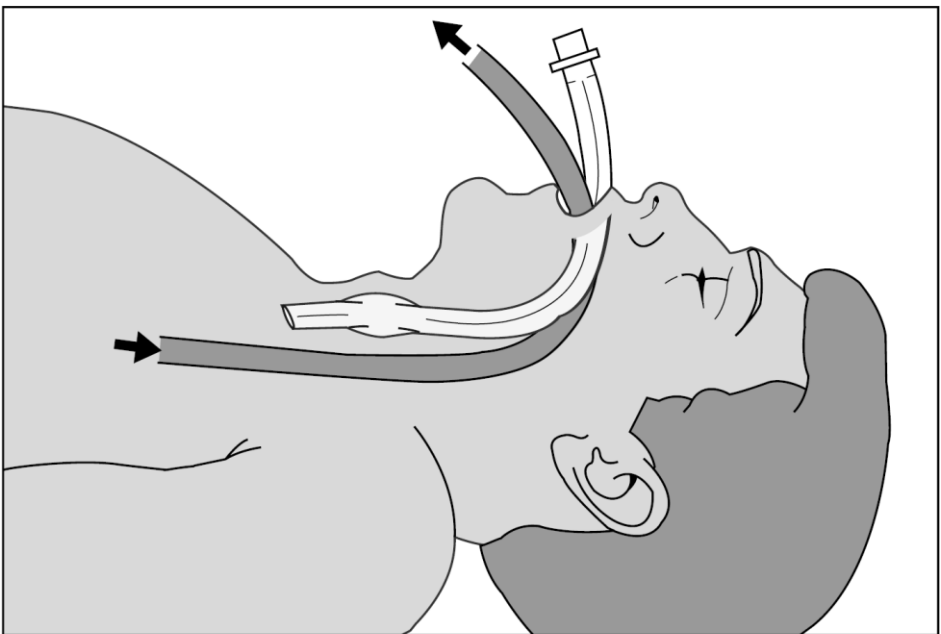
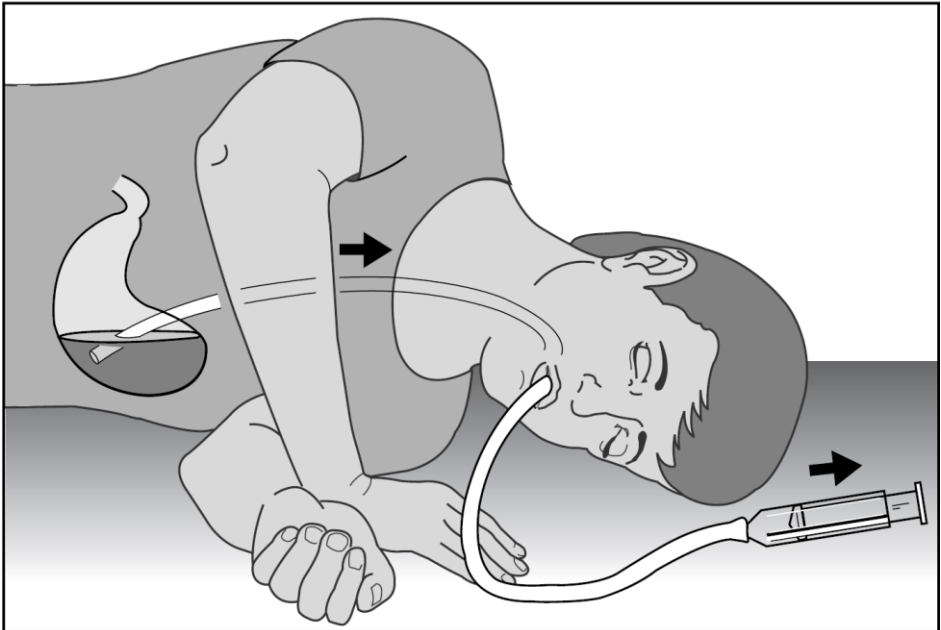
- A potentially toxic dose was ingested
- The substance was ingested less than 60 minutes (a longer time is allowable for anticholinergic agents, salicylates, tricyclic antidepressants)
- To administer activated charcoal and whole-bowel irrigation to patients unwilling or unable to swallow them
- To dilute and remove corrosive liquids from the stomach (Note: this is not a universally accepted indication) and
- To empty the stomach in preparation for endoscopy

Contraindications

- Convulsions
 - Petroleum distillates
 - Strong acid or alkali (this contraindication is not universally accepted)
 - Unconscious patients unless airway is protected
-
- Gastric lavage may potentially increase absorption of toxins by quickening the gastric emptying time and increasing absorption from the small intestines.

Procedure

- I. In patients with impaired consciousness, it will be necessary to protect the airway with a cuffed endotracheal tube.
- II. Place the patient in the **left lateral position** to permit pooling of gastric contents and to reduce the risk of aspiration. His head should be lower than the rest of his body to reduce the chances of accidental aspiration.
- III. Insert a largest diameter orogastric lavage tube (A size 32 to 36 French Ewald tube is ideal) through the mouth or nose and into the stomach



- IV. Once inserted, check the position of the tube to ensure that it is in the stomach and not the trachea. The position must be confirmed prior to commencing lavage. This can be done by the following manoeuvres:
 - a) placing the outer end in a glass of water. Active bubbling on expiration suggests that the tube is in the trachea. In such a case, the tube should be removed and another attempt made to insert it.
 - b) testing aspirate with litmus paper to detect acid
 - c) listening for gurgle sound over epigastrium on pumping air
- V. Administer 100 - 300 ml of lavage fluid via the tube (in children, administer 50 - 100 ml). Then, manually agitate the stomach. After that, withdraw the fluid.
- VI. Repeat this until the lavage return is clear. Generally, anywhere from 5 to 20 L are required to thoroughly cleanse the stomach.
- VII. Remember to save the aspirate for toxicology screening.
- VIII. After completion of the lavage, activated charcoal may be administered via the orogastric lavage tube.

Potential Complications

- Complications that could arise from gastric lavage are:
 - Aspiration pneumonia
 - Bleeding
 - Cardiac arrest
 - Gagging and vomiting
 - Perforation
 - Psychological trauma
 - Vasovagal effects
 - Laryngospasm
 - Fluid and electrolyte disturbances

iv. Catharsis

- This can be used to remove unabsorbed poisons or poisons that have entered the intestines. They can also be used to quicken the passage of the **charcoal-toxin complex**.
- However, there is some controversy about the efficacy of these methods of elimination. Although cathartics have been used in poisons management, there is no proven record of their efficacy in clinical practice.
- In theory, the advantage of using catharsis as the sole method of gastro-intestinal decontamination is that **the increased gastro-intestinal transit speed will decrease the time available for absorption of the poison**.
- However, recently, cathartics have been used to neutralise the constipating effect of activated charcoal. This allows more of the charcoal to be administered and come into contact with the poison

Procedure for Catharsis

- I. Give the patient 250 mg/kg body weight of **magnesium sulphate**.
(Note: the maximum is 25 g) Alternatives are **magnesium citrate, magnesium sulphate, sodium sulphate and sorbitol**.
- II. The cathartic effect should follow within 30 - 60 minutes.
- III. Keep a close watch on the fluid and electrolyte balance.

Contraindications to Catharsis

- Abdominal trauma
- Corrosives
- Electrolyte imbalances
- Ileus or intestinal obstruction
- Impaired renal function
- Pre-existing diarrhoea
- Volume-depleted state

v. Intestinal Lavage

- Like catharsis, the main use of this procedure is in the removal of the poison from the intestine.
- This is carried out by instilling 100 - 250 ml portions of **mannitol** into the small intestine by means of an intestinal suction tube.
- The mannitol is then removed by gentle continuous suction.

vi. Whole Bowel Irrigation

- This procedure is similar to colonic washout in bowel preparation.
- It involves inducing diarrhoea by mechanically flushing the bowel contents through the GIT.
- This is achieved by using large volumes of isotonic non-absorbable solutions.
- No significant fluid shifts are expected to occur with this technique.
- It is especially useful in overdoses with **enteric coated tablets** and **sustained release formulations**.

- Whole bowel irrigation is carried out by giving the patient **2 L of polyethylene glycol**
- Administer bowel preparation solution 2 L/h by gastric tube (children: 500 mL/h or 35 mL/kg/h), until rectal effluent is clear.
- Stop administration after 8–10 L (children: 150–200 mL/kg) if no rectal effluent has appeared.

Indications

- Large ingestions of **iron, lithium**, or other drugs poorly adsorbed to activated charcoal.
- Large ingestions of **sustained-release** or **enteric-coated** tablets containing valproic acid, theophylline, aspirin, verapamil, or other dangerous drugs.
- Ingestion of foreign bodies or drug-filled packets

Contraindications

- Ileus or intestinal obstruction.
- Obtunded, comatose, or convulsing patient unless the airway is protected.

vii. Gastroscopic Removal

- It is used for removal of large quantities of capsules or tablets that are ingested and a mass of drug (drug concretions or bezoars) is formed in the stomach, such that it cannot be removed by gastric lavage or emesis.
- An endoscope that is inserted through the mouth is used for this purpose

viii. Oral Adsorbents

- These are used to decrease the absorption of the poison into the system.
- One of the more commonly used oral adsorbents is **activated charcoal**.
- Activated charcoal is made from a distillation of wood pulp and has a high adsorbent powder.
- Owing to its very large surface area, it is highly effective in adsorbing most toxins.
- Numerous studies suggest that activated charcoal given alone without prior gastric emptying is as effective as or even more effective than **emesis and lavage procedures**

Indications

- Used after virtually any toxic ingestion to limit drug absorption from the gastrointestinal tract.
- When both emesis and lavage are contraindicated
- After completion of emesis or lavage
- **Repeated oral doses of activated charcoal may enhance elimination of some drugs from the bloodstream (In multiple doses as part of GIT dialysis)**

Contraindication

- Ileus or intestinal obstruction without distension is not a contraindication for a single dose of charcoal, but further doses should be withheld.
- Corrosive agent ingestion (charcoal obscures the view during endoscopy)

- Generally, oral adsorbents are most effective when administered within 1 hour of poisoning.
- However, in cases of poisoning by a sustained-release formulation or by drugs which decrease gastrointestinal motility and gastric emptying, oral adsorbents can still be fairly effective even if administered a little later.

Activated charcoal has been shown to be effective in adsorbing the following drugs:

- Acetaminophen
- Tricyclic antidepressants
- Antipyridines
- Arsenic
- Aspirin
- Atropine
- Chlorpheniramine and related antihistamines
- Chlorpromazine and related phenothiazines
- Dextro-amphetamine
- Digoxin
- Glutethimide
- Isoniazid
- Meprobamate
- Salicylates
- Morphine
- Paraquat
- Phenobarbitone and other barbiturates
- Penicillin
- Phenylpropranolamine
- Phenytoin
- Propoxyphene
- Quinidine
- Quinine

Activated charcoal has not been shown to be effective in adsorbing the following

- Acids and caustic alkalis
- Aromatic alcohols
- Boric acid
- Ethylene glycol
- Heavy metals
- Iron
- Lithium
- Malathion
- Methylcarbamate
- Methanol

Administration of Charcoal

- The dosage for adults is as follows:
 - First dose: 50 - 100 g (orally or via a nasogastric tube)
 - Subsequent doses: 15 - 20 g at 4 - 8 hourly intervals for up to 24 hours
- The dosage for children is as follows:
 - First dose: 1 g / kg body weight (orally or via a nasogastric tube)
 - Subsequent doses: 0.5 g / kg body weight at 4 - 8 hourly intervals for up to 24 hours
- Precautions:
 - Activated charcoal should not be given together with Ipecac syrup as the active compounds in Ipecac syrup will be bound by the activated charcoal.
 - Some antidotes (e.g. methionine) are strongly bound to adsorbents like charcoal and as such, they should not be given together.

Adverse Effects

- Activated charcoal is known to result in **constipation** and repeated doses may result in **ileus** and **vomiting**.
- **Distension** of the stomach with a potential risk of pulmonary aspiration
- Many commercially available charcoal products contain charcoal and the cathartic sorbitol in a premixed suspension.
- Even single doses of sorbitol often cause stomach **cramps and vomiting**, and repeated doses may cause serious **fluid shifts** to the intestine, diarrhea, dehydration, and hypernatremia, especially in young children and elderly persons

3a. Gastrointestinal Decontamination

- i. Dilution
- ii. Emesis**
- iii. Gastric lavage**
- iv. Catharsis**
- v. Intestinal lavage
- vi. Whole bowel irrigation**
- vii. Gastrostomy
- viii. Oral adsorbents**

3b. Topical Decontamination

- Consists of decontamination of skin and eyes
- Dermal decontamination
 - Skin is the largest and most superficial organ
 - An intact skin provides many barriers to the absorption of toxins
 - However, when skin is damaged significant absorption through skin can occur

Dermal decontamination: Procedure

1. Remove victim away from the risk area
2. Remove any clothing and other materials (e.g. jewellery, contact lenses) that may be contaminated
3. Precaution: This should be done with care and the decontamination team should avoid being contaminated themselves.
4. Team members should be wearing protective equipment - the minimum precautions include disposable hospital gowns, plastic goggles, latex gloves and a surgical mask.

5. Gently dust off powdery materials with a brush. Add water to some of the dusted off material to test for any reaction prior to wetting the patient.
6. Irrigate the affected areas thoroughly with lukewarm water or saline for at least 15 minutes (Note: In the case of caustic alkalis, irrigation should be for at least 30 minutes).
7. Mild soap solutions may be used to neutralise acid if necessary. They can also be used for oily or greasy contaminants. This is then followed by flushing with water.
8. Scrub the nails with a scrub brush or plastic nail cleaner

9. Generally, neutralising agents should not be used as there is a risk of further injury from the heat generated by the chemical reaction.

10. However, there are several exceptions

Contaminant	Treatment
hydrofluoric acid	magnesium sulphate or calcium gluconate
oxalic acid	calcium gluconate
phenol	mineral oil or other types of oil
white phosphorus	copper sulphate 1% (imparts blue colour to phosphorus granules, making them easier to remove)

Ocular decontamination

- Ocular toxins can produce both local (blindness) and systemic toxicity
- The structures most vulnerable to injury are conjunctivae and cornea
- Cornea is especially sensitive to corrosive agents and hydrocarbon solvents
- All **solvents** (Hydrocarbons, alcohols and detergents) are capable of dissolving lipids in the corneal epithelium, leading to pain and injury.
- However, it is mild and reversible

- Corrosive agents (acids and alkali) can produce tissue destruction that results in blindness
- Acids generally cause superficial damage
- Acids (coagulation necrosis) do not penetrate conjunctiva because hydrogen ions precipitate surface ocular proteins and impeding further acid spread
- Alkali (Liquefaction necrosis) can penetrate all layers of conjunctiva and corneal epithelium (Saponification of lipids) and therefore they cause severe injury

Ocular decontamination: procedure

1. Act quickly to prevent serious damage
2. Place the patient in a reclining chair or in supine position. Remove contact lenses, if present
3. Irrigate the eyes for at least 15 minutes with sterile normal saline or sterile water and taking care not to cross contaminate in uniocular injuries.
4. If available, install local anaesthetic drops

5. If the substance is an acid or alkali, check the pH of the tears after irrigation. If the pH remains abnormal, continue irrigation.
6. Instill a few drops of 1% sterile **fluorescein solution** into the eye. If the fluorescein produces a yellow or green stain, which is indicative of corneal injury, irrigate the eyes for another 5 minutes.
7. Chemical neutralisation should not be attempted as there is a definite risk of further damage from the chemical reaction.
8. The patient should then be sent to an ophthalmologist, preferably within 2 hours of the injury.

3c. Respiratory Decontamination

- Agents that may cause injury to pulmonary tract are **irritating gases**
- This consists of the following:
 1. Remove victim away from the risk area
 2. Precaution: This should be done with care and the decontamination team should avoid being contaminated themselves.
 3. Team members should be wearing protective equipment - the minimum precautions include disposable hospital gowns, plastic goggles, latex gloves and a surgical mask.
 4. Auscultation of lungs to assess the degree of damage
 5. Establishing an airway
 6. Giving of humidified oxygen
 7. Intubation and assisted ventilation, if required
 8. Administration of specific antidote, if available

4. Antidotes

- A therapeutic substance which enhances the LD50 of a toxin
- A therapeutic substance used to counter the toxic action of a specified xenobiotic
- Though specific antidotes are relatively uncommon, administering these should be done as early as possible not only to **reverse pharmacological effects** of the poison, but also to **displace poisons** from target organ receptor sites or to by **binding irreversibly** to the molecule.

An ideal antidote..

- Efficacious
- Non-toxic
- Readily available and should have long shelf life
- Cheap
- Simple to administer

Classification of antidotes based on their mechanisms of action

1. **Limiting absorption:** Activated charcoal
2. **Promote distribution from tissues:** NaHCO_3 (Salicylates)
3. **Inhibit metabolic activation:** Ethanol or fomepizole (methanol, ethylene glycol)
4. **Maintain/enhance detoxification:** NAC or methionine (Paracetamol)
5. **Displace poison/reactivate receptors/by-pass toxicity:** Naloxone (opioids), Pralidoxime (Organophosphorous poisoning) Glucagon (Propranolol)
6. **Sequester poison:** EDTA (Pb), Deferoxamine (Fe)
7. **Symptomatic treatment:** Methylthionium chloride (methaemoglobinaemia)

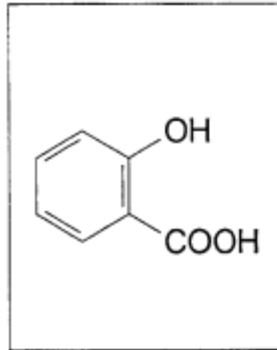
Limiting absorption: Activated charcoal

- Acetaminophen
- Tricyclic antidepressants
- Antipyridines
- Arsenic
- Aspirin
- Atropine
- Chlorpheniramine and related antihistamines
- Chlorpromazine and related phenothiazines
- Dextro-amphetamine
- Digoxin
- Glutethimide
- Isoniazid
- Meprobamate
- Salicylates
- Morphine
- Paraquat
- Phenobarbitone and other barbiturates
- Penicillin
- Phenylpropanolamine
- Phenytoin
- Propoxyphene
- Quinidine
- Quinine

Promote distribution from tissues

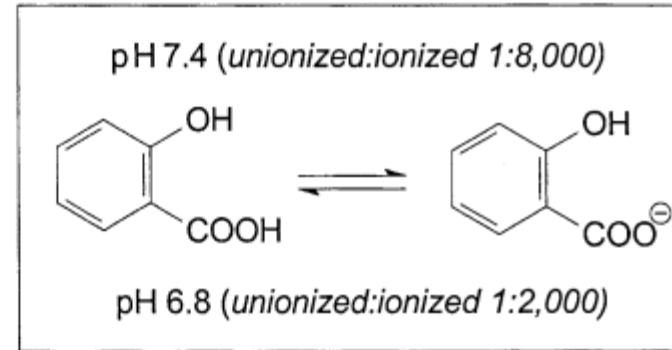
- **Calcium gluconate** gel (2.5 % w/w) is used topically to treat **hydrofluoric acid** burns.
- Insoluble **calcium fluoride** is formed, thus preventing further skin penetration of the poison.
- Intra-arterial or i.v. infusion of calcium gluconate [10 mL 10 % (w/v) calcium gluconate diluted with 40 mL 5 % (w/v) D-glucose] has also been suggested to treat hydrofluoric acid burns on the arms or legs
- **Sodium bicarbonate** given i.v. is valuable in treating severe poisoning with acidic drugs such as salicylates and chlorophenoxy herbicides, chlorpropamide, barbitone and phenobarbitone
- Here sodium bicarbonate administration acts not only by correcting acidosis, but also by promoting diffusion of the poison from tissues into plasma and hence promoting metabolism or excretion in urine or in bile

Brain/other tissues

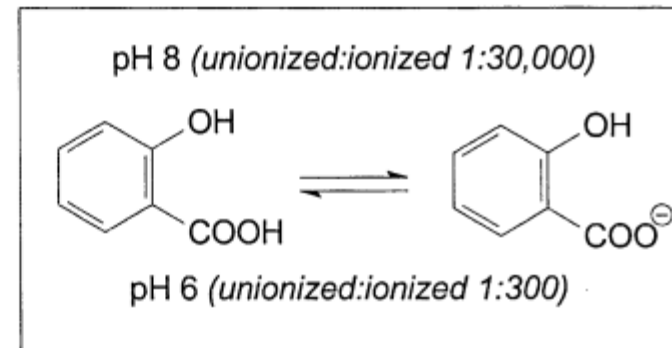


higher
blood
pH
⇌
lower
blood
pH

Blood



lower
urine
pH
↑
↓
higher
urine
pH

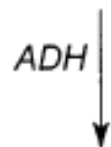


Urine

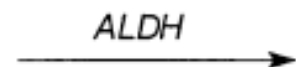
Inhibit metabolic activation

- Serious toxicity due to ethylene glycol (1,2-ethanediol) is the result of hepatic metabolism to glycolate and then to oxalate
- Similarly the toxicity due to methanol is the result of hepatic metabolism to formaldehyde and then to formate respectively
- The initial steps are catalysed by alcohol and it is possible to minimize production of these toxic metabolites by giving the ADH inhibitors **ethanol** or **fomepizole** (4-methylpyrazole)

$\text{HOCH}_2\text{CH}_2\text{OH}$
Ethylene glycol



HOCH_2CHO
Glycolaldehyde



HOCH_2COOH
Glycolic acid



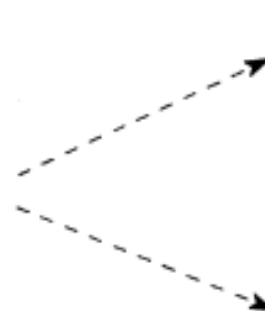
OHCCHO
Glyoxal



OHCCOOH
Glyoxylic acid

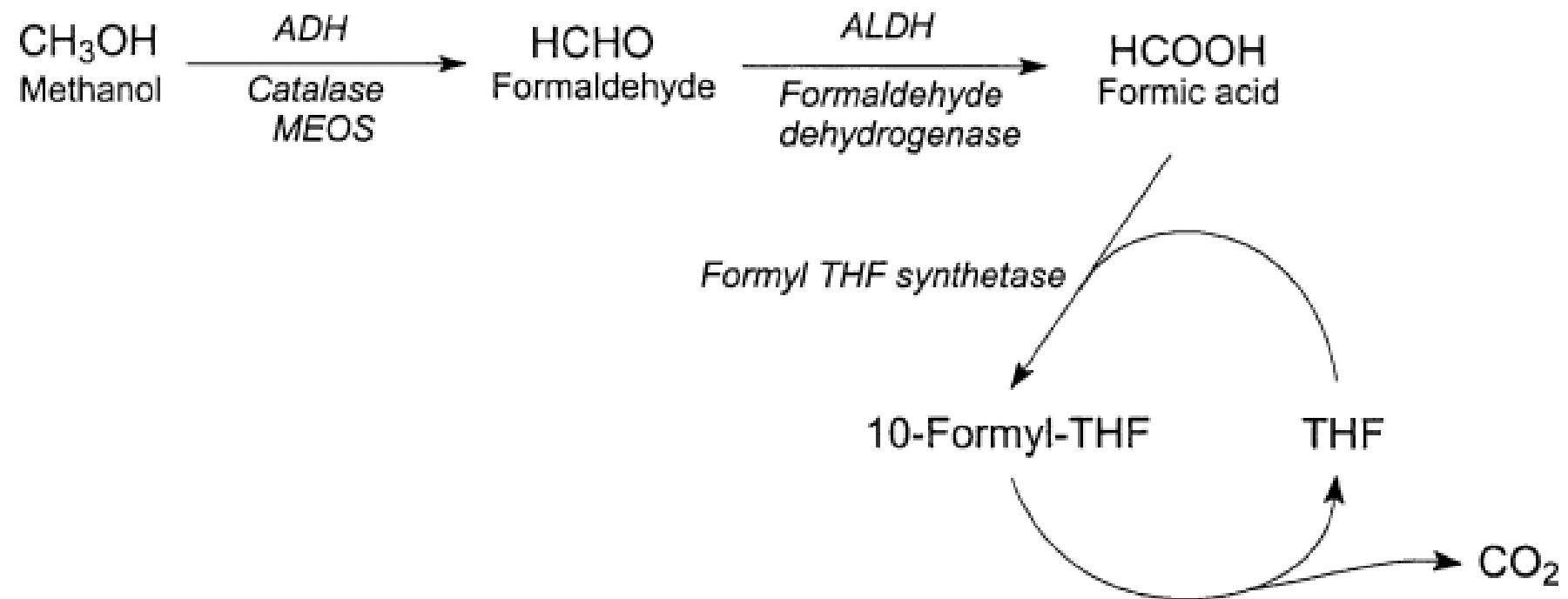


HOOCCOOH
Oxalic acid



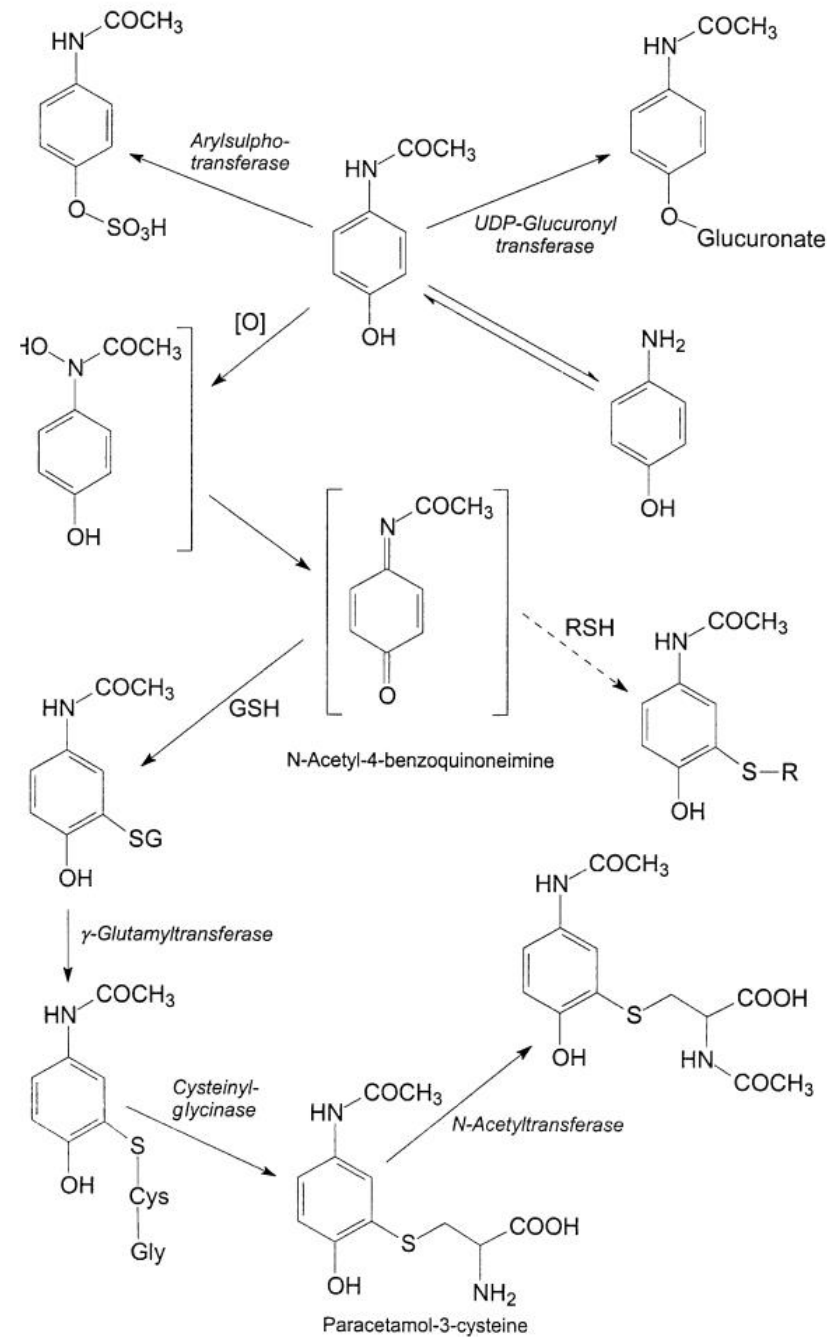
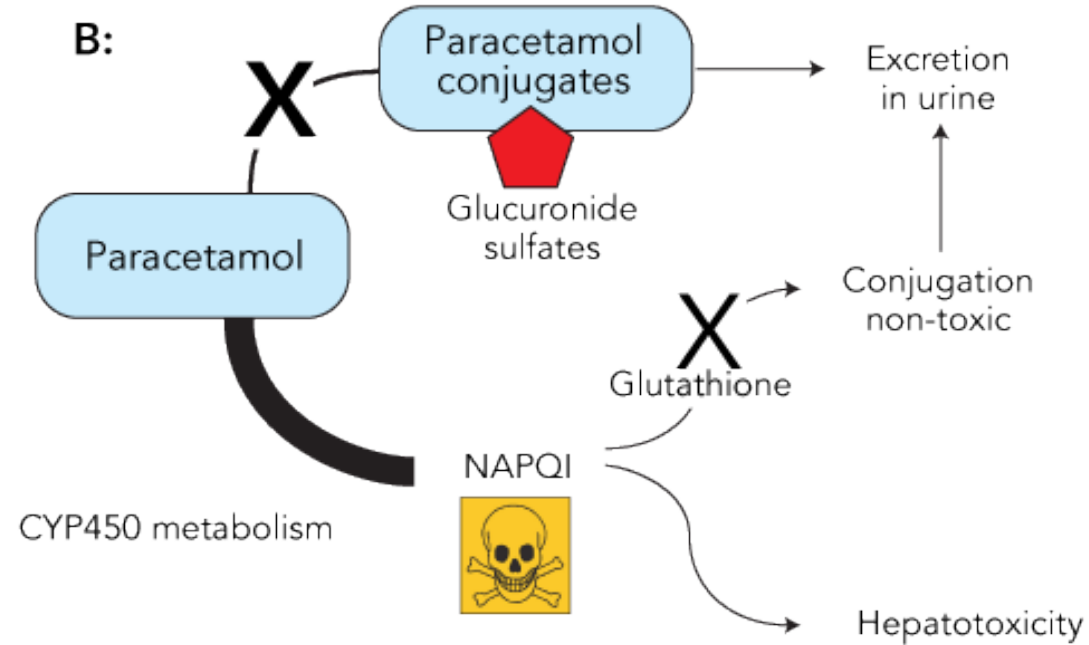
$\text{H}_2\text{NCH}_2\text{COOH}$
Glycine

HCOOH
Formic acid



Maintain/enhance detoxification

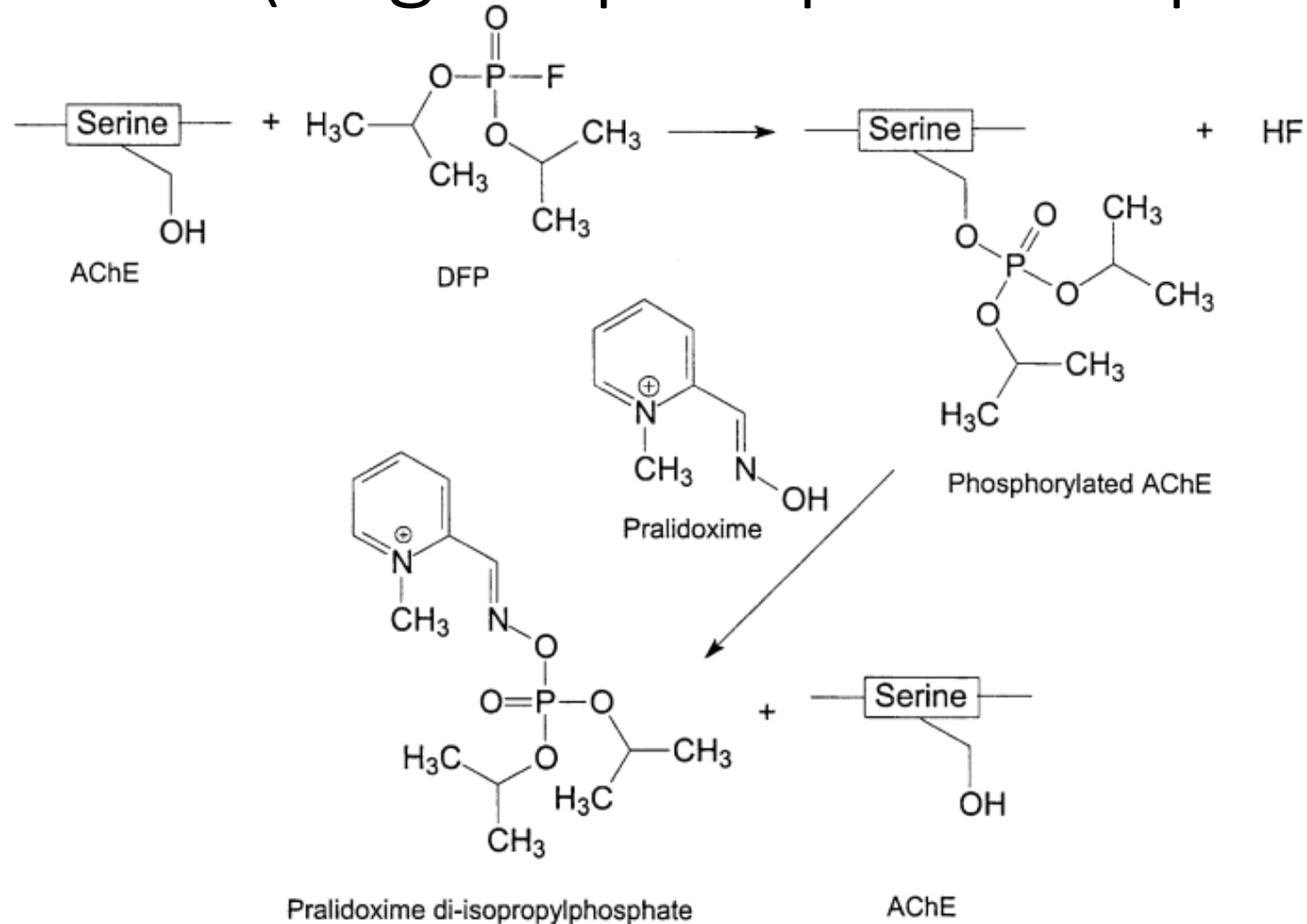
- The cytotoxicity of paracetamol is mediated by a reactive metabolite, **N-acetyl-4-quinoneimine (NAPQI)**, a strong electrophile and oxidizing agent formed in the liver and in the kidney by oxidative metabolism.
- Cells in which NAPQI is formed are normally protected by intracellular GSH
- However, if mitochondrial and cytosolic GSH become depleted, covalent binding of NAPQI to nucleophilic cell macromolecules and other reactions followed eventually by cell death may ensue.
- Administration of sulphhydryl donors, notably **D,L-methionine** (racemethionine) or **NAC** (acetylcysteine; N-acetyl-L-cysteine; mercapturic acid; Mucomyst; Parvolex, Evans), has achieved great prominence as either of these compounds can protect against paracetamol (acetaminophen) cytotoxicity if given within 12 h or so of ingestion



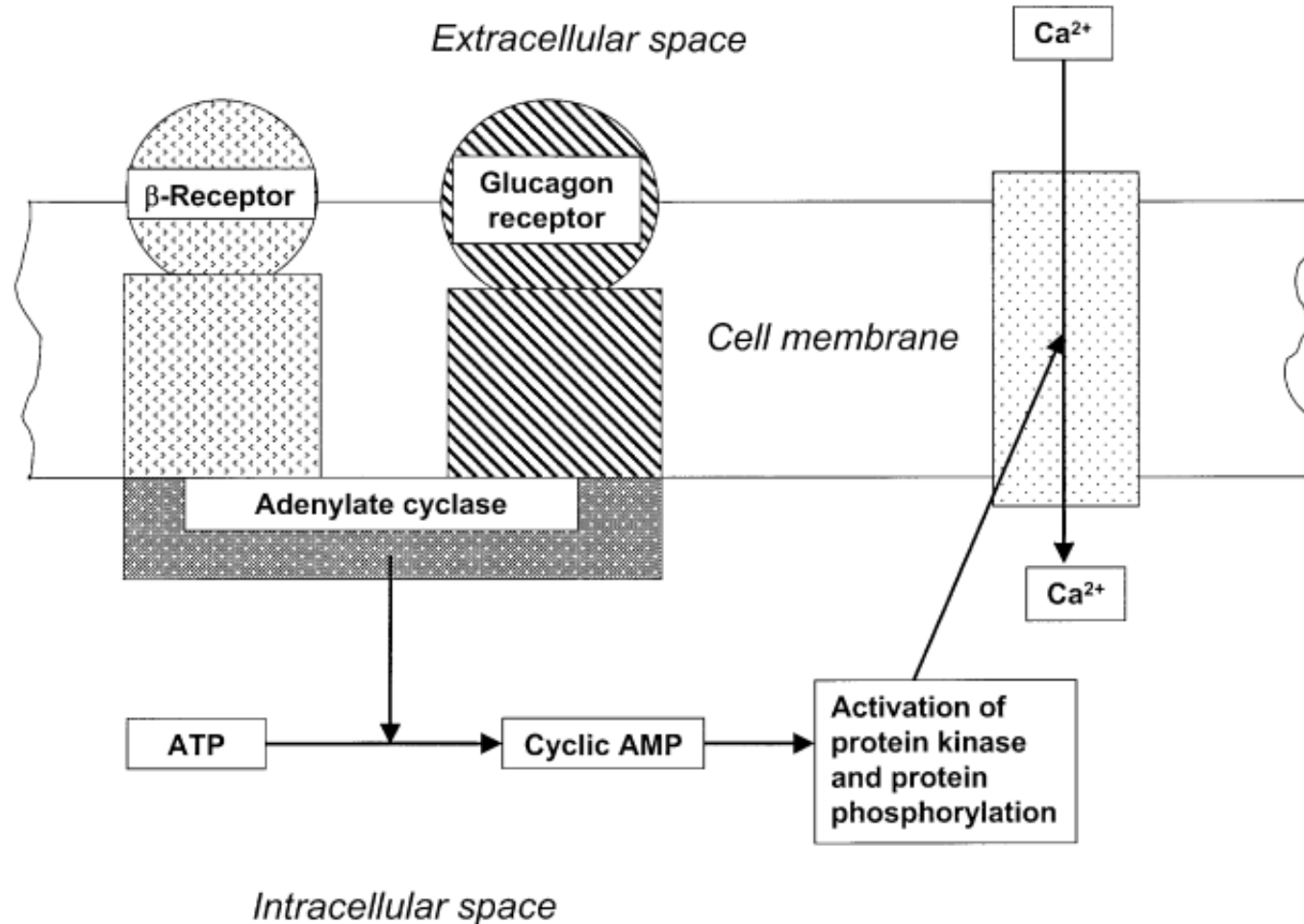
Displace poison/reactivate receptors/by-pass toxicity

- Displace poison:
 - Naloxone is a pure opioid antagonist and is widely used in the treatment of opioid over dosage.
 - Flumazenil is a benzodiazepine receptor antagonist
- Reactivate receptors:
 - Pralidoxime (Organophosphorous poisoning)
- By-pass toxicity:
 - Glucagon (Propranolol)

Reactivate receptors: Pralidoxime (Organophosphorous poisoning)



By-pass toxicity: Glucagon (Propranolol)

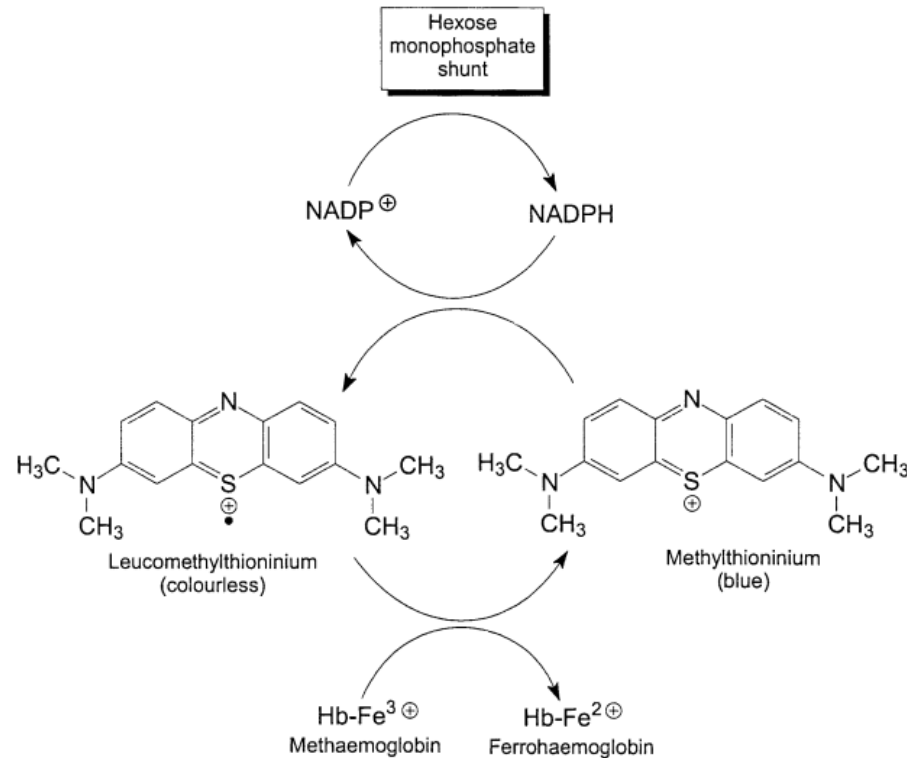


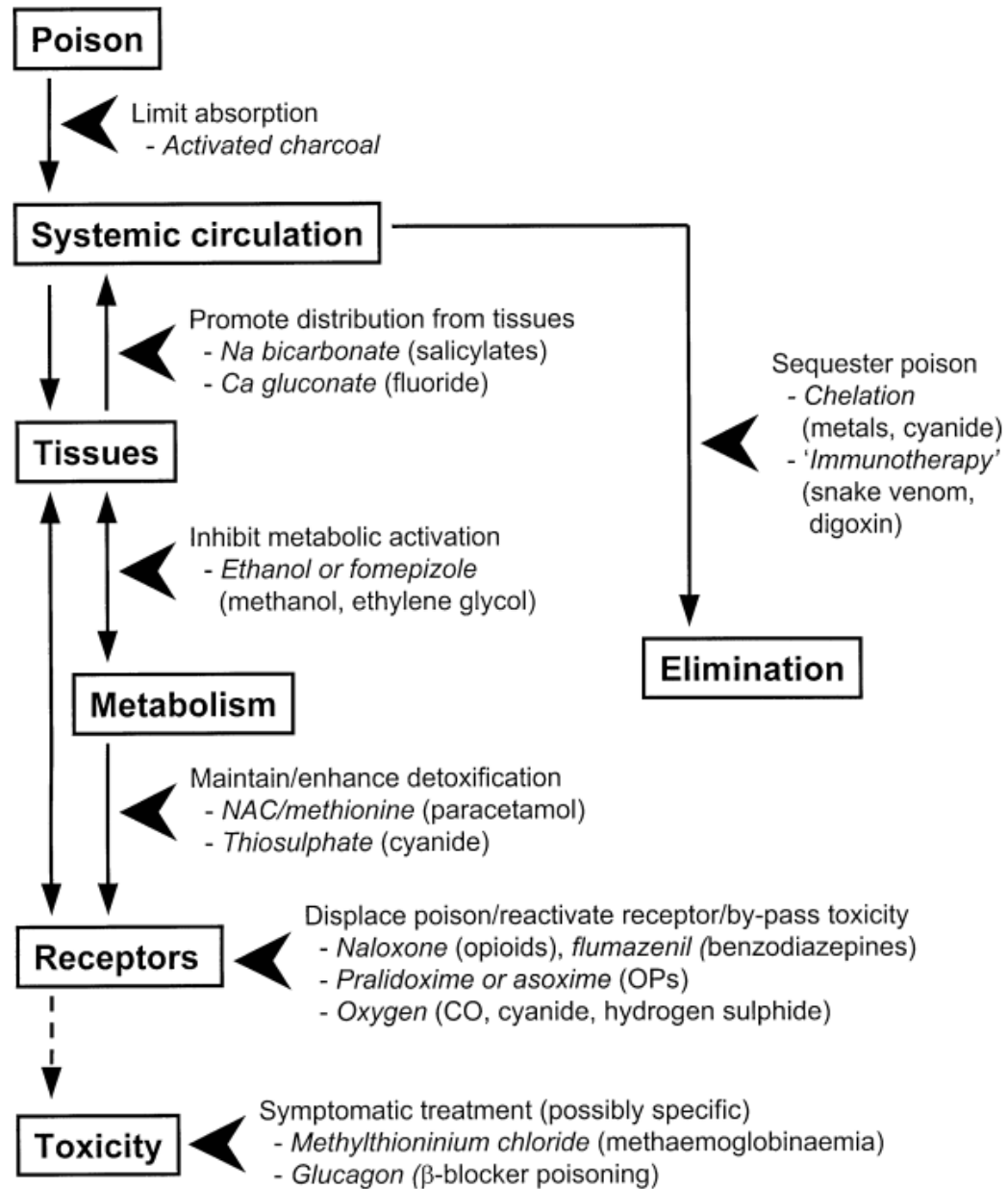
Sequester poison

- Pb: Calcium disodium edetate
- Fe, Al: Deferoxamine
- As, Hg, Cu, Pb: Dimercaprol (British anti-lewisite, BAL)

Symptomatic treatment

- Methylthionium chloride {methylene blue} (methaemoglobinaemia)
- Glucagon (beta blocker toxicity)





5. Enhanced elimination of absorbed poison

- This is usually resorted to when antidotes are not available.
- The main methods for elimination of toxic substances from the body are:
 - 1) Forced diuresis
 - 2) Dialysis
 - 3) Haemoperfusion
 - 4) Haemofiltration
 - 5) Hyperbaric oxygen
 - 6) Multiple dose activated charcoal

Indications

- The use of one of these methods for the elimination of a toxic substance is indicated mainly when:
 - The patient's condition is serious-patient has ingested a known lethal dose or has lethal blood levels of poison
 - The method chosen will remove a significant amount of the poison
 - Poisons with small volume of distribution
 - Poisons that are not lipid soluble
 - Poisons that are highly protein bound
 - Poisons with low endogenous renal clearance rate
 - The normal or usual route of elimination is impaired

5a. Forced diuresis

- In the past, forced diuresis was commonly used in many patients and for most forms of poisoning.
- However, it has been shown that the clinical course of most poisonings is not affected by forced diuresis.
- In addition, the procedure carries with it the dangers of **volume overload** and **electrolyte disturbances**.

- Forced diuresis is based on the principle that for drugs that are excreted by the kidneys, the amount excreted can be increased by increasing the urine output.
- This is, however, useful only for drugs that are excreted either **unchanged or as active metabolites**.
- Generally, this method is not useful for drugs that are metabolised by the liver and then excreted as inactive metabolites.
- Most drugs are partially reabsorbed in the renal tubules. This will reduce the amount of drug excreted despite any increase in urine output.
- However, this reabsorption primarily affects un-ionised, lipid-soluble molecules. By increasing the concentration of the drug that is in the ionised form, reduced re-absorption can be brought about. This will result in increased excretion.

- An increase in the concentration of the ionised drug can be achieved by manipulating the **urine pH**. Acidic drugs tend to remain ionised when in alkaline urine and basic drugs tend to remain ionised when in acidic urine.
- A number of drugs have **large volumes of distribution** and the amount that can be eliminated by forced diuresis is somewhat limited.

Indications

- The indications for forced diuresis are:
 - The substance or its active metabolites are excreted in the urine
 - There is a high plasma concentration of the substance
 - There is a high probability that supportive therapy alone will be insufficient

Contraindications

- The contraindications for forced diuresis are:
 - Impaired renal function
 - Cardiac disease, in particular, cardiac failure
 - Shock
 - Hypotension despite administration of IV fluids
- Care should also be taken when attempting forced diuresis in:
 - Elderly patients
 - Poisoning by cardiotoxic agents
 - Poisoning by nephrotoxic agents

Potential Complications

- The complications that may result from forced diuresis include:
 - Electrolyte and acid-base disturbances
 - Hypokalaemia
 - Hypocalcaemia
 - Hypomagnesaemia
 - Cerebral oedema
 - Pulmonary oedema
 - Water intoxication

Types of Forced Diuresis

- There are two forms of forced diuresis:
 1. Forced diuresis without manipulation of urinary pH
 2. Forced diuresis with manipulation of urinary pH
- Forced diuresis with manipulation of the urinary pH is further subdivided into:
 - Forced alkaline diuresis
 - Forced acid diuresis

Forced Diuresis Without Manipulation of Urinary pH

Drugs that can be removed by simple forced diuresis include the following:

- Alcohol
- Amphetamines
- Aniline
- Barbiturates (long-acting)
- Bromide
- Ethylene glycol
- Isoniazid
- Lithium
- Methanol
- Penicillin
- Phencyclidine
- Quinine
- Salicylates
- Strychnine
- Sulphonamides

Procedure

- The procedure involves a cycle of 1.5 L of fluid every 3 hours, consisting of:
 - 500 ml of normal saline
 - 500 ml of 5% dextrose + 20 ml of 7.45% potassium chloride
 - 500 ml of normal saline
 - IV furosemide 20 mg is given at the end of each cycle.
- Monitoring
- The following should be monitored when attempting forced diuresis:
 - Plasma electrolyte levels
 - Patient's input and output
 - Patient's condition and vital signs

Forced Alkaline Diuresis