Management of poisoning

By Dr. Swathi Swaroopa B

- *Stabilization of Patient*
- *Clinical Evaluation*
- *Decontamination*
- *Poison Elimination Enhancement*
- *Antidote Administration*
- *Supportive and Psychiatric Care*
- *Clinical Follow up*

Approach to poisoned patient

Stabilization of Patient

ABCDE

↓

Clinical Evaluation

↓

Management

GUT decontamination

Enhanced elimination

Antidote therapy

Supportive treatment

↓

Clinical follow up

THE ABCDE APPROACH

The steps are organized according to the issues that pose the most immediate life threats and consist of

airway, **breathing**, **circulation**, **disability** (**neurologic stabilization**), and **exposure**

Stabilization of Patient

AIRWAY

Assessment of the patient's airway

The most common factor contributing to death from drug overdose or poisoning is loss of airway-protective reflexes with subsequent airway obstruction caused by the

- Flaccid tongue,
- Pulmonary aspiration of gastric contents, or
- Respiratory arrest.

A. Position the patient and clear the airway

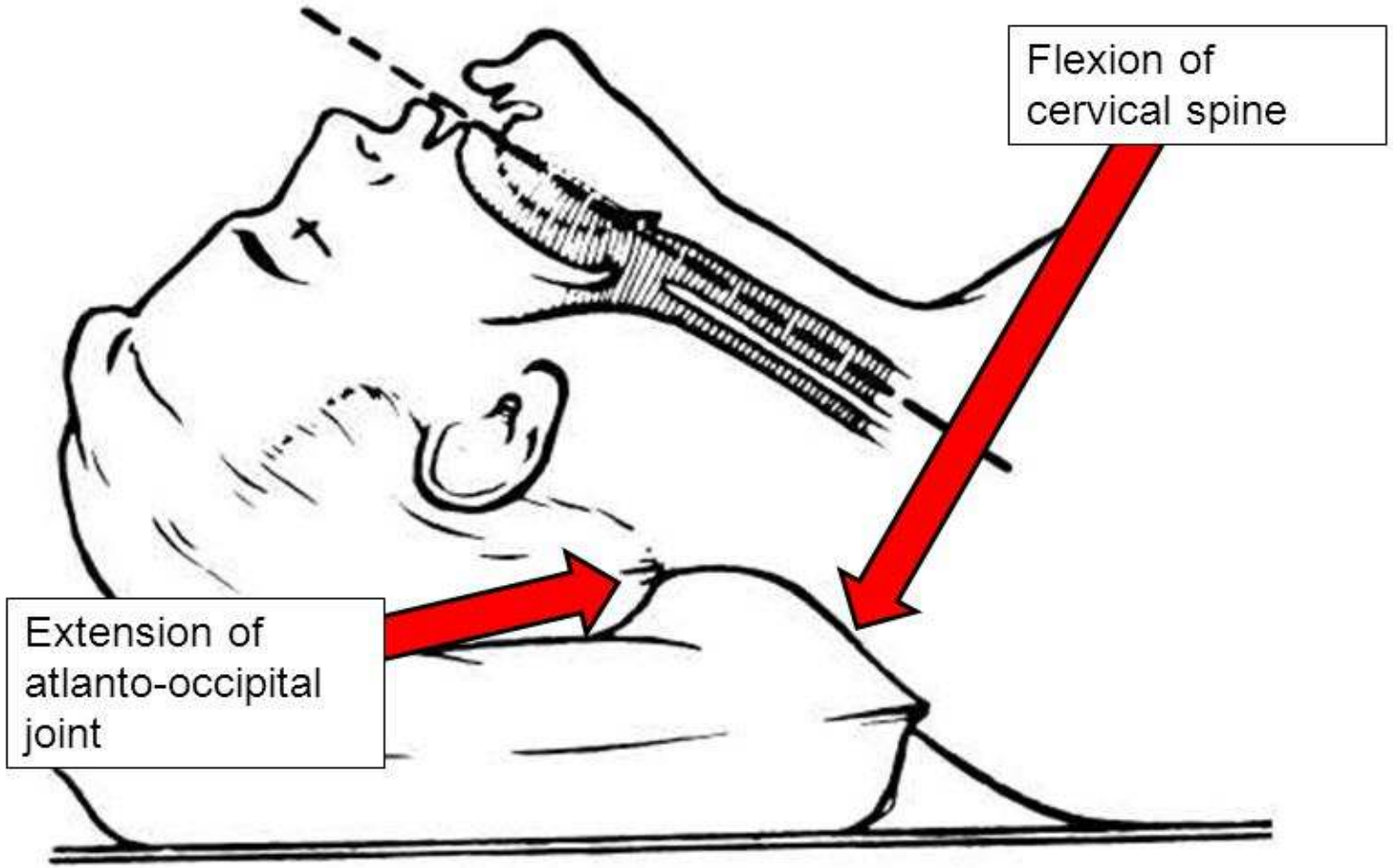
Optimize the airway position to force the flaccid tongue forward and to maximize the airway opening.

The following techniques are useful.

Caution: Do not perform neck manipulation if you suspect a neck injury.

- Place the neck and head in the "sniffing" position, with the neck flexed forward and the head extended

Sniffing Position



- 2. If the airway is still not patent, examine the oropharynx and remove any obstruction or secretions by suction, by a sweep with the finger, or with Magill forceps.

- Apply the "jaw thrust" to create forward movement of the tongue without flexing or extending the neck. Pull the jaw forward by placing the fingers of each hand on the angle of the mandible just below the ears

- Place the patient in a head-down, left-sided position that allows the tongue to fall forward and secretions or vomitus to drain out of the mouth

3. The airway can also be maintained with artificial oropharyngeal or nasopharyngeal airway devices.

These are placed in the mouth or nose to lift the tongue and push it forward.

They are only temporary measures.

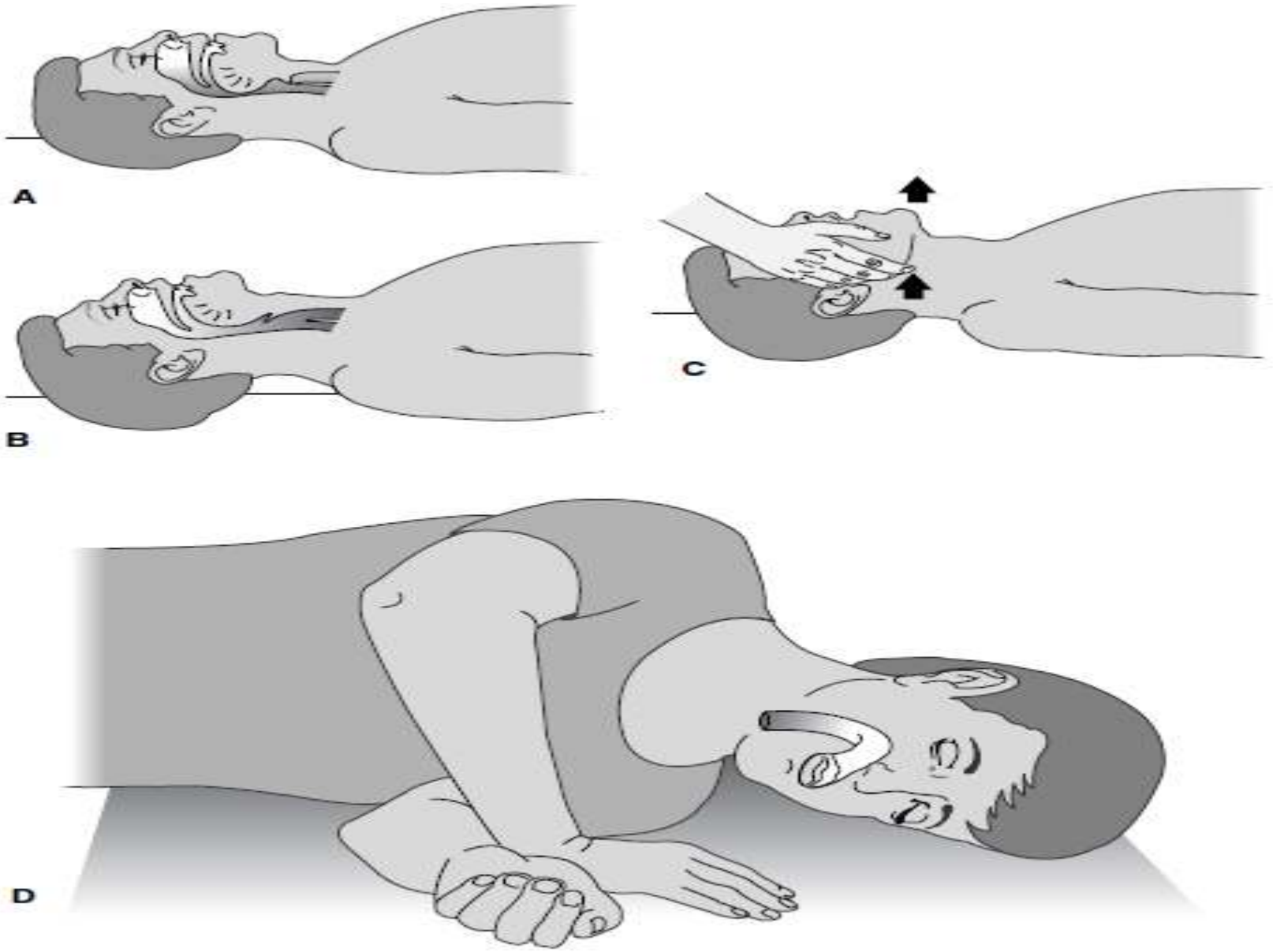


FIGURE I–2. Airway positioning. A: Normal position. B: "Sniffing" position. C: "Jaw thrust" maneuver. D: Left-side, head-down position, showing nasal and oral airway.

Perform endotracheal intubation

- Intubation of the trachea provides the most reliable protection of the airway, preventing aspiration and obstruction and allowing for mechanically assisted ventilation
- Should be attempted only by those with training and experience.
- There are two routes for endotracheal intubation: nasotracheal and orotracheal.

- In nasotracheal intubation, a soft flexible tube is passed through the nose and into the trachea, by using a "blind" technique

- In orotracheal intubation, the tube is passed through the patient's mouth into the trachea under direct vision

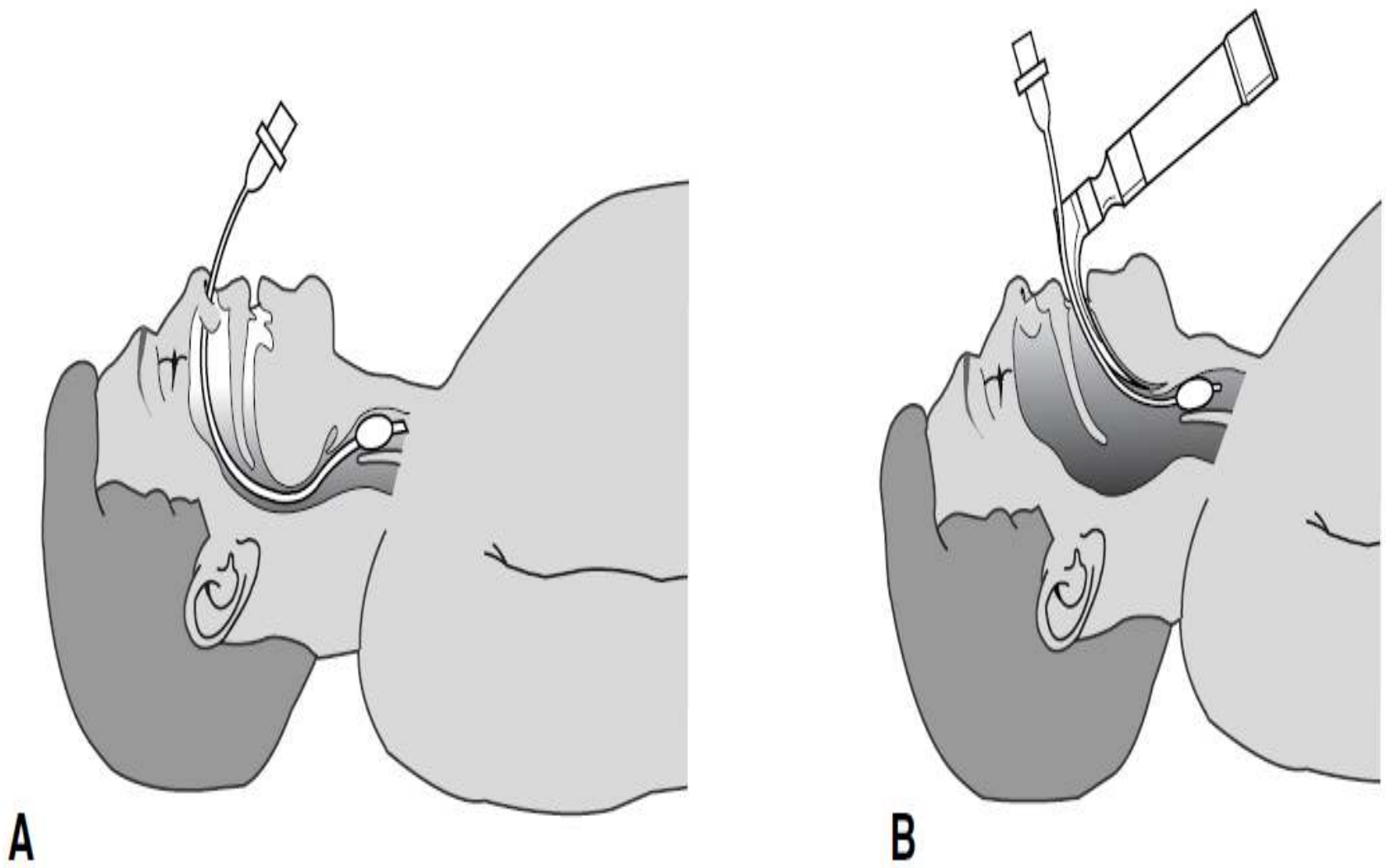


FIGURE I–3. Two routes for endotracheal intubation. A: Nasotracheal intubation. B: Orotracheal intubation.

Other issues to keep airway patent

- Aspiration of secretions and regurgitated food and stomach contents
- Removal of foreign bodies, dentures, or mucus from mouth
- Prevent falling back of the tongue in comatose patient by oropharyngeal tube.

Breathing

- Along with airway problems, breathing difficulties are the major cause of morbidity and death in patients with poisoning or drug overdose.

Patients may have one or more of the following complications:

- Ventilatory failure
- Hypoxia ,
- Bronchospasm.

Ventilatory failure.

- Ventilatory failure is the most common cause of death in poisoned patients.

Ventilatory failure has multiple causes, including failure of the

- Ventilatory muscles,
- Central depression of respiratory drive, and
- Severe pneumonia
- Pulmonary edema.

Complications of Ventilatory failure

1. Hypoxia may result in

- Brain damage,
- cardiac arrhythmias,
- Cardiac arrest.

2. Hypercarbia results in

- Acidosis,
- Arrhythmias.

Hypoxia.

- Insufficient oxygen in ambient air (eg, displacement of oxygen by inert gases).

- Disruption of oxygen absorption by the lung (eg, resulting from pneumonia or pulmonary edema).

- Pneumonia-causes
    - Intravenous injection of foreign material or bacteria
    - Aspiration of petroleum distillates
    - Inhalation of irritant gases
    - Pulmonary aspiration of gastric contents

Pulmonary edema.

- All agents that can cause chemical pneumonia (eg, irritant gases and hydrocarbons) can also cause pulmonary edema.

- Cellular hypoxia,
    - Carbon monoxide
    - Cyanide and hydrogen sulfide

Treatment

- Obtain measurements of arterial blood gases

- If PO_2 < 60 mmHg & PCO_2 > 60 mmHg assist ventilation.

- Administer supplemental oxygen as indicated based on arterial pO2
- Oxygen therapy done to raise the PaO2 to at least 45–55 mmHg (6.0 Kpa to 7.3 Kpa).

Begin with 28% oxygen mask.

- Depending on the response as assessed by periodic arterial gas analysis, either continue with 28% or progress to 35%. If the condition is relentlessly deteriorating, consider mechanical ventilation

Treat pneumonia-

- Obtain frequent sputum samples and initiate appropriate antibiotic therapy
- Some physicians recommend corticosteroids for chemical-induced pneumonia, there is little evidence of their benefit.

Treat pulmonary edema.

- Avoid excessive fluid administration
- Administer supplemental oxygen to maintain a pO2 of at least 60–70 mm Hg.
- Endotracheal intubation and use of positive end-expiratory pressure (PEEP) ventilation may be necessary to maintain adequate oxygenation.

Bronchospasm

- Direct irritant injury from inhaled gases or pulmonary aspiration or stomach contents
- Pharmacologic effects of toxins
- Hypersensitivity

Complications

- Hypoxia and ventilatory failure.

Treatment

- Administer supplemental oxygen. Assist ventilation and perform endotracheal intubation if needed

- Remove the patient from the source of exposure to any irritant gas or other offending agent.

- Immediately discontinue any beta-blocker treatment

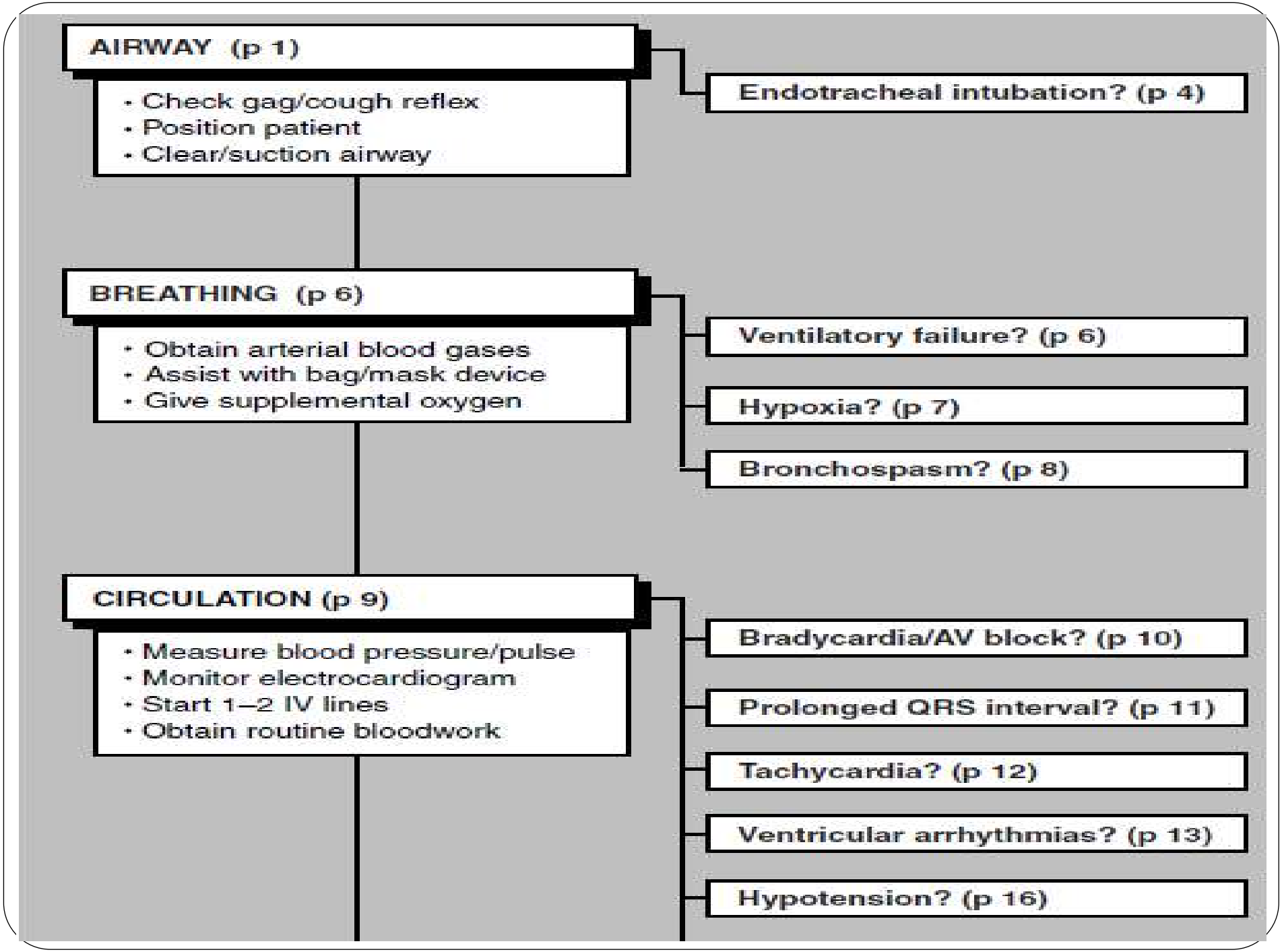
Administer bronchodilators:

- a) Aerosolized beta-2 stimulant (eg, albuterol [2.5–5 mg] in nebulizer).

- Repeat as needed, or give 5–15 mg as a continuous nebulizer treatment over 1 hour (children: 0.3–0.5 mg/kg/h).

- Aerosolized ipratropium bromide, 0.5 mg every 4–6 hours, especially if excessive cholinergic stimulation is suspected.

- For beta-blocker–induced wheezing, also consider aminophylline (6 mg/kg IV over 30 minutes).


AIRWAY (p 1)
• Check gag/cough reflex
• Position patient
• Clear/suction airway
Endotracheal intubation? (p 4)
BREATHING (p 6)
• Obtain arterial blood gases
• Assist with bag/mask device
• Give supplemental oxygen
Ventilatory failure? (p 6)
Hypoxia? (p 7)
Bronchospasm? (p 8)
CIRCULATION (p 9)
• Measure blood pressure/pulse
• Monitor electrocardiogram
• Start 1–2 IV lines
• Obtain routine bloodwork
Bradycardia/AV block? (p 10)
Prolonged QRS interval? (p 11)
Tachycardia? (p 12)
Ventricular arrhythmias? (p 13)
Hypotension? (p 16)

CIRCULATION

Assessment and Initial treatment

- Check blood pressure and pulse rate and rhythm.
- Begin continuous electrocardiographic (ECG) monitoring.
- Secure venous access.
- Draw blood for routine studies
- Begin intravenous infusion
- In seriously ill patients place a Foley catheter in the bladder, obtain urine for routine and toxicologic testing, and measure hourly urine output.

Check blood pressure and pulse rate and rhythm

- Perform cardiopulmonary resuscitation (CPR) if there is no pulse

- Perform advanced cardiac life support (ACLS) for arrhythmias and shock.

Begin continuous electrocardiographic (ECG) monitoring

- All patients with potentially cardiotoxic drug poisoning should be monitored in the emergency department or an intensive care unit for at least 6 hours after the ingestion

Secure venous access.

- Antecubital or forearm veins are usually easy to cannulate.

- Alternative sites include femoral, subclavian, internal jugular, or other central veins.

Draw blood

- **Draw blood** for routine studies

Begin intravenous infusion

- Normal saline
- 5% dextrose in NS
- 5% dextrose in half NS (D5W 0.45% sodium chloride)
- 5% dextrose in water (D5W)
- For children, use 5% dextrose in quarter NS (D5W 0.25% sodium chloride).
- If the patient is hypotensive ,NS or another isotonic crystalloid solution is preferred.

Bradycardia and atrioventricular (AV) block

- Intoxication with calcium antagonists
- Drugs that depress sympathetic tone
- Increase parasympathetic tone
- Membrane-depressant drugs- tricyclic antidepressants, quinidine
- Bradycardia or AV block may also be a reflex response (baroreceptor reflex) to hypertension induced by alpha-adrenergic agents
- In children, bradycardia is commonly caused by respiratory compromise

Complications

- Hypotension
- Asystolic cardiac arrest

Treatment

- Do not treat bradycardia or AV block unless the patient is symptomatic -eg, exhibits signs of syncope or hypotension

- Bradycardia or even AV block may be a protective reflex to lower the blood pressure in a patient with life-threatening hypertension

- Maintain an open airway and assist ventilation

- Administer supplemental oxygen
- Rewarm hypothermic patients. A sinus bradycardia of 40–50/min is normal when the body temperature is 32–35°C (90–95°F).
- Administer atropine, 0.01–0.03 mg/kg IV.
- If this is not successful, use isoproterenol 1–10 mcg/min IV, titrated to the desired rate, or use an emergency transcutaneous or transvenous pacemaker.

- Use specific antidotes if appropriate

QRS interval prolongation

- QRS interval prolongation of greater than 0.12 seconds in the limb leads strongly indicates poisoning by membrane-depressant drugs

- QRS interval prolongation may also result from a ventricular escape rhythm in a patient with complete heart block --from digitalis, calcium antagonist poisoning

Complications

- Hypotension,
- AV block,
- Seizures.

Treatment

- Maintain the airway and assist ventilation if necessary. Administer supplemental oxygen
- Treat hyperkalemia and hypothermia if they occur
- Treat AV block with atropine, isoproterenol , and a pacemaker if necessary
- Give other antidotes if appropriate
- Sodium bicarbonate administration will be useful

Tachycardia

- Sinus tachycardia and supraventricular tachycardia are often caused by
    - excessive sympathetic system stimulation or inhibition of parasympathetic tone.

- Sinus tachycardia may also be a reflex response to hypotension or hypoxia.

Treatment.

- If tachycardia is not associated with hypotension or chest pain, observation and sedation (especially for stimulant intoxication) are usually adequate.

- For sympathomimetic-induced tachycardia, give propranolol, 0.01–0.03 mg/kg IV ; or esmolol, 0.025–0.1 mg/kg/min IV

- For anticholinergic-induced tachycardia, give physostigmine, 0.01–0.03 mg/kg IV ; or neostigmine, 0.01–0.03 mg/kg IV

- Caution: Do not use these drugs in patients with tricyclic antidepressant overdose, because additive depression of conduction may result in asystole.

Ventricular arrhythmias

- Excessive sympathetic stimulation
- Intoxication by a tricyclic antidepressant or other sodium channel–blocking drug
- Agents that cause QT interval prolongation

Treatment.

Ventricular Arrhythmia-Ventricular tachycardia or ventricular fibrillation

- Maintain an open airway and assist ventilation
- Correct acid-base and electrolyte disturbances.

For ventricular fibrillation

- Immediately apply direct-current countershock at 3–5 J/kg.

- Continue CPR if the patient is still without a pulse, and administer epinephrine, repeated counter shocks, amiodarone, and/or lidocaine as recommended in advanced cardiac life support (ACLS) guidelines.

For ventricular tachycardia in patients without a pulse

- Immediately give a precordial thump or apply synchronized direct-current countershock at 1–3 J/kg.

- Next continue like ventricular arrythmia treatment.

For ventricular tachycardia in patients with a pulse

- use lidocaine, 1–3 mg/kg IV , or amiodarone, 300 mg IV or 5 mg/kg in children.

For tricyclic antidepressant or other sodium channel–blocking drug overdose administer

- sodium bicarbonate, 1–2 mEq/kg IV, in repeated boluses until the QRS interval narrows or the serum pH exceeds 7.7.

For torsade de pointes

- Use overdrive pacing or isoproterenol, 1–10 mcg/min IV, to increase the heart rate

- Alternately, administer intravenous magnesium sulfate, 1–2 g in adults, over 20–30 minutes

- Since magnesium is a cofactor in the sodium potassium ATPase activity, it may have prevented the TdP by facilitating influx of potassium into the cells, thereby stabilizing membrane potential, correcting the dispersed repolarization process without shortening it.

Hypotension

- Volume loss because of vomiting, diarrhea, or bleeding;
- Volume depletion caused by venodilation; depression of cardiac contractility; arrhythmias that interfere with cardiac output; and hypothermia.
- Reflex tachycardia
- Bradycardia

Complications

- acute renal tubular necrosis,
- brain damage, and
- cardiac ischemia.
- Metabolic acidosis

Treatment

- Intravenous fluids and low doses of pressor drugs (eg, dopamine).
- Treat the cause of hypotension
- Maintain an open airway and assist ventilation if necessary Administer supplemental oxygen.

- Hypotension associated with hypothermia often will not improve with routine fluid therapy but will rapidly normalize upon rewarming of the patient.

- A systolic blood pressure of 80–90 mm Hg is expected when the body temperature is 32°C (90°F).

- Administer dopamine, 5–15 mcg/kg/min
- Dopamine may be ineffective in some patients with depleted neuronal stores of catecholamines
- In such cases norepinephrine, 0.1 mcg/kg/min IV , may be more effective.\
- Consider specific antidotes

- If the above measures are unsuccessful, insert a central venous pressure (CVP) monitor or pulmonary artery catheter to determine whether further fluids are needed and to measure the cardiac output (CO) and calculate the systemic vascular resistance (SVR) as follows:

$$SVR = 80(MAP - CVP)/\ CO$$

- where MAP is the mean arterial pressure

Select further therapy based on the following results:

a. If the central venous pressure or pulmonary artery wedge pressure remains low, give more intravenous fluids.

b. If the cardiac output is low, give more dopamine or dobutamine.

c. If the systemic vascular resistance is low, administer norepinephrine, 4–8 mcg/min .

Hypertension

- Hypertension is frequently overlooked in drug-intoxicated patients and often goes untreated.

Hypertension may be caused by a variety of mechanisms

- Through sympathetic stimulation

- With reflex (baroreceptor- mediated) bradycardia or even AV block.
- Anticholinergic agents cause mild hypertension with tachycardia
- Substances that stimulate nicotinic cholinergic receptors (eg, organophosphates) may initially cause tachycardia and hypertension, followed later by bradycardia and hypotension.

Complications

- Intracranial hemorrhage,
- Aortic dissection,
- Myocardial infarction,
- Congestive heart failure.

Treatment

- For a patient with chronic hypertension, lowering the diastolic pressure to 100 mm Hg is acceptable.

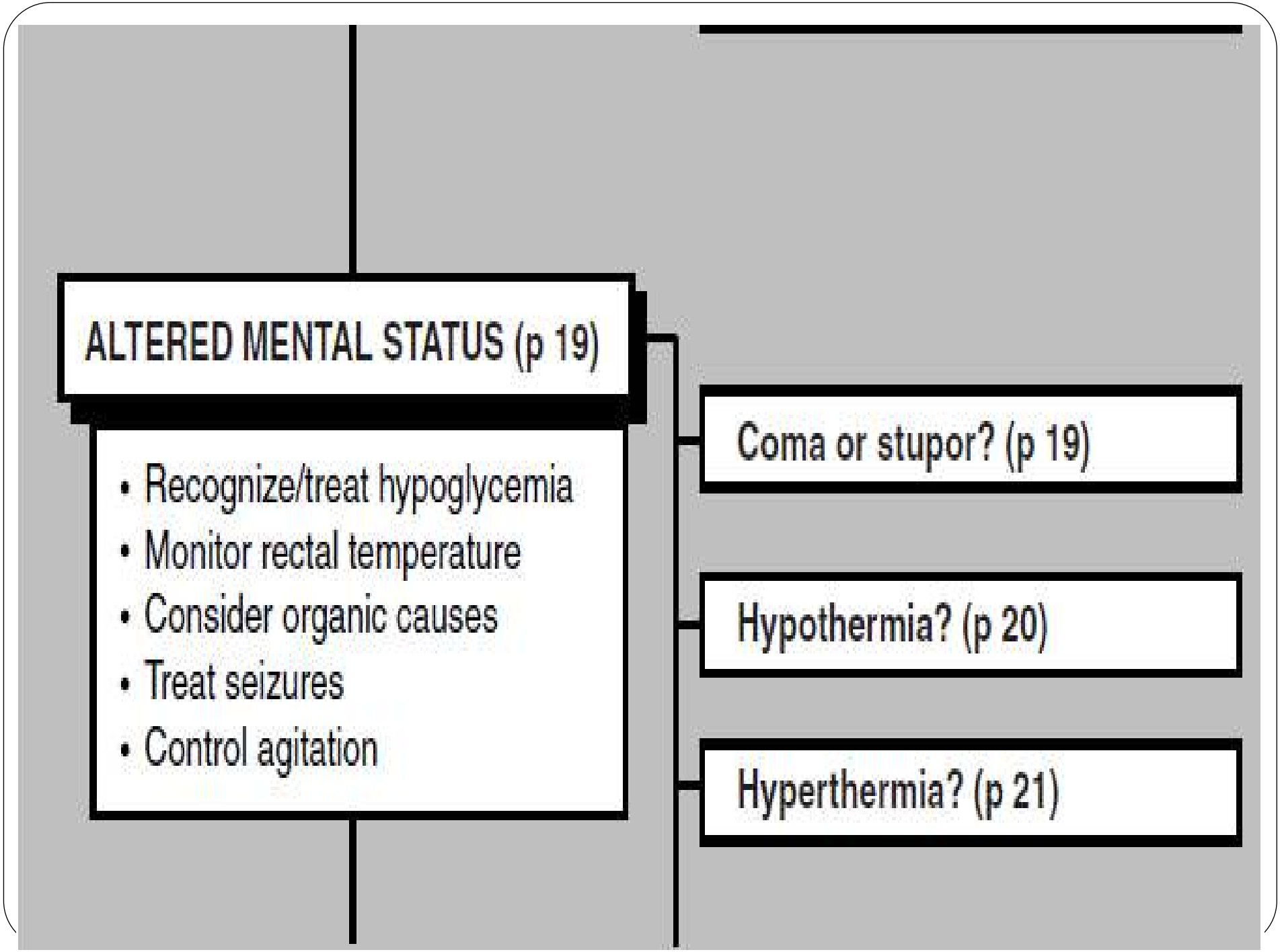
- On the other hand, for a young person whose normal diastolic blood pressure is 60 mm Hg, the diastolic pressure should be lowered to 80 mm Hg.

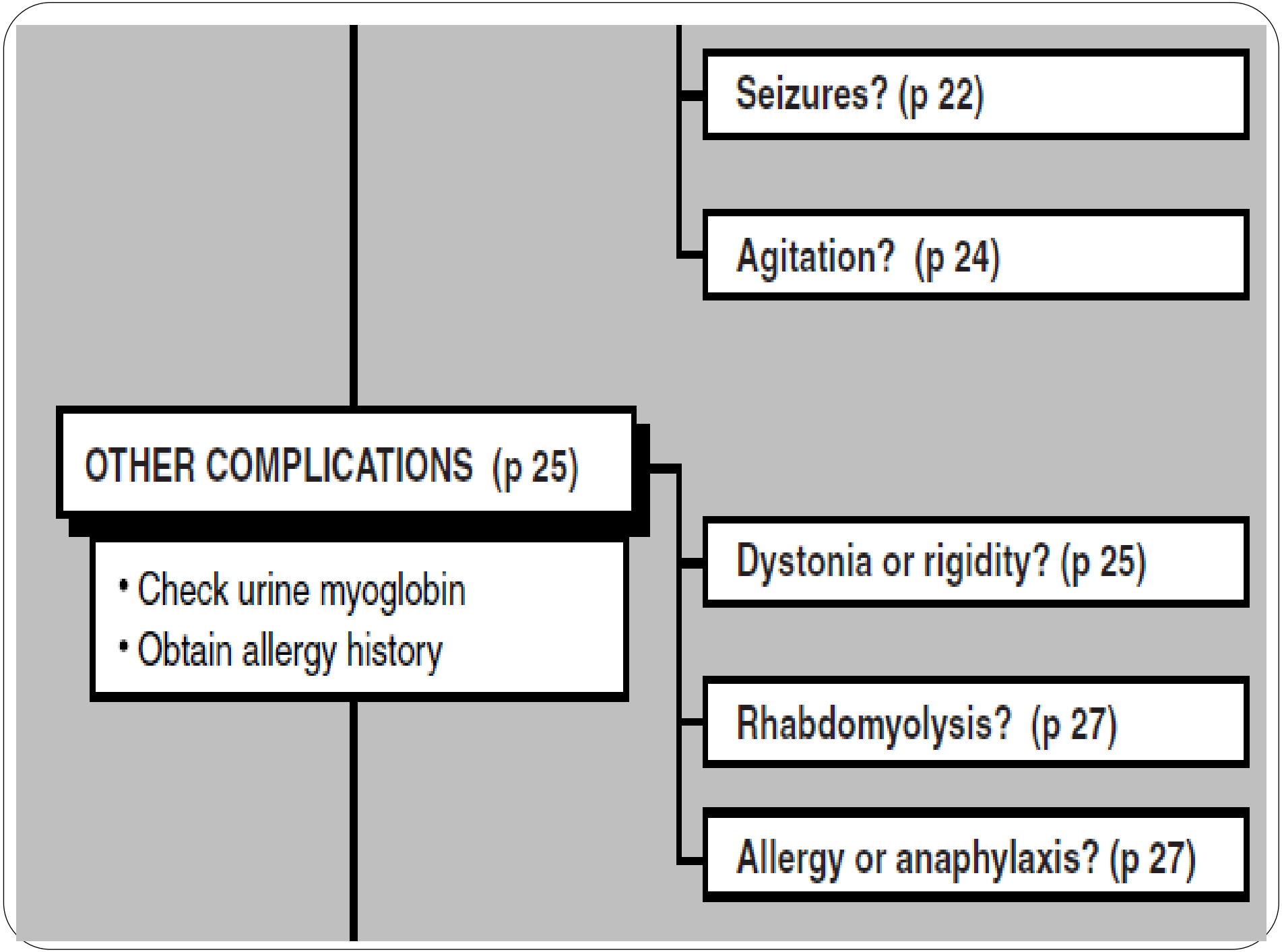
- For hypertension with little or no tachycardia, use phentolamine, 0.02–0.1 mg/kg IV, or nitroprusside, 2–10 mcg/kg/min IV

- For hypertension with tachycardia add to the treatment in item 1 above propranolol, 0.02–0.1 mg/kg IV; or esmolol, 0.025–0.1 mg/kg/min IV; or labetalol, 0.2–0.3 mg/kg IV

- If hypertension is accompanied by a focally abnormal neurologic examination perform (CT) scan

- In a patient with a cerebrovascular accident, hypertension should generally not be treated unless specific complications of the elevated pressure


ALTERED MENTAL STATUS (p 19)
• Recognize/treat hypoglycemia
• Monitor rectal temperature
• Consider organic causes
• Treat seizures
• Control agitation
Coma or stupor? (p 19)
Hypothermia? (p 20)
Hyperthermia? (p 21)


Seizures? (p 22)
Agitation? (p 24)
OTHER COMPLICATIONS (p 25)
• Check urine myoglobin
• Obtain allergy history
Dystonia or rigidity? (p 25)
Rhabdomyolysis? (p 27)
Allergy or anaphylaxis? (p 27)

Disability (altered mental status)

D)Disability

- **Once ABC are addressed, the neurological status should be assessed, mainly:**

Level of consciousness & convulsions .

- **I-level of consciousness:**
- **a)Coma and b)stupor**

- **Stupor: is a grade of unconsciousness in which the patient can be aroused (awakened) only by painful stimuli.**

- **Coma: is a state of prolonged unconsciousness in which the patient cannot be aroused by painful stimuli.**

- **The level of consciousness is evaluated roughly by the <u>responsive scale AVPU:</u>**

- **A=awake and alert.**
- **V= respond to verbal stimuli.**
- **P=respond to pain.**
- **U= unresponsive**

➢ Reed's classification of the level of consiousness

stage	**Consious level**	Pain response	Reflexes	Resp	Circul.
0	**Asleep**	Arousable	Intact	Normal	Normal
I	**Comatose**	**Withdrawal**	Intact	Normal	Normal
II	**Comatose**	None	Intact	Normal	Normal
III	**Comatose**	None	Absent	Normal	Normal
IV	**Comatose**	None	Absent	**cyanosed**	**Shock**

MODIFIED GLASGOW COMA SCALE

Eyes open
- spontaneously 4
- to speech 3
- to pain 2
- never 1

Best verbal response
- oriented 5
- confused 4
- inappropriate words 3
- incomprehensible words 2
- none 1

Best motor response
- obeys commands 5
- localizes pain 4
- flexion to pain 3
- extension to pain 2
- none 1

Coma and stupor

- Global depression of the brain's reticular activating System
- A postictal phenomenon after a drug- or toxin-induced seizure.
- Brain injury associated with infarction or intracranial bleeding

Complications

- Respiratory depression, which is a major cause of death.
- Hypotension
- Hypothermia
- Hyperthermia
- Rhabdomyolysis

Treatment

- Maintain the airway and assist ventilation if necessary
- Administer supplemental oxygen.
- Give dextrose, thiamine, and naloxone

Dextrose-

- All patients with depressed consciousness should receive concentrated dextrose unless hypoglycemia is ruled out

(1) Adults: 50% dextrose, 50 mL (25 g) IV.

(2) Children: 25% dextrose, 2 mL/kg IV.

Thiamine

- Give thiamine, 100 mg, IV or intramuscularly
- It is not given routinely to children.
- Thiamine is given to prevent abrupt precipitation of Wernicke's syndrome resulting from thiamine deficiency in alcoholic patients and others with suspected vitamin deficiencies.
- Thiamine should be administered before dextrose.

Naloxone

- All patients with respiratory depression should receive naloxone
- Naloxone is indicated for the reversal of respiratory depression associated with narcotic overdoses.
- (1) Give naloxone, 0.4 mg IV (may also be given intramuscularly).
- (2) If there is no response within 1–2 minutes, give naloxone, 2 mg IV.
- If and when naloxone is indicated, administer it only in low, titrated doses to carefully reverse the respiratory depression.

- (3) If there is still no response and opiate overdose is highly suspected by history or clinical presentation (pinpoint pupils, apnea, or hypotension), give naloxone, 10–20 mg IV.

- Normalize the body temperature

- If meningitis or encephalitis is suspected treat with appropriate antibiotics

- Consider flumazenil if benzodiazepines (acute BZ overdose) are the only suspected cause of coma and there are no contraindications

- Till recently it was recommended that in every case where the identity of the poison was not known
- Was useful in unknown comprise cases of overdose from opiates, alcohol, and hypoglycaemic agents, these drugs would work in such cases to at least indicate the possible diagnosis.
- Even if a particular case was not due to any of these causes, administration of these antidotes was considered relatively harmless.
- All patients with depressed mental status should receive 100% oxygen in a mask, (high flow—8 to 10 litres/min).

Hypothermia

- Caused by exposure to low ambient temperatures in a patient with blunted thermoregulatory response mechanisms.

- A patient whose **temperature is lower than 32°C (90°F) may appear to be dead**, with a barely detectable pulse or blood pressure and without reflexes.

Drugs and toxins may induce hypothermia by causing

- Vasodilation,
- Inhibiting the shivering response,
- Decreasing metabolic activity, or

- The ECG may reveal J wave or Osborne wave

- It is essential to use a low reading rectal thermometer.

- Electronic thermometers with flexible probes are best which can also be used to record the oesophageal and bladder temperatures.

Complications

- Hypotension
- Bradycardia
- Ventricular fibrillation
- Cardiac arrest.

Treatment

- Rewarm slowly to prevent rewarming arrhythmias.
- Using blankets,
- Warm intravenous fluids, and
- Warmed-mist inhalation.

- For mild cases, a warm water bath (115°F) is sufficient until the core temperature rises to 92° F, when the patient is placed in a bed with warm blankets.

- The rate of rewarming should not exceed 5° F per hour.

For patients in cardiac arrest

- Provide gastric or peritoneal lavage with warmed fluids and perform CPR.

- Antiarrhythmic agents and direct current counter shock is ineffective until the temperature is above 32–35°C

Cardiac arrest and Unresponsive to the above treatment

- Open cardiac massage, with direct warm irrigation of the ventricle
- Partial cardiopulmonary bypass

Hyperthermia

- Temperature > 40°C or 104°F
- It may be caused by excessive heat generation because of sustained seizures
- Rigidity, or muscular hyperactivity
- An increased metabolic rate
- Impaired dissipation of heat secondary to impaired sweating
- Hypothalamic disorders

Complications

- Hypotension,
- Rhabdomyolysis,
- Coagulopathy,
- Cardiac and Renal failure,
- Brain injury, and death.

Treatment

- Remove all clothes, and pack the neck and groin with ice
- Immersion in cold water bath (77oF) is very effective but dangerous in the elderly and in heart patients.
- Stop cooling measures when core temperature falls below 102oF, and nurse the patient in bed in a cool room.
- Maintain the airway and assist ventilation if necessary. Administer supplemental oxygen

- Begin external cooling with tepid (lukewarm) sponging and fanning

- Shivering often occurs with rapid external cooling, and shivering may generate yet more heat.

- Treat shivering with use diazepam, 0.1–0.2 mg/kg IV; lorazepam, 0.05–0.1 mg/kg IV; or midazolam, 0.05–0.1 mg/kg IV or IM

- Treat seizures , agitation , or muscular rigidity

- The most rapidly effective and reliable means of lowering the temperature is by neuromuscular paralysis.

- Administer a nondepolarizing agent such as pancuronium, 0.1 mg/kg IV or vecuronium, 0.1 mg/kg IV.

- Caution: The patient will stop breathing; be prepared to ventilate and intubate endotracheally.

- Neuroleptic malignant syndrome (NMS) is a hyperthermic disorder seen in some patients who use antipsychotic agents and is characterized by hyperthermia, muscle rigidity (often so severe as to be called "lead-pipe" rigidity), metabolic acidosis, and confusion.

- 2. Malignant hyperthermia is an inherited disorder that causes severe hyperthermia, metabolic acidosis, and rigidity after certain anesthetic agents (most commonly halothane and succinylcholine) are used.

- **Serotonin syndrome** occurs primarily in patients taking monoamine oxidase (MAO) inhibitors who also take serotonin-enhancing drugs, such as meperidine (Demerol™), fluoxetine (Prozac™), or other serotonin reuptake inhibitors , and is characterized by irritability, rigidity, myoclonus, diaphoresis, autonomic instability, and hyperthermia.

- It may also occur in people taking an overdose of or combinations of SSRIs even without concurrent use of MAO inhibitors.

Malignant hyperthermia

- If muscle rigidity persists despite administration of neuromuscular blockers, a defect at the muscle cell level (ie, malignant hyperthermia) should be suspected. Give dantrolene, 1–10 mg/kg IV

- Neuroleptic malignant syndrome. Consider bromocriptine

- Serotonin syndrome. Anecdotal case reports suggest benefit with cyproheptadine (Periactin™), 4 mg orally (PO) every hour for 3–4 doses ; or methysergide, 2 mg PO every 6 hours for 3–4 doses.

Seizures

- Seizures may be single and brief or multiple and sustained and may result from a variety of mechanisms

Complications

- Airway compromise resulting in apnea
- Pulmonary aspiration.
- Metabolic acidosis
- Hyperthermia
- Rhabdomyolysis
- Brain damage

Treatment

- Maintain an open airway and assist ventilation if necessary. Administer supplemental oxygen

- Administer naloxone if seizures are thought to be caused by hypoxia resulting from narcotic-associated respiratory depression.

- Check for hypoglycemia and administer dextrose and thiamine as for coma.

Anticonvulsants

Caution: Anticonvulsants can cause hypotension, cardiac arrest, or respiratory arrest if administered too rapidly.

- Diazepam, 0.1–0.2 mg/kg IV
- Lorazepam, 0.05–0.1 mg/kg IV
- Midazolam, 0.1–0.2 mg/kg IM or 0.05–0.1 mg/kg IV
- Phenobarbital, 10–15 mg/kg IV; slow infusion over 15–20 minutes
- Pentobarbital, 5–6 mg/kg IV; slow infusion over 8–10 minutes, then continuous infusion at 0.5–3 mg/kg/h titrated to effect
- Propofol, 2–2.5 mg/kg (children: 2.5–3.5 mg/kg), given in increments (40 mg at a time in adults) IV every 10–20 seconds until desired effect

Agitation, delirium, or psychosis

- Agitation, delirium, or psychosis may be caused by a variety of drugs and toxins

Complications

- Hyperkinetic behavior and struggling result in hyperthermia and rhabdomyolysis

Treatment

- Sometimes the patient can be calmed with reassuring words and reduction of noise, light, and physical stimulation.

- If this is not quickly effective, determine the rectal or tympanic temperature and begin rapid cooling and other treatment if needed

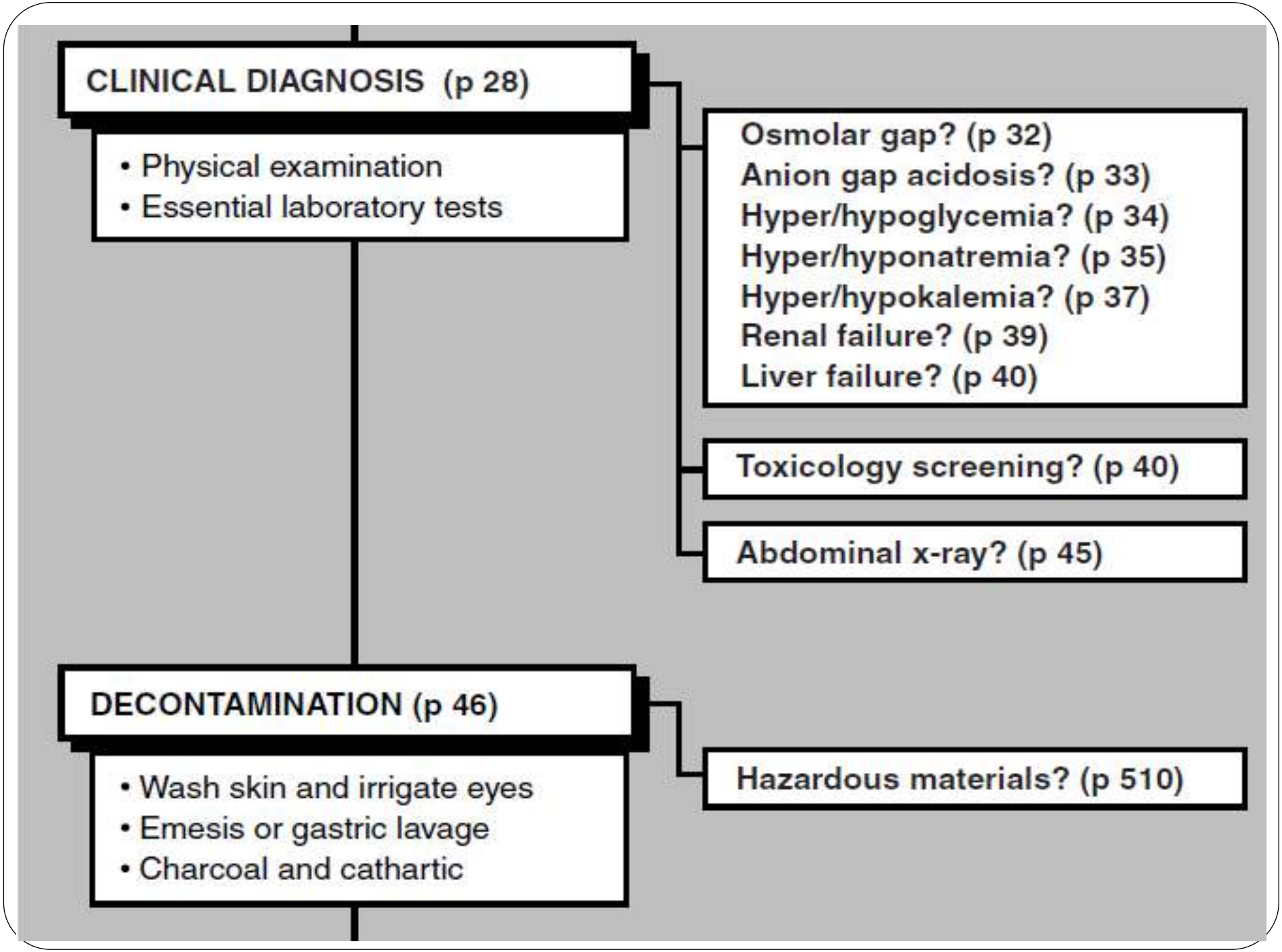
- Maintain an open airway and assist ventilation if necessary. Administer supplemental oxygen.

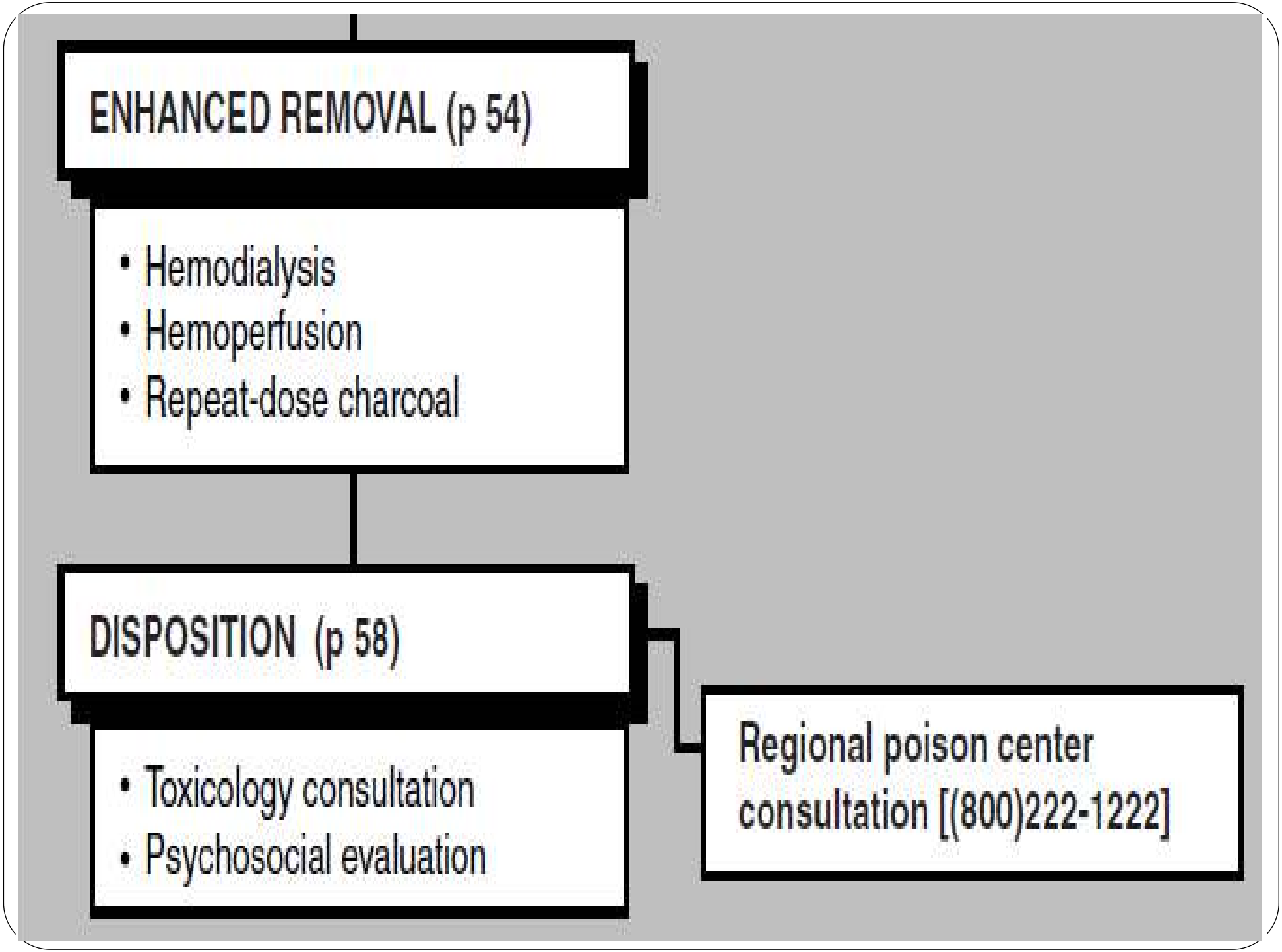
- Treat hypoglycemia , hypoxia , or other metabolic disturbances.

Administer sedatives

- Midazolam, 0.05–0.1 mg/kg IV over 1 minute, or 0.1–0.2 mg/kg IM
- Lorazepam, 0.05–0.1 mg/kg IV over 1 minute
- Diazepam, 0.1–0.2 mg/kg IV over 1 minute
- Droperidol, 2.5–5 mg IV; or haloperidol, 0.1–0.2 mg/kg IM or IV over 1 minute

- Caution: Droperidol and Haloperidol should be avoided in patients with preexisting QT prolongation or with toxicity from agents known to prolong the QT.


CLINICAL DIAGNOSIS (p 28)
• Physical examination
• Essential laboratory tests
Osmolar gap? (p 32)
Anion gap acidosis? (p 33)
Hyper/hypoglycemia? (p 34)
Hyper/hyponatremia? (p 35)
Hyper/hypokalemia? (p 37)
Renal failure? (p 39)
Liver failure? (p 40)
Toxicology screening? (p 40)
Abdominal x-ray? (p 45)
DECONTAMINATION (p 46)
• Wash skin and irrigate eyes
• Emesis or gastric lavage
• Charcoal and cathartic
Hazardous materials? (p 510)


ENHANCED REMOVAL (p 54)
• Hemodialysis
• Hemoperfusion
• Repeat-dose charcoal
DISPOSITION (p 58)
• Toxicology consultation
• Psychosocial evaluation
Regional poison center consultation [(800)222-1222]

Clinical evaluation

DIAGNOSIS OF POISONING

I. History
II. Directed physical examination
III. Laboratory tests

II. Physical examination

a) General findings.

Perform a carefully directed examination emphasizing key physical findings that may uncover one of the common "autonomic syndromes."

AUTONOMIC SYNDROMES

	Blood Pressure	Pulse Rate	Pupil Size	Sweating	Peristalsis
Alpha-adrenergic	+	–	+	+	–
Beta-adrenergic	±	+	±	±	±
Mixed adrenergic	+	+	+	+	–
Sympatholytic	–	–	- -	–	–
Nicotinic	+	+	±	+	+
Muscarinic	–	- -	- -	+	+
Mixed cholinergic	±	±	- -	+	+
Anticholinergic	±	+	+	- -	- -

[a]Key to symbols: + = increased; – = decreased; - - = markedly decreased; ± = mixed effect, no effect, or unpredictable.
[b]Adapted, with permission, from Olson KR et al: *Med Toxicol* 1987;2:54.

b) Eye findings

Pupil size

Horizontal-gaze nystagmus

c) Neuropathy

d) Abdominal findings

Vomiting

Acute bowel infarction

Perforation and peritonitis

Mechanical obstruction

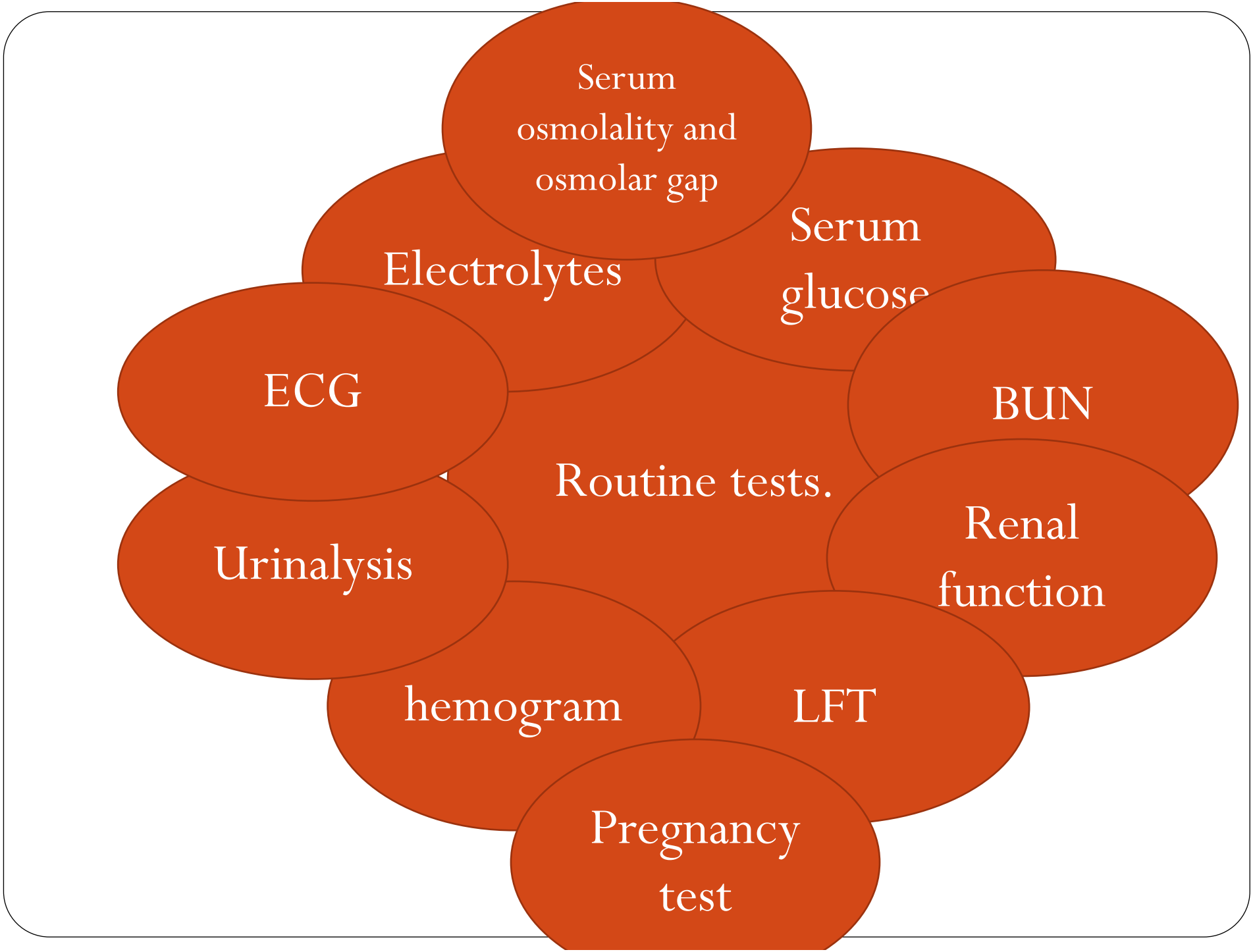
Skin findings

- Sweating or absence of sweating (autonomic syndromes)
- Flushed red skin (phenothiazines or disulfiram-ethanol interaction, hydrocarbons, or anticholinergic agents)
- Pale coloration (amphetamines, ergot)
- Cyanosis (sulfhemoglobinemia, or methemoglobine)

COMMON ODORS CAUSED BY TOXINS AND DRUGS

Odor	Drug or Toxin
Acetone	Acetone, isopropyl alcohol
Acrid or pearlike	Chloral hydrate, paraldehyde
Bitter almonds	Cyanide
Carrots	Cicutoxin (water hemlock)
Garlic	Arsenic, organophosphates, selenium, thallium
Mothballs	Naphthalene, paradichlorobenzene
Pungent aromatic	Ethchlorvynol
Rotten eggs	Hydrogen sulfide, stibine, mercaptans, old sulfa drugs
Wintergreen	Methyl salicylate

- **III. Essential clinical laboratory tests.**


Serum osmolality and osmolar gap
Electrolytes
Serum glucose
ECG
BUN
Routine tests.
Urinalysis
Renal function
hemogram
LFT
Pregnancy test

Hyperkalaemia

- Potassium level more than 5.5 mEq/L
- Digitalis, beta-2 antagonists, potassium sparing diuretics, NSAIDs, fluoride, heparin, succinylcholine
- ECG changes are important – tall, peaked T waves, ST segment depression, prolonged PR interval, and QRS prolongation
- Treatment: Glucose, insulin infusion, sodium bicarbonate, and calcium gluconate.
- Haemodialysis and exchange resins may be required.

Hypokalaemia

- Potassium level less than 3.5 mEq/L
- The causes include beta2 agonists, theophylline, insulin, chloroquine, caffeine, dextrose, loop diuretics, thiazide diuretics, oral hypoglycaemics, salicylates, sympathomimetics.
- ECG changes—flat or inverted T waves, prominent U waves, ST segment depression. In severe cases there is A-V block and ventricular fibrillation
- Treatment: Oral or IV potassium.

Hypernatraemia

- Sodium level more than 150 mEq/L
- The causes include colchicine, lithium, propoxyphene, rifampicin, phenytoin, alcohol, mannitol, sorbitol, sodium salts, excessive water loss, IV saline solutions, and salt emetics

Treatment

- Treatment depends on the cause.

- Caution: Do not reduce the serum sodium level too quickly, because osmotic imbalance may cause excessive fluid shift into brain cells, resulting in cerebral edema.

- The correction should take place over 24–36 hours;
- The serum sodium should be lowered about 1 mEq/L/h.

Hypovolemia.

- Administer normal saline (0.9% sodium chloride, NS) to restore fluid balance, then half NS in dextrose (D5W-0.45% sodium chloride).

Volume overload

- Treat with a combination of sodium-free or low sodium fluid (eg, 5% dextrose or D5W-0.25% sodium chloride) and a loop diuretic such as furosemide, 0.5–1 mg/kg.

Hyponatraemia

- Is a common electrolyte disorder defined as serum sodium level less than135 mEq per L.

- The causes include carbamazepine, chlorpropamide, NSAIDs, amitryptiline, biguanides, sulfonylureas, captopril and other ACE inhibitors, lithium, imipramine, oxytocin, and excessive water intake

Table 1. Differential Diagnosis and Treatment of Hyponatremia

Condition	*Diagnosis*	*Treatment*
Pseudohyponatremia		
Hyperglycemia (e.g., in diabetic ketoacidosis)	Elevated glucose levels (> 400 mg per dL [22.2 mmol per L]), elevated anion gap	Insulin, intravenous fluids, isotonic saline
Hyperlipidemia	Elevated total and low-density lipoprotein cholesterol levels	Statin therapy
Hyperproteinemia (e.g., in multiple myeloma)	Serum and urinary monoclonal protein, bone marrow biopsy, lytic bone lesions detected on radiography	Chemotherapy
Laboratory errors	Repeat sodium levels	—

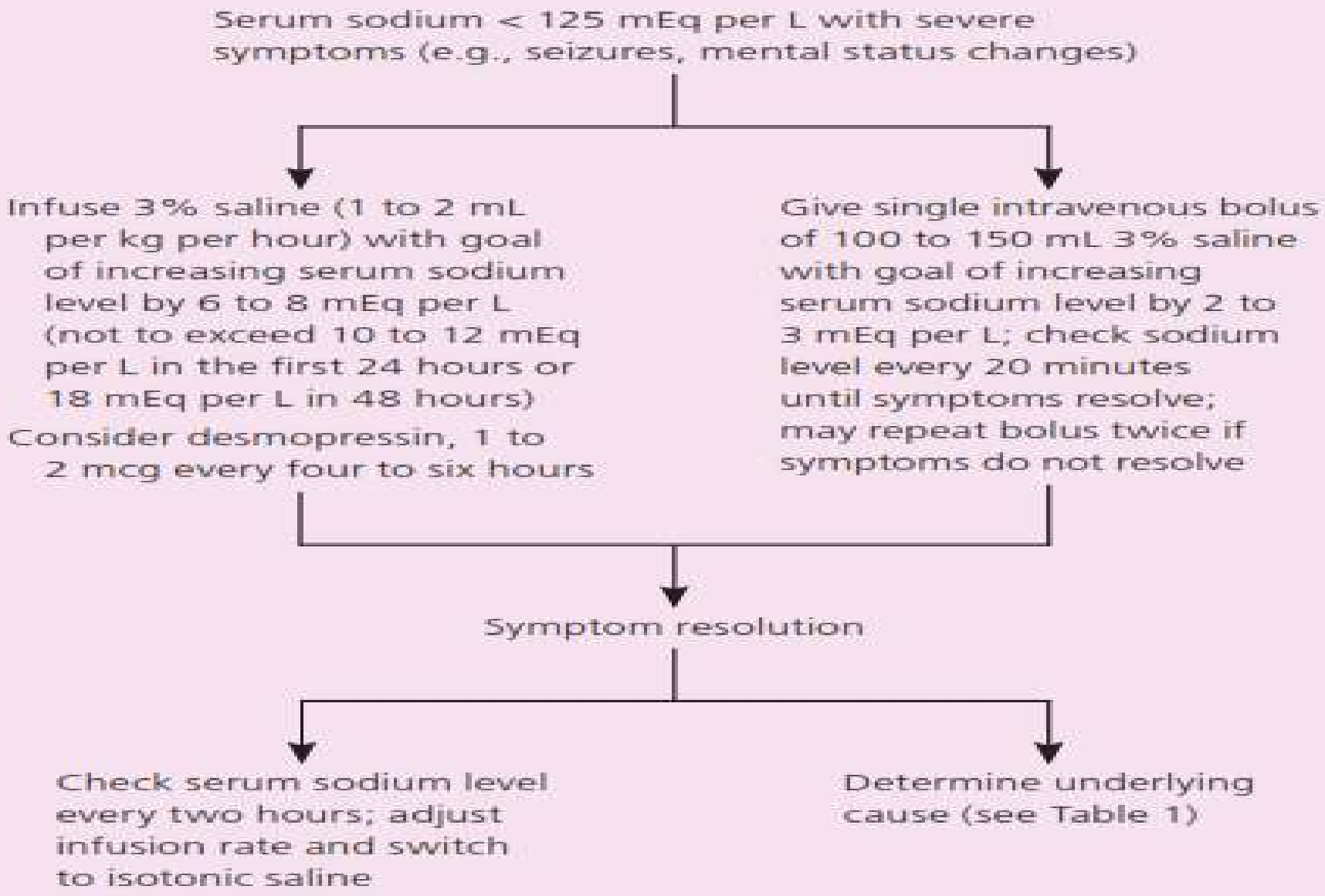
https://www.aafp.org/afp/2015/0301/p299.pdf

Hypovolemic hyponatremia		
Cerebral salt wasting	Diagnosis of exclusion (e.g., head injuries, intracranial hemorrhage); urinary sodium > 20 mEq per L	Isotonic or hypertonic saline
Diuretic use	Clinical; urinary sodium > 20 mEq per L	Stop diuretic therapy
Gastrointestinal loss (e.g., diarrhea, vomiting)	Clinical; urinary sodium < 20 mEq per L	Intravenous fluids
Mineralocorticoid deficiency (e.g., Addison disease [primary], pituitary failure [secondary], hypothalamic failure [tertiary])	Low aldosterone and morning cortisol levels, hyperkalemia, increased plasma renin level, low or increased adrenocorticotropic hormone level (cause-dependent), urinary sodium > 20 mEq per L, positive results on cosyntropin stimulation test, 21-hydroxylase autoantibodies (Addison disease), computed tomography of adrenal glands to rule out infarction	Steroid replacement therapy
Osmotic diuresis	Elevated glucose level, mannitol use	Correct glucose level, stop mannitol use
Renal tubular acidosis	Urinary osmolar gap, increased urinary pH, urinary sodium > 25 mEq per L, fractional excretion of bicarbonate > 15% to 20%, hyperchloremic acidosis, decreased serum bicarbonate level, potassium abnormalities (type dependent)	Correct acidosis, sodium bicarbonate
Salt-wasting nephropathies	Urinary sodium > 20 mEq per L	Correct underlying cause
Third spacing (e.g., bowel obstruction, burns)	Clinical; computed tomography	Intravenous fluids, relieve obstruction

Euvolemic hyponatremia		
Exercise-associated hyponatremia	Clinical	Isotonic or hypertonic saline, depending on symptoms
Glucocorticoid deficiency	Low aldosterone, morning cortisol, and adrenocorticotropic hormone levels, hyperkalemia, increased plasma renin level	Steroid replacement therapy
Hypothyroidism	Elevated thyroid-stimulating hormone level, low free thyroxine level	Thyroid replacement therapy
Low solute intake	Clinical	Increase sodium intake
Nephrogenic SIADH	Same as SIADH, with low vasopressin levels	Fluid restriction, loop diuretics
Psychogenic polydipsia	History of schizophrenia with excessive water intake	Psychiatric therapy
Reset osmostat	Free water challenge test, normal fractional excretion of uric acid (urate)	Treat underlying disease
SIADH	Decreased osmolality, urinary osmolality > 100 mOsm per kg, euvolemia, urinary sodium > 20 mEq per L, absence of thyroid disorders or hypocortisolism, normal renal function, no diuretic use	Fluid restriction, consider vaptans
SIADH secondary to medication use (e.g., barbiturates, carbamazepine [Tegretol], chlorpropamide, diuretics, opioids, selective serotonin reuptake inhibitors, tolbutamide, vincristine)	SIADH with use of causative agent	Stop causative medication
Water intoxication	Clinical; excessive water intake	Diuresis

Hypervolemic hyponatremia		
Heart failure	Clinical (e.g., jugular venous distention, edema), elevated B-type natriuretic peptide level, echocardiography, urinary sodium < 20 mEq per L	Diuretics, angiotensin-converting enzyme inhibitors, beta blockers
Hepatic failure/cirrhosis	Elevated liver function tests, ascites, elevated ammonia level, biopsy, urinary sodium < 20 mEq per L	Furosemide (Lasix), spironolactone (Aldactone), transplant
Nephrotic syndrome	Urinary protein, urinary sodium < 20 mEq per L	Treat underlying cause
Renal failure (acute or chronic)	Blood urea nitrogen–to-creatinine ratio, glomerular filtration rate, proteinuria, urinary sodium > 20 mEq per L	Correct underlying disease with angiotensin-converting enzyme inhibitors or angiotensin receptor blockers

Treatment of Severe Symptomatic Hyponatremia



Hypernatremia

- Hypernatremia is defined as a serum sodium level greater than 145 mEq per L.
- The causes include colchicine, lithium, propoxyphene, rifampicin, phenytoin, alcohol, mannitol, sorbitol, sodium salts, excessive water loss, IV saline solutions, and salt emetics

Table 2. Differential Diagnosis and Treatment of Hypernatremia

Condition	*Diagnosis*	*Treatment*
Hypovolemic hypernatremia		
Body fluid loss (e.g., burns, sweating)	Clinical	Free water replacement
Diuretic use	Clinical	Stop diuretic
Gastrointestinal loss (e.g., vomiting, diarrhea, fistulas)	Clinical	Free water replacement
Heat injury	Elevated temperature, myoglobinuria, elevated creatinine level	Intravenous fluids, supportive care
Osmotic diuresis (e.g., hyperosmolar nonketotic coma, mannitol use, enteral feeding)	Elevated glucose level; sodium level often elevated after correction	Correct glucose level, stop causative agent
Post-obstruction	Clinical	Supportive care

Euvolemic hypernatremia		
Central diabetes insipidus	Clinical history of central nervous system insult; urinary concentration after administration of desmopressin	Treatment is rarely required unless thirst is impaired
Fever	Clinical	Treat underlying cause
Hyperventilation/mechanical ventilation	Clinical	Adjust ventilation
Hypodipsia	Clinical	Increase free water consumption
Medications (e.g., amphotericin, aminoglycosides, lithium, phenytoin [Dilantin])	Medication review	Stop causative medication
Nephrogenic diabetes insipidus	History of nephrotoxic medication use (amphotericin, demeclocycline [Declomycin], foscarnet, lithium, methoxyflurane), failure to concentrate urine after administration of desmopressin	Stop causative medication
Sickle cell disease	Hemoglobin electrophoresis	Treat underlying disease
Suprasellar and infrasellar tumors	Magnetic resonance imaging	Treat underlying disease

Hypervolemic hypernatremia		
Cushing syndrome	24-hour urinary cortisol and adrenocorticotropic hormone levels, dexamethasone suppression test	Treat underlying disease
Hemodialysis	Clinical history	Treat underlying disease
Hyperaldosteronism	History of hypertension and hypokalemia, plasma aldosterone-to-renin ratio,[3] history of hypertension and hypokalemia	Treatment usually not needed for hypernatremia
Iatrogenic (e.g., salt tablet or salt water ingestion, saline infusions, saline enemas, intravenous bicarbonate, enteral feedings)	Recent administration of hypertonic saline, enteral feedings, sodium bicarbonate infusion, or hypertonic dialysis	Stop causative medication, rapid free water replacement

Treatment

- Treatment depends on the cause
- Caution: Avoid overly rapid correction of the sodium, because brain damage (central pontine myelinolysis) may occur if the sodium is increased by more than 25 mEq/L in the first 24 hours
- Obtain frequent measurements of serum and urine sodium levels and adjust the rate of infusion as needed to increase the serum sodium by no more than 1–1.5 mEq/h.
- For patients with profound hyponatremia (serum sodium < 110 mEq/L) accompanied by coma or seizures, administer hypertonic (3% sodium chloride) saline, 100–200 mL.

Hyponatremia with hypovolemia

- Replace lost volume with normal saline (0.9% sodium chloride, NS).

- If adrenal insufficiency is suspected, give hydrocortisone, 100 mg every 6–8 hours.

Hyponatremia with volume overload

- Restrict water (0.5–1 L/d) and treat the underlying condition
- If diuretics are given, do not allow excessive free water intake
- Hypertonic saline is dangerous in these patients; if it is used, also administer furosemide, 0.5–1 mg/kg
- Consider hemodialysis to reduce volume and restore the sodium level.

Hyponatremia with normal volume

- Asymptomatic patients may be treated conservatively with water restriction (0.5–1 L/d).

- For patients with coma or seizures, give hypertonic (3%) saline, 100–200 mL, along with furosemide, 0.5–1 mg/kg.

Hypocalcaemia

- Calcium level less than 4 mEq/L
- The causes include hydrogen fluoride, oxalates, aminoglycosides, ethanol, phenobarbitone, phenytoin, theophylline, and ethylene glycol.
- Treatment: Calcium gluconate IV (10% solution, 10 ml at a time, slowly).

Decontamination

I. Surface decontamination

- Skin
- Eyes
- Inhalation

II. Gastrointestinal decontamination.

Skin

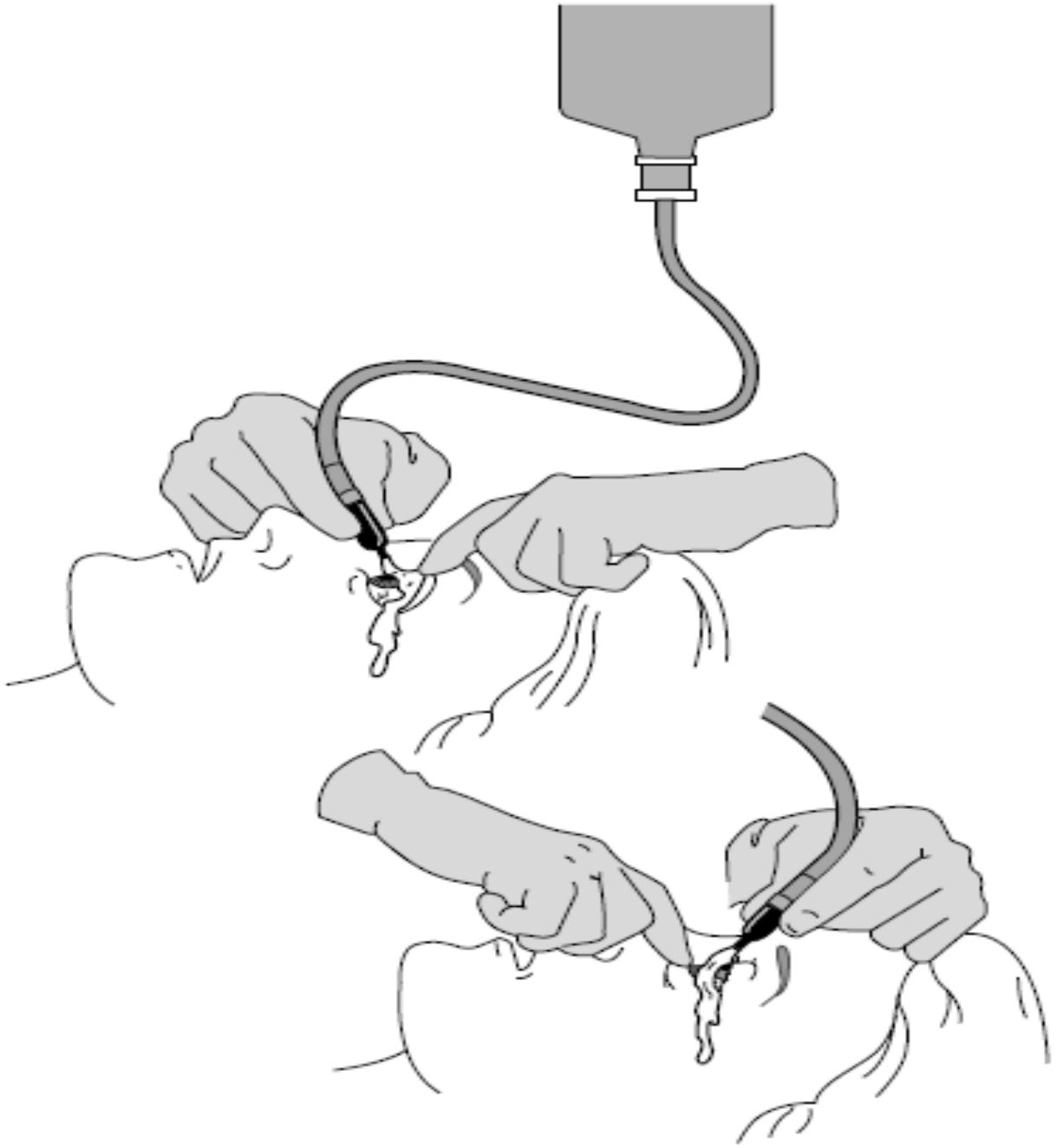
- Exposed persons should rinse with cold water
- Corroded areas should be irrigated with water or saline for at least 15 minutes.
- Remove all contaminated clothes and provide fresh clothes, or cover with clean bed sheet.
- Be careful not to expose yourself
- Rarely a need for chemical neutralization of a substance spilled on the skin, heat generated by chemical neutralization can potentially create worse injury

SOME TOPICAL AGENTS FOR CHEMICAL EXPOSURES TO THE SKIN

Chemical Corrosive Agent	Topical Treatment
Hydrofluoric acid	Calcium soaks
Oxalic acid	Calcium soaks
Phenol	Mineral oil or other oil; isopropyl alcohol
Phosphorus (white)	Copper sulfate 1% (colors embedded granules blue, facilitates removal)

Eye

- Cornea is sensitive
- Corrosive agents and hydrocarbon solvents may rapidly damage the corneal surface
- Flush exposed eyes with tepid tap water or saline
- Instill local anesthetic drops in the eye first to facilitate irrigation
- Place the victim in a supine position under a tap or use intravenous tubing to direct a stream of water across the nasal bridge into the medial aspect of the eye.
- Use at least 1 L to irrigate each eye



- If the substance is an acid or a base check the pH of the tears after irrigation and continue irrigation if the pH remains abnormal.

- After irrigation is complete, check the conjunctival and corneal surfaces carefully for injury

- If injury is suspected refer ophthalmologist immediately.

Inhalation.

- Give supplemental humidified oxygen, if available. Assist ventilation if necessary
- Endotracheally intubate patients who show evidence of progressive airway compromise.
- Observe for late-onset noncardiogenic pulmonary edema resulting from slower-acting toxins

II. Gastrointestinal decontamination.

- Emesis
- Gastric lavage
- Catharsis
- Activated charcoal
- Whole bowel irrigation.

- Delay of 60 minutes or more after ingestion, very little of the ingested dose is removed by emesis or gastric lavage

- In some circumstances, aggressive gut decontamination may be life saving, even after more than 1–2 hours.

- Examples include ingestion of highly toxic drugs
- Colchicine, 150–200 aspirin tablets

Emesis

- **Syrup of Ipecac**
- **Apomorphine**
- **Stimulation of the posterior pharynx**

Syrup of Ipecac

- The only recommended method of inducing a poisoned patient to vomit is administration of syrup of ipecacuanha (or ipecac)

- The current consensus is that syrup of ipecac must NOT be used, except in justifiable circumstances.

- Root of a small shrub (Cephaelis ipecacuanha or C. acuminata)

Active principles:

- Cephaeline, emetine, and traces of psychotrine

Indications:

- Conscious and alert poisoned patient who has ingested a poison not more than 4 to 6 hours earlier.

Mode of action:

- Local activation of peripheral sensory receptors in the gastrointestinal tract.
- Central stimulation of the chemoreceptor trigger zone with subsequent activation of the central vomiting center.

Contra-indications

Relative :	Absolute :
–Very young (less than 1 year), -very old patient – Pregnancy – Heart disease – Bleeding diathesis – Ingestion of cardiotoxic poison –Time lapse of more than 6 to 8 hours	– Convulsions, or ingestion of a convulsant poison – Impaired gag reflex – Coma – Foreign body ingestion – Corrosive ingestion – Ingestion of petroleum distillates, or those drugs which cause altered mental status (phenothiazines, antihistamines, opiates, ethanol, benzodiazepines, tricyclics).

Complications

- Cardiotoxicity
- Aspiration pneumonia
- Oesophageal mucosal or Mallory Weiss tears

Apomorphine

- Other acceptable method of inducing emesis that is advocated involves the use of apomorphine

Mechanism –

- directly acts on the chemoreceptor trigger zone

Dose

- 6 mg (adult), and 1 to 2 mg (child). Causes vomiting within 3 to 5 minutes

Contraindication-

- Its Respiratory depressant so contraindicated in all situations of CNS depression

Not recommended for emesis

- Copper sulfate
- Zinc sulfate
- warm saline
- Mustard water

Gastric Lavage (Stomach Wash)

- Lavage should be considered only if a patient has ingested a life-threatening amount of a poison and presents to the hospital within 1 to 2 hours of ingestion.

- American Academy of Clinical Toxicology (AACT), and the European Association of Poison Centres and Clinical Toxicology (EAPCCT) says use of gastric lavage should not be employed routinely in the management of poisoned patients

- In addition, the procedure may delay administration of activated charcoal and may hasten the movement of drugs and poisons into the small intestine.

Indications

- life-threatening massive overdose
- Exhibit significant morbidity and present within 1 to 2 hours of ingestion
- Some still recommend Lavage upto 6 to 12 hours post-ingestion in the case of salicylates, tricyclics, carbamazepine, and barbiturates
- Unwilling or unable to swallow for whole-bowel irrigation and activated charcoal
- To dilute and remove corrosive liquids from the stomach and to empty the stomach in preparation for endoscopy

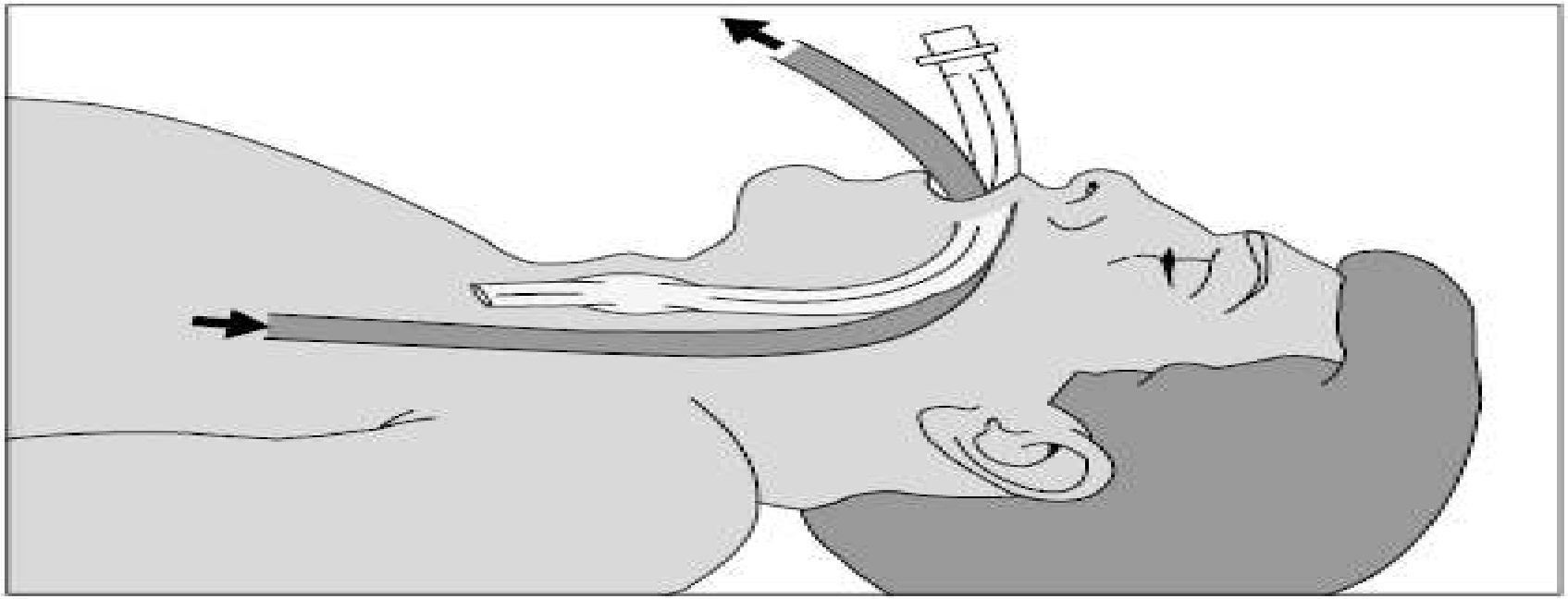
Contraindications

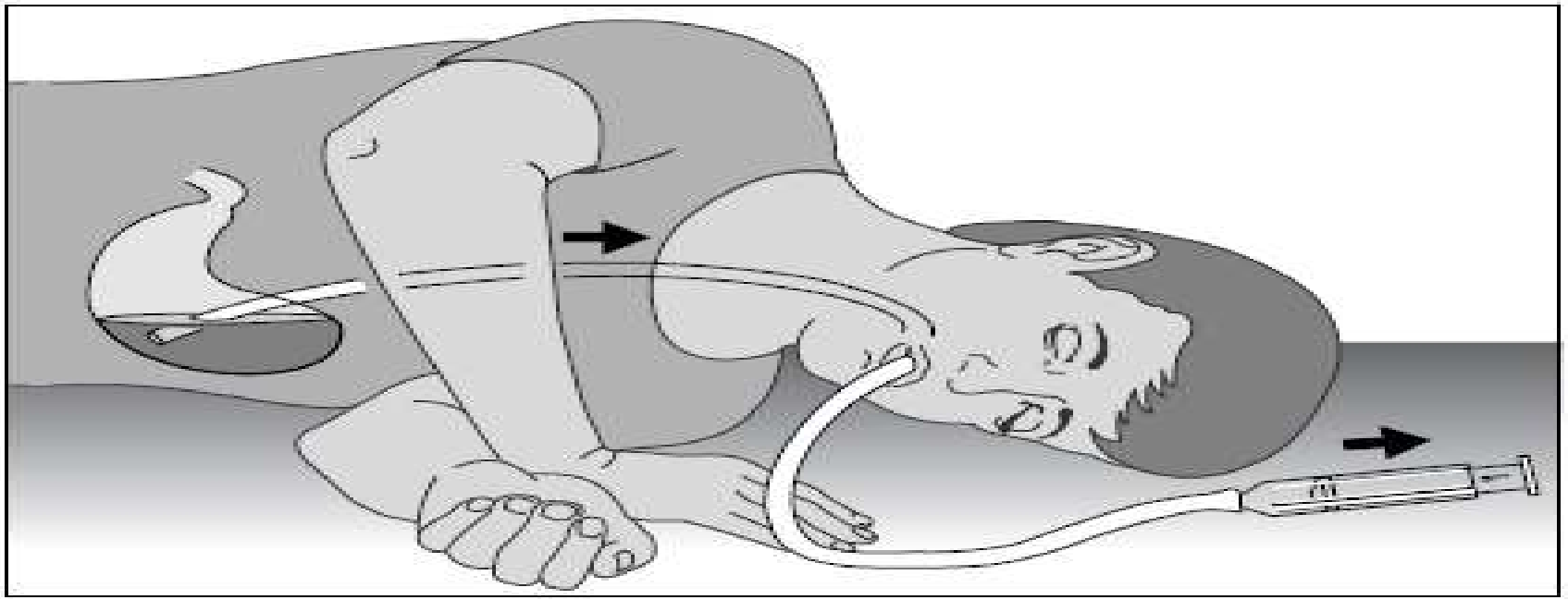
Relative:	Absolute:
Haemorrhagic diathesis, Oesophageal varices, recent surgery, advanced pregnancy, ingestion of alkali, coma.	Marked hypothermia, prior significant vomiting, unprotected airway in coma, and ingestion of acid or convulsant or petroleum distillate, and sharp substances.

Technique

- Obtain consent
- Endotracheal intubation must be done prior to lavage in the comatose patient.
- Place the patient head down on his left lateral side (20o tilt on the table).
- Mark the length of tube to be inserted (50 cm for an adult, 25 cm for a child)
- The ideal tube for lavage is the lavacuator (clear plastic or gastric hose)
- In India however, the Ewald tube is most often used
- Tube inner diameter corresponds to at least 36 to 40 French size for adult
- In child-at least 22 to 28 French, Ryle's tube may be sufficient

Fig. 3.3: Ryle's tube





- The preferred route of insertion is oral
- Lubricate the inserting end of the tube with vaseline or glycerine
- After insertion , check position with air insufflation while listening with a stethoscope or by aspiration with pH testing of the aspirate.
- In an adult, 200 to 300 ml of warm (38o C) saline or plain water are used
- In a child, 10 to 15 ml/kg body weight of warm saline is used each time
- Lavage is carried out using small quantities

- Remove by gravity or active suction
- In certain specific types of poisoning, special solutions may be used in place of water or saline
- Lavage should be continued until no further particulate matter is seen, and the efferent lavage solution is clear
- At the end of lavage, pour a slurry of activated charcoal in water (1 gm/kg), and an appropriate dose of an ionic cathartic into the stomach, and then remove the tube.

Complications

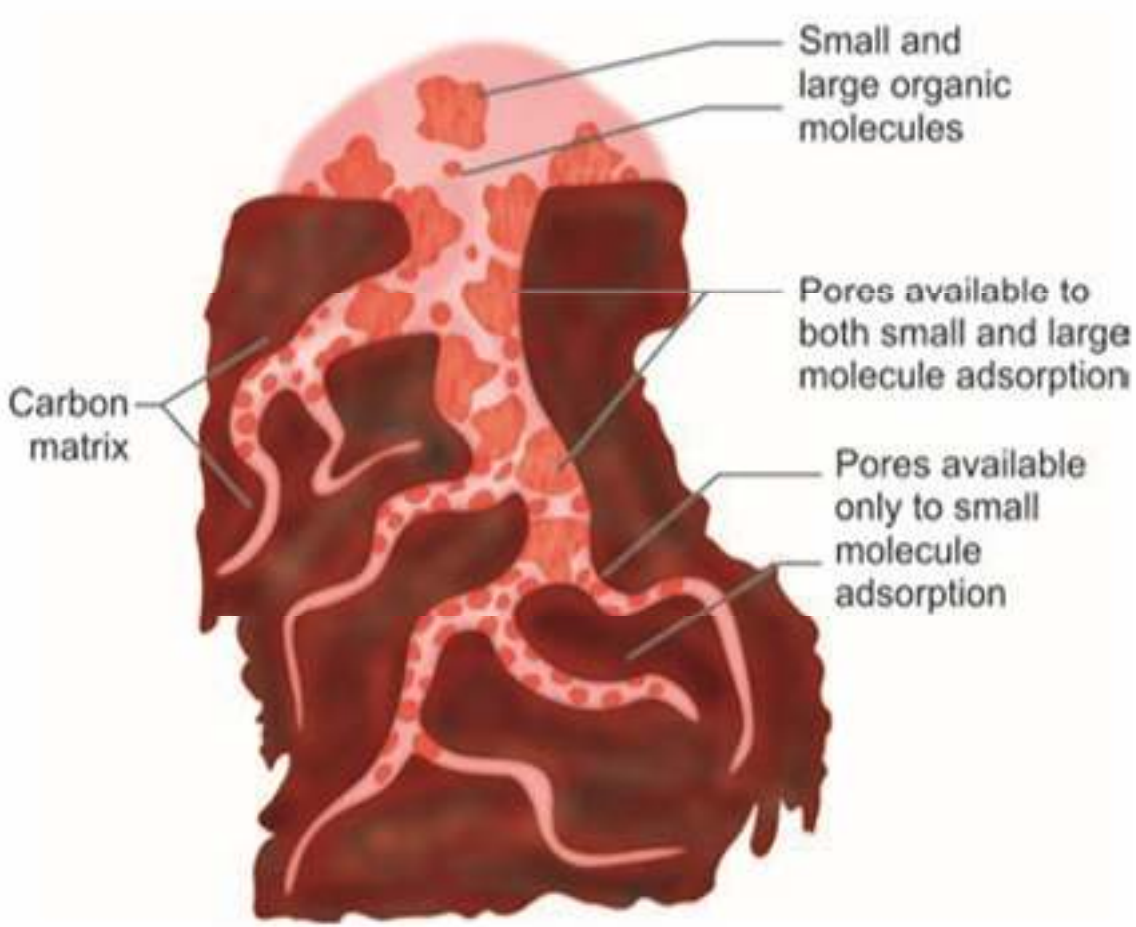
- Aspiration pneumonia.
- Laryngospasm.
- Sinus bradycardia and ST elevation on the ECG.
- Perforation of stomach or oesophagus

Activated charcoal

- Activated charcoal is a fine, black, odourless, tasteless powder.
- Made from burning wood, coconut shell, bone, sucrose, or rice starch, followed by treatment with an activating agent (steam, carbon dioxide, etc.).
- Particles are extremely small, but have an extremely large surface area.
- Each gram of activated charcoal works out to a surface area of 1000 square metres

Mode of action

- Adsorbing poison on to its surface and decreasing their absorption



- Dose :1 gm/kg body weight (usually 50 to 100 gm in an adult, 10 to 30 gm in a child).

- Procedure: Add four to eight times the quantity of water to the calculated dose of activated charcoal, and mix to produce a slurry or suspension and administered to the patient after emesis or lavage, or as sole intervention.

- Multiple-dose Activated Charcoal: The use of repeated doses (amounting to 150 to 200 gm of activated charcoal) has been demonstrated to be very effective in the elimination of certain drugs such as theophylline, phenobarbitone, quinine, digitoxin, phenylbutazone, salicylates and carbamazepine.

- The actual dose of activated charcoal for multiple dosing has varied considerably in the available medical literature, ranging from 0.25 to 0.5 gm/kg every 1 to 6 hours, to 20 to 60 gm for adults every 1, 2, 4, or 6 hours. The total dose administered is more important than frequency of administration.

- Disadvantages:

Unpleasant taste, Provocation of vomiting , Constipation/diarrhea, Pulmonary aspiration ,Intestinal obstruction (especially with multiple-dose activated charcoal).

- Contraindications

Absent bowel sounds or proven ileus

Small bowel obstruction ,Caustic ingestion ,

Ingestion of petroleum distillates

Catharsis

- Catharsis means purification.
- It is achieved by purging the gastrointestinal tract (particularly the bowel) of all poisonous material.
- The two main groups of cathartics used
    - **Ionic or Saline: –**
    - These cathartics alter physico-chemical forces within the intestinal lumen leading to osmotic retention of fluid which activates motility reflexes and enhances expulsion.
    - The doses of recommended cathartics are as follows: - Magnesium citrate: 4 ml/kg - Magnesium sulfate: 30 gm (250 mg/kg in a child) - Sodium sulfate: 30 gm (250 mg/kg in a child).

Catharsis

- **Saccharides:** – Sorbitol (D-glucitol) is the cathartic of choice in adults because of better efficacy than saline cathartics, but must not be used as far as possible in young children owing to risk of fluid and electrolyte imbalance (especially hypernatraemia).

- Dose of sorbitol: 50 ml of 70% solution (adult).

Catharsis

- Efficacy of catharsis: While cathartics do reduce the transit time of drugs in the gastrointestinal tract, there is no real evidence that it improves morbidity or mortality in cases of poisoning.
- Contraindications:

Corrosives

Existing electrolyte imbalance

Paralytic ileus

Severe diarrhoea

Recent bowel surgery

Abdominal trauma

Renal failure.

Catharsis

- Oil based cathartics should never be used in poisoning since they increase the risk of lipoid pneumonia, increase the absorption of fat soluble poisons, and inactivate medicinal charcoal's effects when administered along with them.

Whole bowel irrigation (Whole Gut lavage)

- This is a method that is being increasingly recommended for late presenting overdoses

- It involves the instillation of large volumes of a suitable solution into the stomach in a nasogastric tube over a period of 2 to 6 hours producing voluminous diarrhea

- Special solutions are used such as PEG-ELS (i.e. polyethylene glycol and electrolytes lavage solution combined together, which is an isosmolar electrolyte solution), and PEG-3350 (high molecular weight polyethylene glycol)

- These are safe and efficacious, without producing any significant changes in serum electrolytes, serum osmolality, body weight, or haematocrit

Indications—

- Ingestion of large amounts of toxic drugs in patients presenting late (> 4 hours post-exposure)
- Overdose with sustained-release preparations.
- Ingestion of substances not adsorbed by activated charcoal, particularly heavy metals.
- Ingestion of foreign bodies such as miniature disc batteries (button cells), cocaine filled packets (body packer syndrome),** etc.
- Ingestion of slowly dissolving substances: iron tablets, paint chips, bezoars, concretions, etc.

Procedure—

- Insert a nasogastric tube into the stomach and instil one of the recommended solutions at room temperature, at a rate of 2 litres per hour in adults, and 0.5 litre per hour in children.

- The patient should preferably be seated in a commode.

- The use of metoclopramide IV, (10 mg in adults, 0.1 to 0.3 mg/ kg in children) can minimise the incidence of vomiting.

- The procedure should be continued until the rectal effluent is clear, which usually occurs in about 2 to 6 hours

Complications—

- Vomiting
- Abdominal distension and cramps
- Anal irritation.

Contraindications—

- Gastrointestinal pathology such as obstruction, ileus, haemorrhage, or perforation.

Elimination Enhancement

- Forced Diuresis
- Extracorporeal techniques
  - Haemodialysis
  - Haemoperfusion
  - Peritoneal dialysis
  - Haemofiltration
  - Plasmapheresis
  - Plasma perfusion

Indications

Does the patient need enhanced removal?

1. Severe or critical intoxication with a deteriorating condition despite maximal supportive care (eg, phenobarbital overdose with intractable hypotension).

2. The normal or usual route of elimination is impaired (e.g., lithium overdose in a patient with renal failure).

3. The patient has ingested a known lethal dose or has a lethal blood level (eg, theophylline or methanol)

4. The patient has underlying medical problems that could increase the hazards of prolonged coma or other complications (e.g., severe chronic obstructive pulmonary disease or congestive heart failure).

Is the drug or toxin accessible to the removal procedure?

- For a drug to be accessible to removal by extracorporeal procedures, it should be located primarily within the **bloodstream or in the extracellular fluid.**

1. **Volume of distribution**
2. **Protein binding**

Will the method work?

Clearance

CL = extraction ratio × blood flow rate

- Clearance is not the same as elimination rate (milligrams per minute). If the blood concentration is small, the actual amount of drug removed is also small.
- **Total clearance**
- Renal excretion plus hepatic metabolism plus respiratory and skin excretion plus dialysis.
- If the contribution of dialysis is small compared with the total clearance rate, then the procedure will contribute little to the overall elimination rate

- **half-life** (T1/2) depends on the volume of distribution and the clearance

Forced Diuresis

- Ionisation of acidic drugs is increased in an alkaline environment, and that of basic drugs is increased in an acid solution.

- Manipulation of the urinary pH enhances renal excretion.

Forced alkaline diuresis

- This is most useful in the case of phenobarbitone, lithium, and salicylates.

- Administer 1500 ml of fluid IV, in the first hour as follows :

– 500 ml of 5% dextrose

– 500 ml of 1.2 or 1.4% sodium bicarbonate

– 500 ml of 5% dextrose.

The movement of substance occur:

- **Diffusion** : Depends on the concentration difference between blood and dialysate and molecule size. Water and low molecular weight solutes move through the pores of semipermeable membrane to establish equilibrium. Smaller molecule will be cleared from blood.

- **Ultra filtration** : A pressure gradient either positive or negative across the semi permeable membrane will produce a net directional movement of fluid from relative high to low pressure regions.

- **Convection** : Any molecule carried by ultra filtration may move passively with flow by Convection. Larger molecules are cleared effectively by convection.

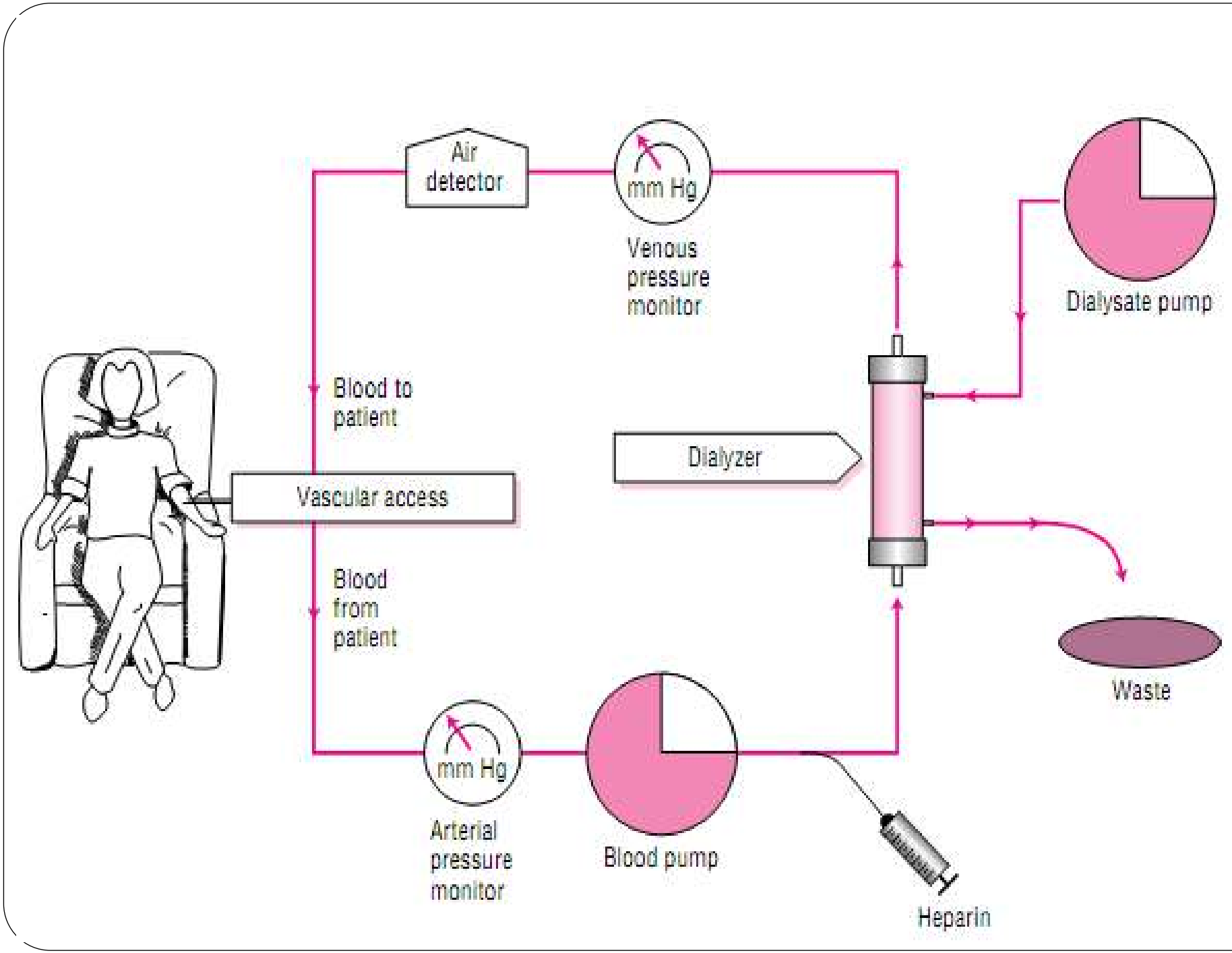
Haemodialysis.

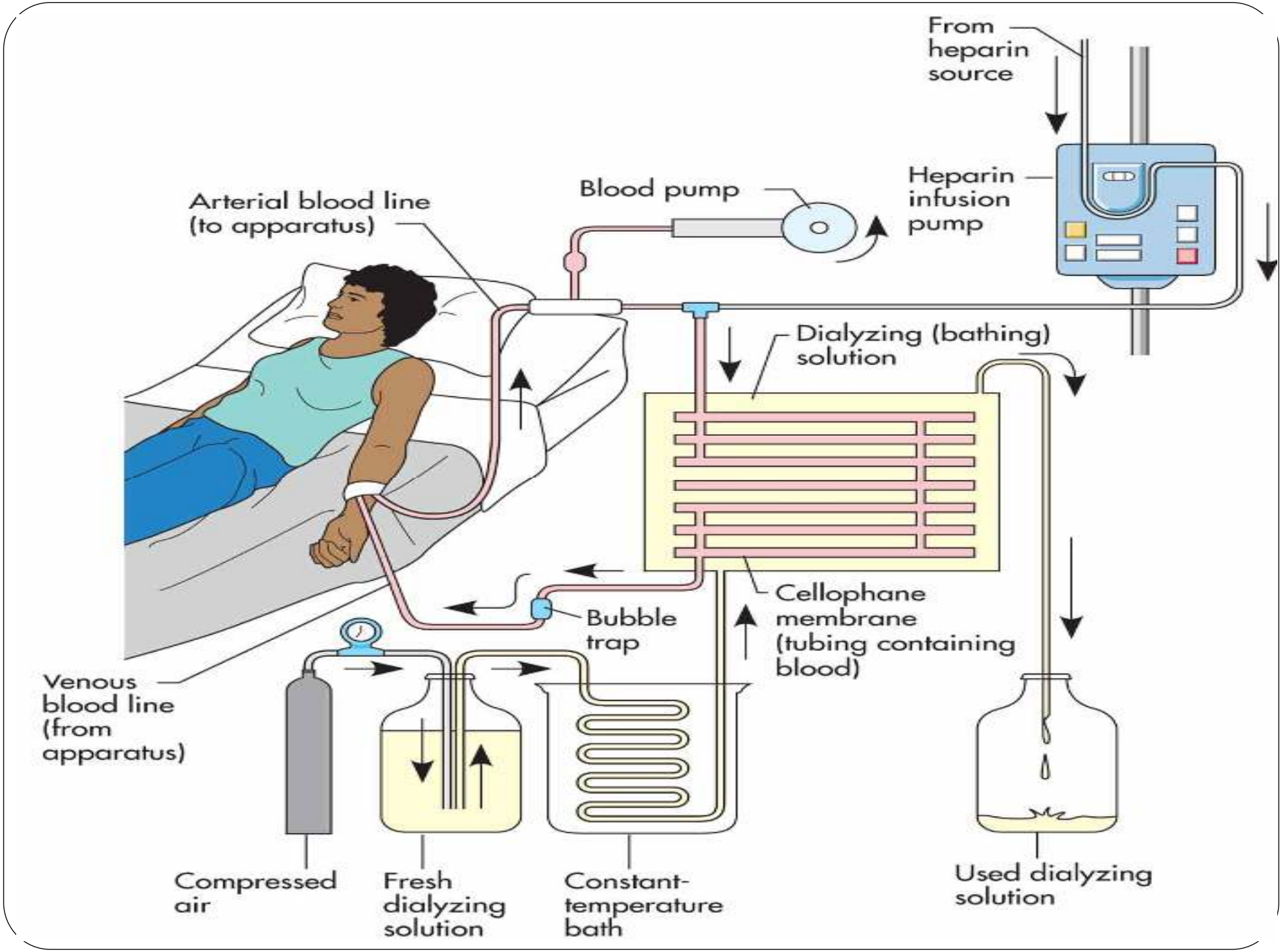
- Blood is heparinized and diverted out of a large central venous cannula line and actively pumped through lumen of dialyser, returning to the patient by a venous line.

- In haemodialys, the blood flows through a dialysis machine that filters away the waste products.

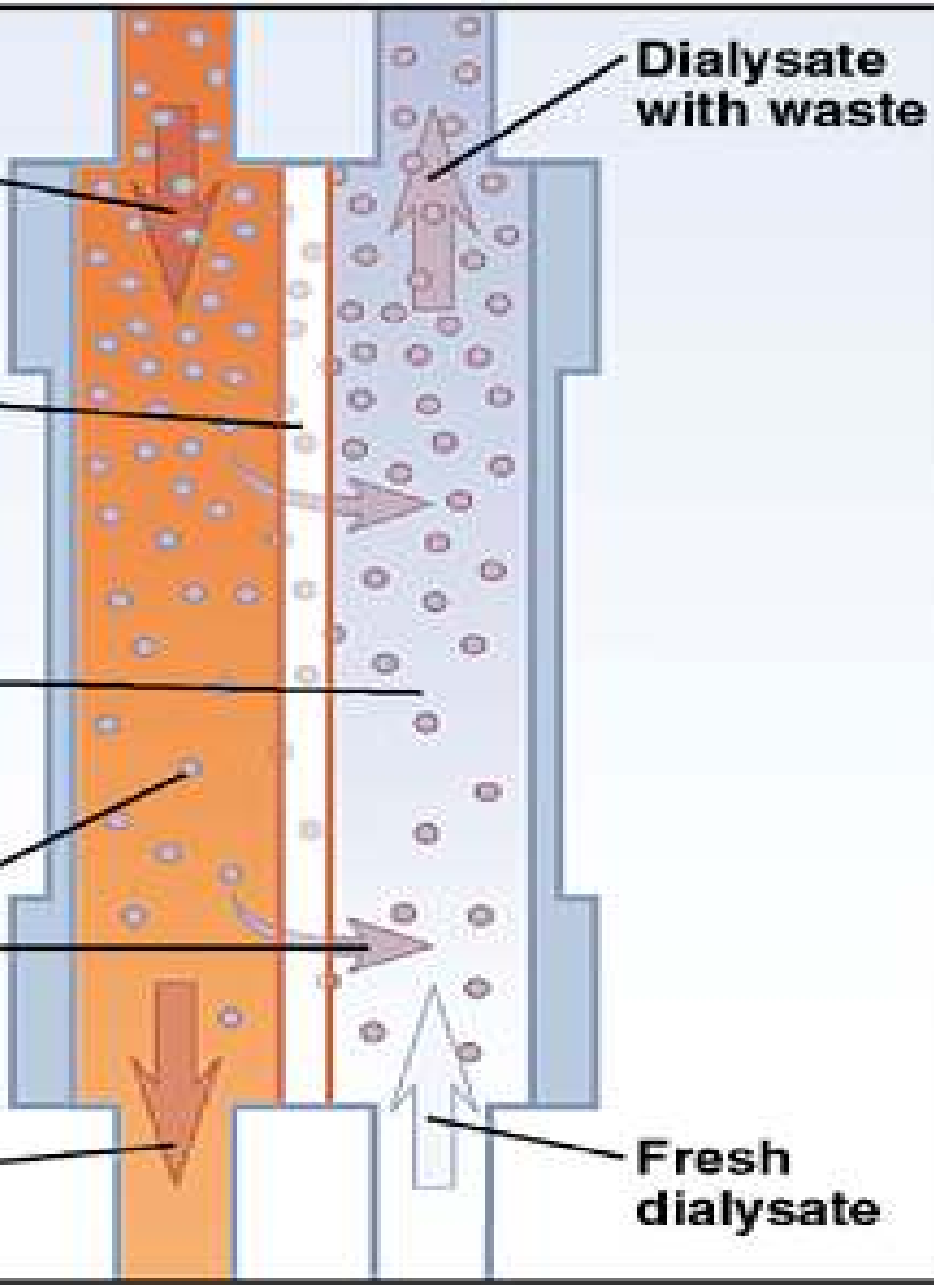
- This artificial kidney or dialyser is of various sizes and contains thousands of hollow fibres.

-


Air detector
mm Hg
Venous pressure monitor
Dialysate pump
Blood to patient
Dialyzer
Vascular access
Blood from patient
Waste
mm Hg
Arterial pressure monitor
Blood pump
Heparin


From heparin source
Heparin infusion pump
Blood pump
Arterial blood line (to apparatus)
Dialyzing (bathing) solution
Cellophane membrane (tubing containing blood)
Bubble trap
Venous blood line (from apparatus)
Compressed air
Fresh dialyzing solution
Constant-temperature bath
Used dialyzing solution

Inside the Dialyzer



Blood from your body enters the machine and flows past one side of a membrane.

The membrane is a barrier that keeps blood and dialysate from mixing, but lets waste through.

Dialysate is a special fluid that pulls waste from blood. It flows past the other side of the membrane.

Waste, extra fluid, and chemicals move through the membrane into the dialysate.

Clean, filtered blood goes back to your body.

- These fibers act like a semi-permeable membrane, they allow wastes to pass through but retain proteins.

- The blood circulates on one side of the membrane and the dialysate (a solution of water& electrolytes) on the other side.

- The toxic products and excess fluids pass through the dialyser and are carried away in the dialysate and cleansed blood, flows back into the body.
- Eg; Lithium, Phenobarbitone, Salicylates

- Drugs and toxins flow passively across the semipermeable membrane down a concentration gradient into a dialysate (electrolyte and buffer) solution.

- Fluid and electrolyte abnormalities can be corrected concurrently.

- Flow rates of up to 300–500 mL/min can be achieved, and clearance rates may reach 200–300 mL/min. Removal of drug is dependent on flow rate

Enhance clearance

- Small size (molecular weight < 500 daltons),
- Water solubility, and
- Low protein binding
- Low Vd

Complications

- Infection (especially AIDS, hepatitis B)
- Thrombosis
- Hypotension
- Air embolism
- Bleeding (due to use of heparin as a systemic anticoagulant).

Hemoperfusion

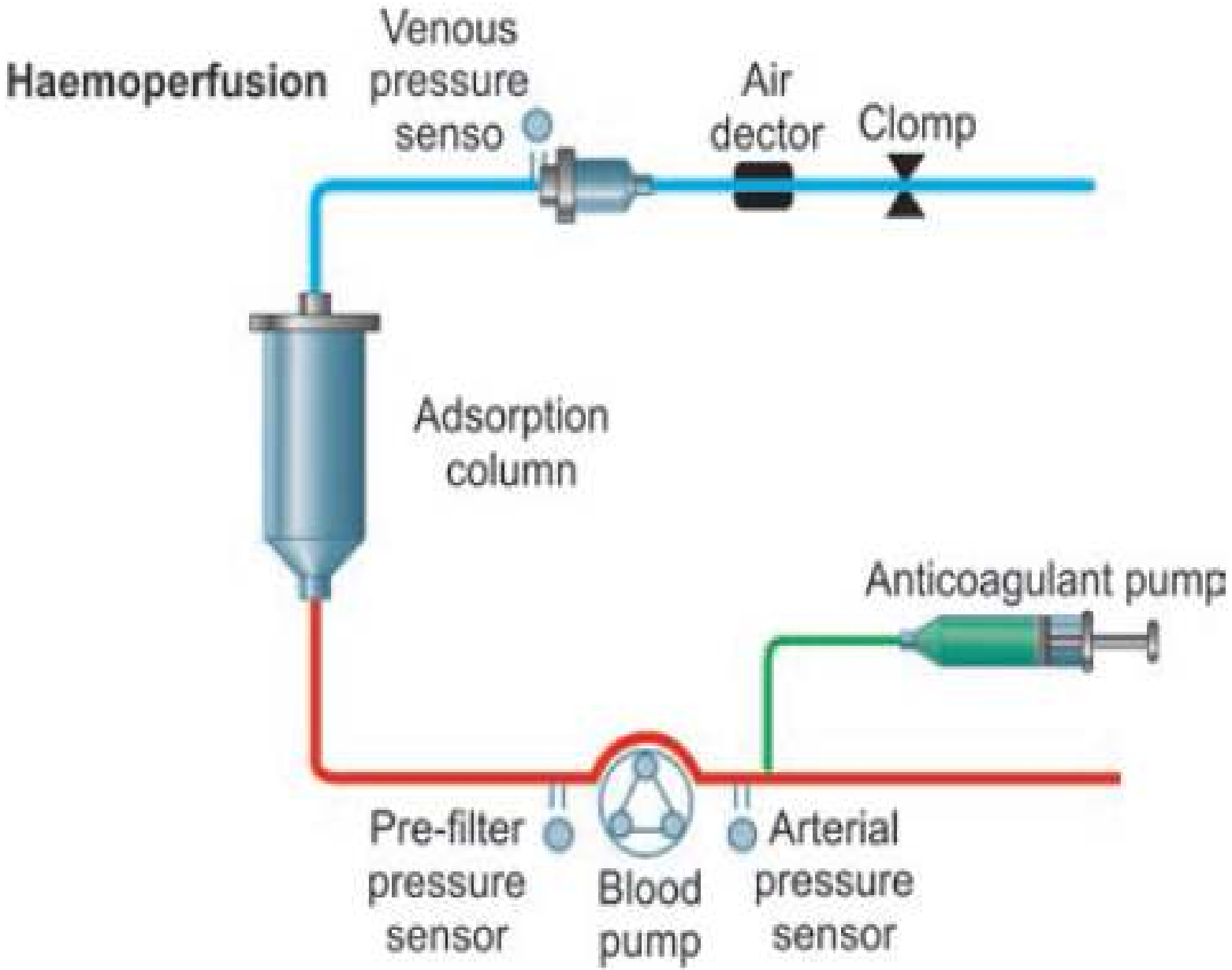
- Using equipment and vascular access similar to that for hemodialysis, the blood is pumped directly through a column containing an adsorbent material (either charcoal or Amberlite™ resin).

- Systemic anticoagulation is required, often in higher doses than for hemodialysis.

- The drug or toxin is in direct contact with the adsorbent material, drug size, water solubility, and protein binding are less important limiting factors

- For most drugs, hemoperfusion can achieve greater clearance rates than hemodialysis

- Hemodialysis clearance rate for phenobarbital is 60–80 mL/min, whereas the hemoperfusion clearance rate is 200–300 mL/min.


Haemoperfusion
Venous pressure senso
Air dector
Clomp
Adsorption column
Anticoagulant pump
Pre-filter pressure sensor
Blood pump
Arterial pressure sensor

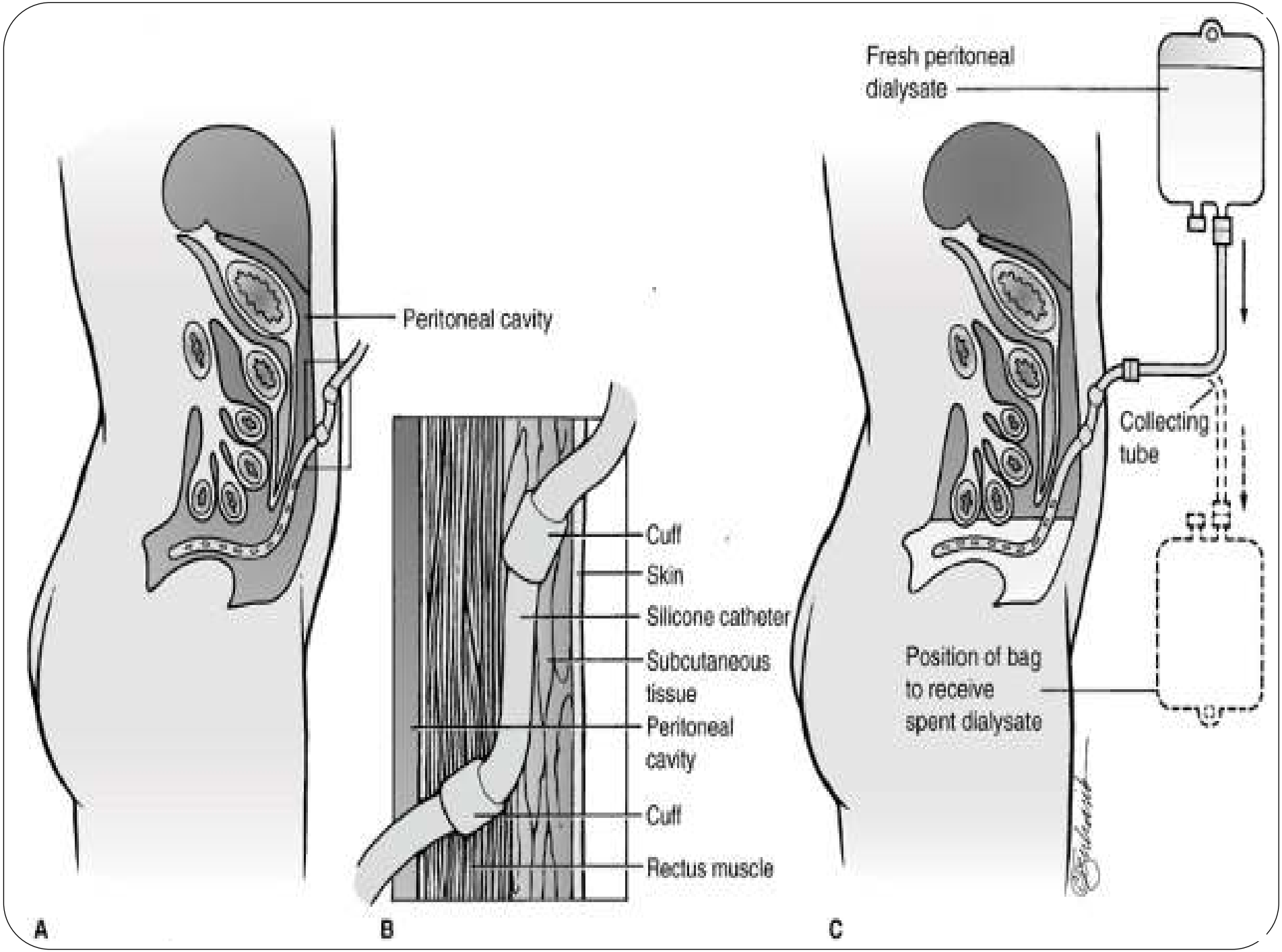
Complications

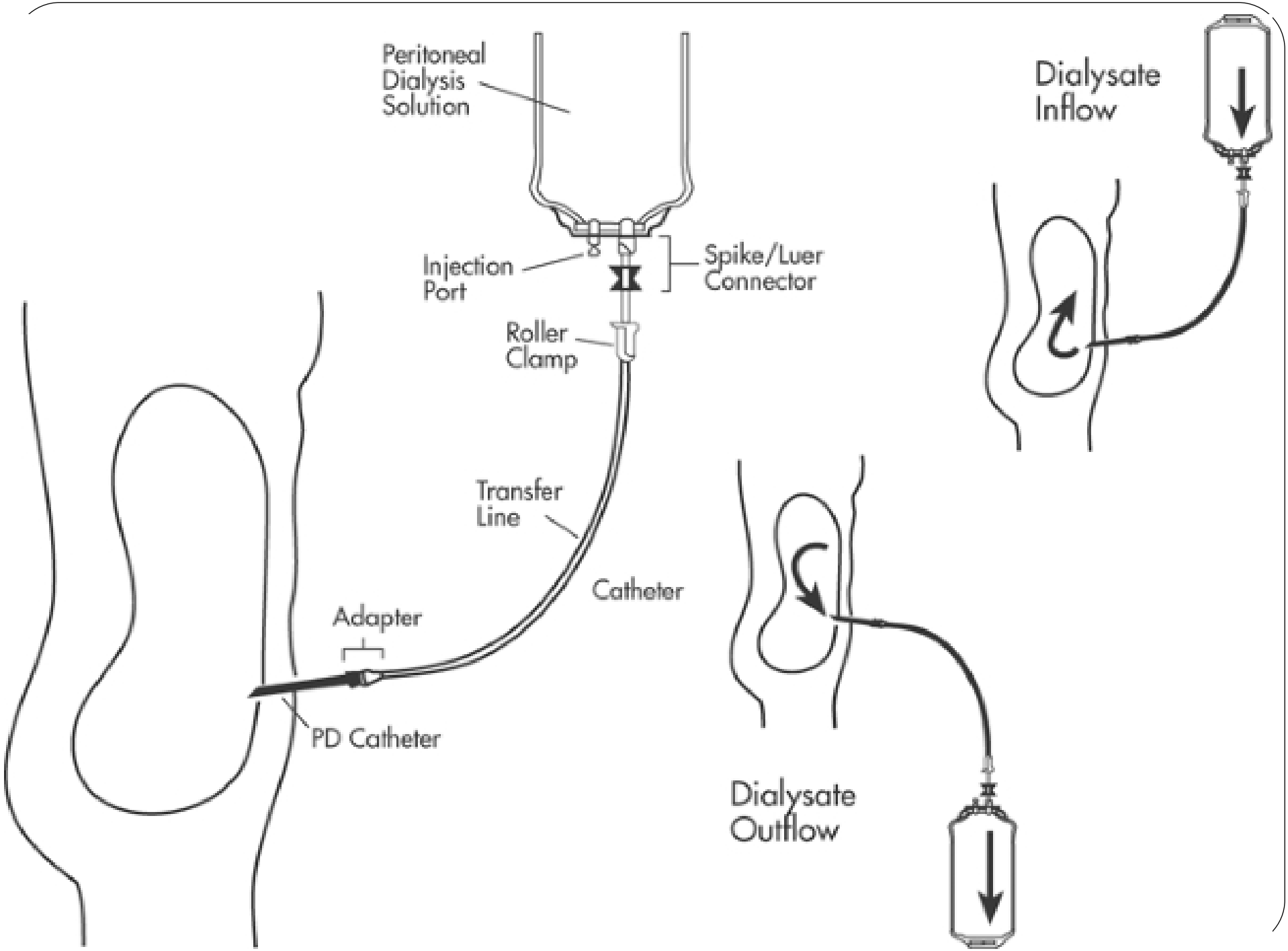
- Thrombocytopenia (common)
- Bleeding (because of heparinisation)
- Air embolism
- Infection
- Hypocalcaemia
- Hypotension.

- **In patient with risk of hemorrhage when haparinized, Epoprostenol, a PG with a short plasma half life of 2-3 min that inhibit platelet aggregation may be used.**

Peritonial dialysis

- Dialysate fluid is infused into the peritoneal cavity through a transcutaneous catheter and drained off
- The gut wall and peritoneal lining serve as the semipermeable membrane
- The solution contains a sugar called dextrose that will pull wastes and extra fluid into the abdominal cavity.
- These wastes and fluid then leave your body when the dialysis solution is drained.


Peritoneal cavity
Cuff
Skin
Silicone catheter
Subcutaneous tissue
Peritoneal cavity
Cuff
Rectus muscle
Fresh peritoneal dialysate
Collecting tube
Position of bag to receive spent dialysate
A
B
C


Peritoneal Dialysis Solution
Injection Port
Spike/Luer Connector
Roller Clamp
Transfer Line
Catheter
Adapter
PD Catheter
Dialysate Inflow
Dialysate Outflow

- The period the dialysis solution is in your abdomen is called the dwell time.
- A typical schedule calls for four exchanges a day, each with a dwell time of 4 to 6 hours.
- In general, it is only **10 to 25%** as effective as haemodialysis, and often only slightly more effective than forced diuresis.
- The only **advantages** are that it does not require **anticoagulation and uses minimal equipment**
- It has poor extraction ratios and slower flow rates (clearance rates 10–15 mL/min)

- Peritoneal dialysis can be performed continuously, 24 hours a day

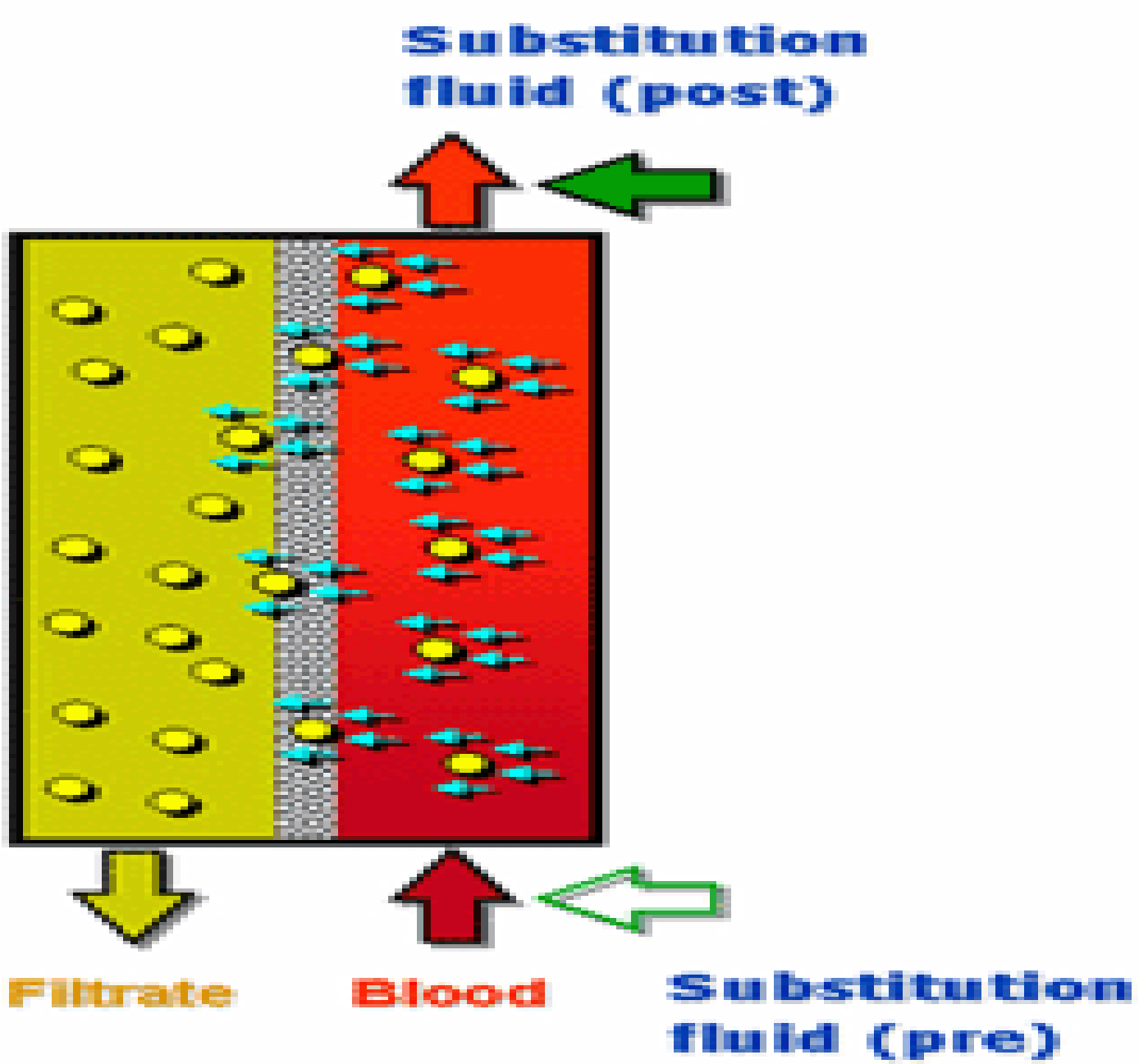
- A 24-hour peritoneal dialysis with dialysate exchange every 1–2 hours is approximately equal to 4 hours of hemodialysis.

Complications

- Pain
- Haemorrhage (from vascular laceration)
- Perforation of viscus
- Bacterial peritonitis
- Arrhythmias
- Volume depletion/overload
- Pneumonia
- Pleural effusion
- Hyperglycaemia
- Electrolyte imbalance.

Haemofiltration

- Haemofiltration is performed similar to haemodialysis except that the blood is pumped through a haemofilter
- The driving force is **a pressure gradient** rather than a concentration gradient.
- Solute transfer across semipermeable membranes by pressure induced water flow (***convection, "solute drag"***)
- The rate of solute removal is proportional to the applied pressure that can be adjusted to meet the needs of the clinical situation.



- The selectivity of the process is determined exclusively by the **sieving properties of the membrane**.

- The removal of large amounts of plasma water from the patient requires volume substitution.

- Substitution fluid, typically a buffered electrolyte solution close to plasma water composition, can be administered pre or post filter (pre-dilution mode, post-dilution mode).

- Advantage ; Remove compounds of relative large molecular weight
- E.g. : Aminoglycosides, Antibiotics, metal chelates (such as iron-desferrioxamine).

Haemodiafiltration

- **<u>Principle:</u>**
- - *Combination* of diffusive and convective solute transport (*HD* + *HF* = *HDF*)
- - Volume substitution (pre or post filter) *plus* dialysate required.

Plasmapheresis

- Separate blood components from plasma .
- The cells are re-suspended in colloids albumin or fresh frozen plasma and re-infused.
- Plasmapheresis has been used in cases of overdose with theophylline, carbamazepine, amanita, mercury,etc.,
- Serious complications greatly limit its utility

Complications—

- Bleeding disorders: DIC, thrombocytopenia
- Hypercoagulation: Cerebral thrombosis, pulmonary embolism, myocardial infarction.
- Anaphylaxis.
- Fluid overload: Hypertension, congestive heart failure.
- Infection.
- Vessel perforation, air embolism.
- Dysequilibrium syndrome: Vomiting, hypovolaemia.
- Citrate toxicity: Paraesthesias, tetany, chills, arrhythmias.
- Convulsions.
- Metabolic alkalosis.

Plasma Perfusion

- This is a combination of plasmapheresis and haemoperfusion, and has rarely been used in poisoning.

ANTIDOTE ADMINISTRATION

- **Inert complex formation :** e.g- Chelating agents for heavy metals, Prussian blue for Thallium.
- **Accelerated detoxification** : e.g- Thiosulfate accelerates the conversion of cynaide to non-toxic thiocynate.
- **Reduced toxic conversion** : e.g Ethanol inhibits the metabolism of Methanol
- **Receptor site competition** : Naloxone antagonizes the action of opiates.
- **Receptor site blockade :** Atropine blocks the effects of Anticholinesterase like OP at muscarinic receptor.
- **Toxic effects bypass :** 100% oxygen in cynaide poisoning.

Antidote	*Main Indication*	*Other Applications*
Acetylcysteine	Paracetamol	Amanitin
Amyl nitrite	Cyanide	Hydrogen sulfide
Ascorbic acid	Organic peroxides (Osmium)	—
Atropine	Cholinergic agents	—
Aurintricarboxylic acid (ATA)	Beryllium	—
Benzyl penicillin	Amanitins	—
β aminoproprionitrile	Acids	—
Calcium salts	Oxalates, fluorides	Calcium antagonists
Dantrolene	Malignant hyperthermia	Malignant neuroleptic syndrome
Desferrioxamine	Iron, aluminium	Paraquat
Diazepam	Chloroquine	—
Dicobalt edetate	Cyanide	—
Digoxin specific antibody fragments	Digitalis glycosides	—
Dimercaprol	Arsenic	Copper, gold, mercury
4,Dimethyl aminophenol (4 -DMAP)	Cyanide	Hydrogen sulfide
Ethanol	Methanol, ethylene glycol	—
Flumazenil	Benzodiazepines	—
Glucagon	Beta blockers	—
Glucose	Insulin	—
Guanidine	Botulism	—

Hydroxocobalamin	Cyanide	—
Isoprenaline	Beta blockers	—
Methionine	Paracetamol	—
4, Methylpyrazole	Ethylene glycol, methanol	Disulfiram, coprin
N-Acetylpenicillamine	Mercury	—
Naloxone	Opiates	—
Neostigmine	Peripheral anticholinergics	—
Oximes	Organophosphates	—
Oxygen	Cyanide, carbon monoxide,hydrogen sulfide	—
Oxygen (Hyperbaric)	Carbon monoxide	Cyanide, hydrogen sulfide,carbon tetra-chloride
Penicillamine	Copper	Gold, lead, mercury
Pentetic acid (DTPA)	Radioactive metals	—
Phentolamine	Alpha adrenergics	—
Physostigmine	Central anticholinergics	—
Phytomenadione (Vitamin K)	Coumarin derivatives	—
Potassium hexacyanoferrate (Prussian Blue)	Thallium	—
Propranolol	Beta adrenergics	—
Protamine sulfate	Heparin	—
Pyridoxine	Isoniazid	Ethylene glycol, gyrometrine,hydrazines

Sodium nitrite	Cyanide	Hydrogen sulfide
Sodium nitroprusside	Ergotism	–
Sodium salicylate	Beryllium	–
Sodium thiosulfate	Cyanide	Bromate, chlorate, iodine
Succimer (DMSA)	Lead, mercury	–
Tocopherol	Carbon monoxide	Oxygen toxicity
Toluidine blue	Methaemoglobinaemia	–
Trientine (triethylene tetramine)	Copper	–
Unithiol (DMPS)	Arsenic	Copper, nickel, lead, cadmium, mercury

Psychiatric Care