Chapter 1

Clinical Management of Poisoning: General Issues

INTRODUCTION

In clinical management of poisons, immediate checking of airway, breathing, circulation and decontamination is necessary for assessing and monitoring the overall status of the patients. Key to the successful management in a critical poisoning patient lies in initial evaluation and regular monitoring of vital signs.

After airway, breathing and circulations are addressed, the focus must be on confirmation of toxic ingestion and specific management issues based on the toxidromes.

The treatment goals of poisoned patients include supportive measures already mentioned and prevention of further poison absorption by stomach wash and activated charcoal, administration of antidotes, the prevention of reabsorption by enterohepatic circulation of poisons by gut dialysis (multiple doses of activated charcoal), skin decontamination and enhancement of elimination of poisons by cathartics, whole bowel irrigation, dilution, forced alkaline diuresis and extracorporeal removal of poisons.

Most of the times, history from accompanying persons like family members, friends and prescribing physicians, gives clues to the diagnosis. The physical examination should include evaluation for head trauma, focal neurological deficits, needle track marks, unusual odor from the patient and the auscultation for lung signs. A comprehensive team approach is required to bring down the morbidity and mortality in toxicological emergencies.

General principles in the management of poisoning are:

- Supportive care
- Prevention of further poison absorption
- Enhancement of poison elimination
- Administration of antidotes
- Prevention of re-exposure

SUPPORTIVE CARE

1. Airway protection
2. Oxygenation/ventilation
3. Treatment of arrhythmias
4. Hemodynamic support
5. Treatment of seizures
6. Treatment of temperature abnormalities
7. Treatment of metabolic derangements
8. Prevention of secondary complications

PREVENTION OF POISON ABSORPTION

Gastrointestinal Decontamination

It includes:

a. Gastric lavage
b. Activated charcoal

c. Whole bowel irrigation
d. Dilution
e. Endoscopic/surgical removal

Decontamination of other sites

- Eye decontamination
- Skin decontamination
- Body cavity evacuation

a. **Gastric lavage**

- Gastric lavage should be considered for life-threatening poisons that cannot be treated effectively with other decontamination, elimination, or antidotal therapies (e.g. colchicine).
- The efficacy of all decontamination procedures decreases with time, and data are insufficient to support or exclude a beneficial effect when they are used >1 hour after ingestion.
- The average time from ingestion to presentation for treatment is >1 hour for children and >3 hours for adults.
- There are some circumstances where aggressive gut decontamination may be lifesaving, even after >1–2 hours.

Examples:

- Highly toxic drugs (e.g. calcium antagonists, colchicine)
- Ingestion of massive amounts of a drug (e.g. 150–200 aspirin tablets)
- Ingestion of sustained-release or enteric-coated products in addition to whole bowel irrigation.

Indications

- To remove ingested massive overdose, lavage is effective if initiated within 30–60 minutes of the ingestion, although it may be useful several hours after ingestion of agents that slow gastric emptying (e.g. salicylates or anticholinergic drugs).
- To dilute and remove poison from the stomach and to empty the stomach in preparation for endoscopy.

Technique

- If the patient is deeply obtunded, protect the airway by intubating the trachea with a cuffed endotracheal tube (Figs 1.1A and B).

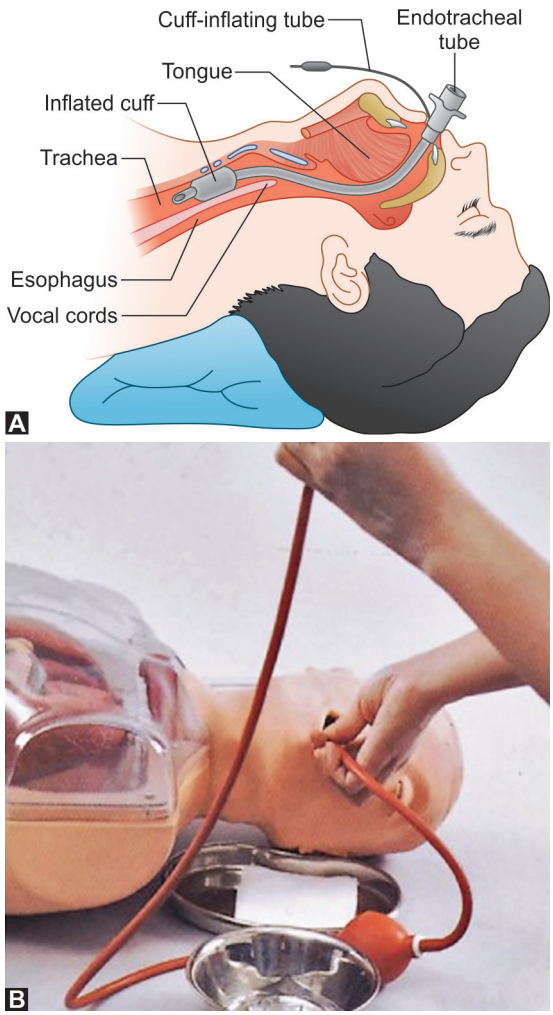

Fig. 1.1: A. Inserting endotracheal tube **B.** Inserting gastric lavage tube

- Keep the patient in the left lateral position to prevent ingested material from being pushed into the duodenum during lavage.
- Insert a large gastric tube through the mouth or Ryle's tube through the nose and into the stomach (36–40° F catheter size) in adults; check tube position with air insufflation while listening with a stethoscope positioned on the patient's stomach.

- Withdraw as much of the stomach contents as possible.
- Administer activated charcoal—60–100 g (1 g/kg) down the tube before starting lavage to begin adsorption of material that may enter the intestine during the lavage procedure.
- Instill tepid (lukewarm) water or saline of 5 ml/kg (200–300 ml) aliquots, and remove by gravity or active suction.
- Use repeated aliquots for a total of 2 L or until the return is free of pills or toxic material.

Precautions

- Gastric lavage must be used with caution in obtunded patients. In such cases, endotracheal intubation with a cuffed endotracheal tube should be performed first to protect the airway.
- If sustained-release or enteric-coated tablets are swallowed, whole bowel irrigation is preferred.
- After ingestion of a corrosive substance gastric lavage is contraindicated.

Adverse effects

- Perforation of the esophagus or stomach.
- Nasal bleeding due to nasal trauma during passage of the tube.
- Vomiting resulting in pulmonary aspiration of gastric contents in an obtunded patient without airway protection.

b. **Activated charcoal**

- Activated charcoal is a highly adsorbent powdered material made from distillation of wood pulp, with very large surface area, and so it is highly effective in adsorbing most toxins when given in a ratio of approximately 10:1 (charcoal to poison).
- In case of toxins, poorly adsorbed by charcoal, requires a higher ratio of activated charcoal to poison (e.g. for cyanide a ratio of about 100:1 is necessary).

Mechanism

- Charcoal adsorbs ingested poisons within the gut lumen, allowing the charcoal–poison complex to be passed in stool (Table 1.1).
- Charged (ionized) chemicals like mineral acids, alkalis, and dissociated salts of cyanide, fluoride, iron, lithium, and other inorganic compounds are not well adsorbed (Table 1.1).

Activated charcoal suspension (in water) is given orally in a cup, straw, or small-bore nasogastric tube. A sweetener (sorbitol) or a flavoring agent (cherry, chocolate) is added to increase palatability.

a. *Single-dose activated charcoal*

- Give activated charcoal aqueous suspension (without sorbitol)—60–100 g (1 g/kg) orally or by gastric tube.
- Check for bowel sounds prior to administration.
- Single-dose activated charcoal should not be used in drowsy patients if the airway is not properly protected. In case of ileus without distension single dose of charcoal

Table 1.1: Substances poorly adsorbed by activated charcoal

Hydrocarbons and alcohols	*Metals*	*Corrosives*	*Cyanides*
Ethanol	Lithium	Acids	
Isopropyl alcohol	Iron	Alkalis	
Ethylene glycol	Potassium	Copper sulphate	
Methanol	Lead		
	Arsenic		
	Mercury		

can be administered, but further doses should not be given.

Complications of activated charcoal use

1. Vomiting (30%)
2. Charcoal aspiration
3. Constipation
4. Charcoal bezoar formation, bowel obstruction, bowel perforation (rare)
5. Corneal abrasion

b. *Cathartics:* Cathartics can be used with activated charcoal to increase the elimination of poisons, to enhance gastrointestinal transit of the charcoal–toxin complex, decreasing formation of a 'charcoal bezoar' and to hasten passage of iron tablets and other ingestions not adsorbed by charcoal.

Administration

- Administer the cathartic orally as 10% magnesium citrate, 3–4 ml/kg, or 70% sorbitol 1 ml/kg along with activated charcoal or as mixture.
- Repeat with one-half the original dose if there is no charcoal stool after 6–8 hours.
- Do not use combinations containing charcoal sorbitol.

Contraindications

- Ileus or intestinal obstruction.
- Sodium- and magnesium-containing cathartics should not be used in patients with fluid overload or renal insufficiency, respectively.
- Oil-based cathartics should not be used.

Adverse effects

- Severe fluid loss, hypernatremia, and hyperosmolarity result from overuse or repeated doses of cathartics.
- Hypermagnesemia in patients with renal insufficiency.
- Abdominal cramps and vomiting especially with sorbitol.

c. **Whole bowel irrigation**

For whole bowel irrigation, surgical bowel-cleansing solution containing a non-absorbable polyethylene glycol in a balanced electrolyte solution, that is formulated to pass through the intestinal tract without being absorbed, is used.

Technique

- The patient must be in a sitting position.
- It is performed by administering electrolytes and polyethylene glycol orally or by gastric tube at a rate of 2 L/h (0.5 L/h in children) until rectal effluent is clear.

Indications

- Large ingestion of iron, lithium or drugs poorly adsorbed to activated charcoal
- Large ingestions of sustained release or enteric coated tablets containing valproic acid, theophylline, aspirin, diltiazem.
- Ingestion of foreign bodies, drug-filled packets or condoms, body stuffers.

Adverse effects

- Nausea and bloating
- Regurgitation and pulmonary aspiration

Contraindications

- Ileus or intestinal obstruction
- Comatose or convulsions

d. **Dilution**

- It is indicated only in cases of ingestion of corrosives (acids, alkali).
- *Dilutents:* Drinking water or milk 5 ml/kg of body weight
- Dilution increases the absorption and dissolution rate of capsules, tablets, and other solid ingestants and hence should not be used.

e. **Endoscopic/surgical removal**

Drug-filled packets or condoms, intact tablets, or tablet concretions persist despite aggressive gastric lavage or whole gut lavage, and surgical removal becomes necessary. Patients who suffer from cocaine toxicity due to its leakage from ingested drug packets require immediate surgical intervention.

Complications

- Perforation of the esophagus or stomach.
- Nose bleed from nasal trauma during passage of the tube.
- Vomiting resulting in pulmonary aspiration of gastric contents in an obtunded patient without airway protection.

Decontamination of other sites

Eye decontamination: The cornea is especially sensitive to corrosive agents and hydrocarbons that rapidly damage the corneal surface and lead to permanent scarring. In such cases,

a. Act quickly to prevent serious damage. Flush exposed eyes with copious quantities of tepid tap water or saline. Instill local anesthetic drops in the eye first to facilitate irrigation. Remove the victim's contact lenses if they are being worn.
b. 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 of water to irrigate each eye (Fig. 1.2A).
c. If the substance is an acid or a base, check the pH of the victim's tears after irrigation and continue irrigation if the pH remains abnormal.
d. Do not instill any neutralizing solution, it may further damage the eye.
e. After irrigation is complete, check the conjunctival and corneal surfaces carefully for evidence of full-thickness injury (Fig. 1.2B).

Skin decontamination: Remove contaminated clothing and flush exposed areas with copious quantities of tepid (lukewarm) water or saline as corrosive agents rapidly injure the skin and must be removed immediately. Wash carefully behind ears, under nails, and in skin folds. Use soap and shampoo for oily substances. Rapid action only can prevent systemic absorption (Fig. 1.3).

ENHANCEMENT OF POISON ELIMINATION

- Multiple-dose activated charcoal administration
- Alteration of urinary pH
- Extracorporeal removal
  - Hemodialysis
  - Hemoperfuson
  - Hemofiltration

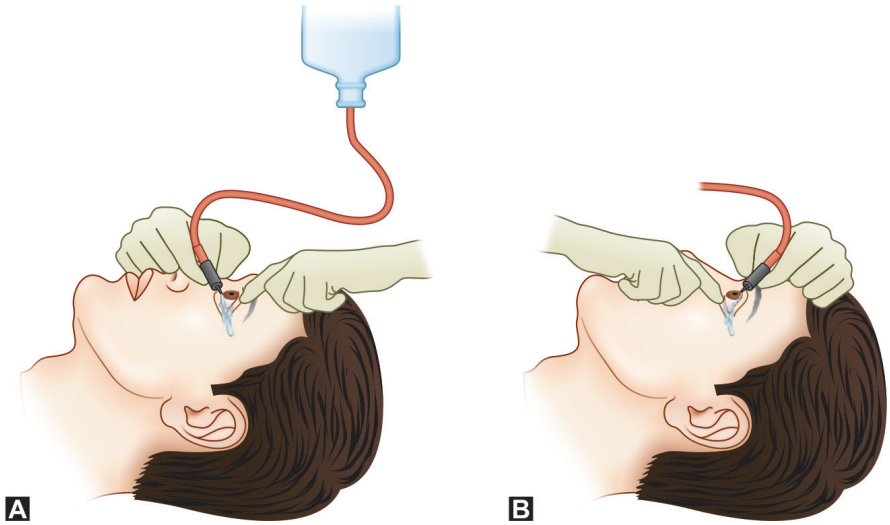

Fig. 1.2: Eye decontamination

Fig. 1.3: Decontamination chamber

- Plasmapheresis
- Exchange transfusion
- Hyperbaric oxygenation

Multiple-dose Activated Charcoal

Repeated administration of oral activated charcoal progressively fills the entire gut lumen with charcoal. This increases the elimination in two ways:

1. **Interruption of enterohepatic circulation:**
   - Effective for drugs undergoing enterohepatic circulation and has a relatively small volume of distribution.
   - Charcoal in small intestine binds the drug and prevents reabsorption and thus enhances elimination.
2. **Gastrointestinal dialysis (gut dialysis):**
   - Effective for drug which is relatively a small molecule, lipid soluble, has small volume of distribution and low protein binding.
   - Drug passes across the gut mucosa from a relatively high concentration in intravascular compartment to a low concentration in the gut lumen, which is maintained by continuing adsorption to charcoal.

Method

- Give an initial dose of 1 g/kg of activated charcoal, repeat dose of 0.5 g/kg every 2 hours.
- Check for bowel sounds prior to administration of each dose.
- Reconsider the indications and clinical end points for therapy every 6 hours. MDAC rarely required beyond 6 hours.

Indications used in poisoning by

- Caffeine
- Carbamazepine
- Dapsone
- Digoxin
- Nadolol
- Phenobarbital
- Phenylbutazone
- Phenytoin
- Salicylates
- Theophylline

Contraindications

- Ileus or bowel obstruction

Forced Alkaline Diuresis

As the membranes are more permeable to non-ionized molecules than to their ionized counterparts, acidic poisons are ionized and trapped in alkaline urine, whereas basic ones become ionized and trapped in acid urine. Ion trapping through alteration of urine pH prevents the renal reabsorption of poisons that undergo excretion by glomerular filtration and active tubular secretion. Urine pH modulation causes ion trapping and decreases the renal reabsorption.

Technique

- 500 ml of 0.9% NS over 1 hour
- Followed by 400 ml of 5% dextrose with 100 ml of sodium bicarbonate over 1 hour
- Followed by 500 ml 0.9% NS with 10 mEq of KCl over 1 hour.
- If urine output <100 ml/hr—give inj. lasix 20 mg IV stat

Table 1.2: Forced alkaline diuresis	
Indications	*Contraindications*
Copper sulphate	Cerebral edema
Fluoride	Congestive heart failure
Hair dye	Renal failure
Herbicides	
Methotrexate	
Phenobarbitone	
Phenoxyacetate	
Salicylates	
Sulfonamides	

- If urine output is not increasing give another dose of inj. lasix 20 mg IV
- If urine output <100 ml/hr—stop FAD-plan for hemodialysis (Table 1.2).
- If urine output >100 ml/hr—continue FAD.

Extracorporeal Removal

The drug or toxic substance should either diffuse easily through the peritoneum or dialysis membrane, should have low molecular weight, high water solubility, low protein binding, small volume of distribution, long half-life, high dialysis clearance relative to total body clearance (Fig. 1.4).

Indications

- High plasma concentrations of the toxic agents
- Progressive clinical deterioration despite best supportive management
- Prolonged coma with complications

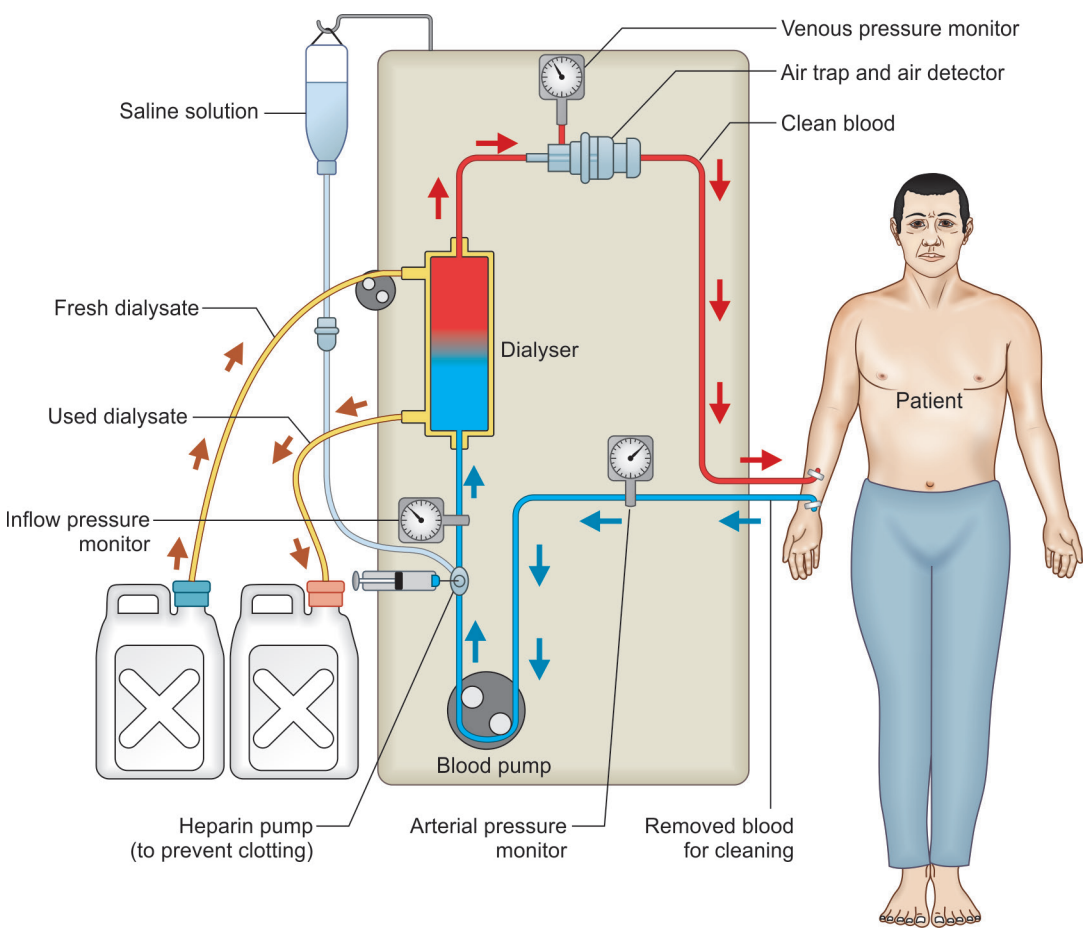

Fig. 1.4: Extracorporeal hemodialysis

- Severe clinical intoxication, e.g. grade 4 coma, hypotension, hypothermia, and hypoventilation

Useful in eliminating the following drugs

- Ethanol
- Ethylene glycol
- Isopropanol
- Lithium
- Methanol
- Phenobarbitone
- Salicylates

Complications

- Air embolism
- Hemorrhage because of heparinisation
- Hypocalcemia
- Infection
- Leucopenia
- Thrombocytopenia

Contraindications

- Availability of antidote
- Rapidly acting metabolic poison
- Irreversibly acting poisons, e.g. organophosphorus compound
- Relatively non-toxic substances, e.g. benzodiazepine
- Poison having a very large volume of distribution
- Cardiogenic shock
- Coagulopathy

AIRWAY PROTECTION

The most common cause of death from drug or poisoning is loss of airway-protective reflexes followed by airway obstruction caused by flaccid tongue, pulmonary aspiration of gastric contents and respiratory arrest.

Positioning: Optimize the airway position to force the flaccid tongue forward and to maximize the airway opening. Place the neck and head in the 'sniffing' position, with the neck flexed forward and the head extended. Apply the 'jaw thrust' to create forward movement of the tongue without flexing or extending the neck.

Hemodynamic Instability Management

Hypotension

Causes:

a. Volume loss because of vomiting, diarrhea, or bleeding
b. Apparent volume depletion caused by venodilation, arteriolar dilation
c. Depression of cardiac contractility
d. Arrhythmias that interfere with cardiac output
e. Hypothermia
f. Volume loss, venodilation, and arteriolar dilation cause hypotension + reflex tachycardia.

Hypotension with bradycardia

Causes

- Sympatholytic agents
- Membrane-depressant drugs (e.g. ethanol, antihistaminics)
- Calcium channel blockers
- Cardiac glycosides
- Presence of hypothermia

Treatment of Hypotension

- 0.9% NS, 10–20 ml/kg IV bolus or another crystalloid solution
- Norepinephrine, 0.1 μg/kg/min IV or dopamine, 5–15 μg/kg/min IV as infusion.

Note: Dopamine is ineffective in some patients with depleted neuronal stores of catecholamines (e.g. in reserpine, or TCA overdose).

Hypertension

Hypertension with a little or no tachycardia

- Nitroprusside, 2–10 μg/kg/min IV
- Phentolamine 0.02–0.1 mg/kg IV

Hypertension with tachycardia

- Esmolol, 0.025–0.1 mg/kg/min IV
- Labetalol, 0.2–0.3 mg/kg IV
- Propranolol, 0.02–0.1 mg/kg IV

Note: Do not use propranolol or esmolol alone to treat hypertensive crisis as beta-blockers can paradoxically worsen hypertension if it is caused primarily by alpha-adrenergic stimulation.

SEIZURES AND ITS MANAGEMENT

Seizures constitute a major cause of morbidity and mortality due to drug overdose or poisoning.

Treatment

Any one of the following drugs.

- Diazepam—0.1–0.2 mg/kg IV
- Lorazepam—0.05–0.1 mg/kg IV
- Midazolam—0.1–0.2 mg/kg IM (useful when intravenous access is difficult), or 0.05–0.1 mg/kg IV
- Pentobarbital—5–6 mg/kg IV; slow infusion over 8–10 minutes, then continuous infusion at 0.5–3 mg/kg/hr
- Phenobarbital—10–15 mg/kg IV slow infusion over 15–20 minutes

Note: Phenytoin is contraindicated in toxicologic seizures.

TEMPERATURE ABNORMALITIES

Hypothermia

Treatment includes rewarming slowly (using blankets, warm intravenous fluids, and warmed-mist inhalation) to prevent rewarming arrhythmias. For patients in cardiac arrest, provide gastric or peritoneal lavage with warmed fluids and perform CPR. For ventricular fibrillation, bretylium, 5–10 mg/kg IV may be effective.

Hyperthermia

- Neuroleptic malignant syndrome (NMS)—hyperthermic disorder seen in those who use antipsychotic agents characterized by hyperthermia, muscle rigidity ('lead-pipe' rigidity), metabolic acidosis, and confusion.
- Malignant hyperthermia—an inherited disorder that causes severe hyperthermia, metabolic acidosis, and rigidity after certain anesthetic agents (halothane I and succinylcholine).
- Serotonin syndrome occurs primarily in patients taking monoamine oxidase (MAO) inhibitors and serotonin-enhancing drugs (meperidine, fluoxetine) 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 selective serotonin reuptake indicators (SSRIs) alone even without concurrent use of MAO inhibitors.

Treatment

Immediate rapid cooling is essential to prevent death or serious brain damage.

- Begin external cooling with tepid (lukewarm) sponging and fanning. This evaporative method is the most efficient method of cooling.
- Shivering often occurs with rapid external cooling, and shivering may generate yet more heat. It is preferable to use diazepam, 0.1–0.2 mg/kg IV or lorazepam 0.05–0.1 mg/kg IV or midazolam 0.05–0.1 mg/kg IV or IM.
- The most rapidly effective and reliable means of lowering the temperature is by neuromuscular paralysis.
- Administer a non-depolarizing agent such as pancuronium 0.1 mg/kg IV or vecuronium 0.1 mg/kg IV followed by endotracheal intubation and mechanical ventilation.
- Malignant hyperthermia—dantrolene, 1–10 mg/kg IV
- Neuroleptic malignant syndrome—bromocriptine 2.5–10 mg orally.
- Serotonin syndrome—cyproheptadine 4 mg orally (PO) every hour for 3–4 doses or methysergide 2 mg PO every 6 hours for 3–4 doses.

PREVENTION OF RE-EXPOSURE

- The best approach to young children and patients with intentional overdose (deliberate self-harm or attempted suicide) is to limit their access to poisons.
- In houses alcoholic beverages, medications, household products (automotive, cleaning, fuel, pet-care, and toiletry products), inedible plants, and vitamins should be kept out of reach of children or in locked or child-proof cabinets.
- Depressed or psychotic patients should undergo psychiatric assessment, disposition, and follow-up.
- They should be given prescriptions for a limited supply of drugs and should be monitored for compliance and response to therapy.

Suggested Reading

1. American Academy of Clinical Toxicology: http://www.clintox.org
2. American Association of Poison Control Centers: http://www.aapcc.org
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