Poisoning is contact with a substance that results in toxicity. Symptoms vary, but certain common syndromes may suggest particular classes of poisons. Diagnosis is primarily clinical, but for some poisonings, blood and urine tests can help. Treatment is supportive for most poisonings; specific antidotes are necessary for a few. Prevention includes labeling drug containers clearly and keeping poisons out of the reach of children.

Most poisonings are dose-related. Dose is determined by concentration over time. Toxicity may result from exposure to excess amounts of normally nontoxic substances. Some poisonings result from exposure to substances that are poisonous at all doses. Poisoning is distinguished from **hypersensitivity** and **idiosyncratic reactions**, which are unpredictable and not dose-related, and from intolerance, which is a toxic reaction to a usually nontoxic dose of a substance.

Poisoning is commonly due to ingestion but can result from injection, inhalation, or exposure of body surfaces (eg, skin, eye, mucous membranes). Many commonly ingested nonfood substances are generally nontoxic; however, almost any substance can be toxic if ingested in excessive amounts.

Accidental poisoning is common among young children, who are curious and ingest items indiscriminately despite noxious tastes and odors; usually, only a single substance is involved. Poisoning is also common among older children, adolescents, and adults attempting suicide; multiple drugs, including alcohol, acetaminophen, and other over-the-counter (OTC) drugs, may be involved. Accidental poisoning may occur in older people because of confusion, poor eyesight, mental impairment, or multiple prescriptions of the same drug by different physicians.

After exposure or ingestion and absorption, most poisons are metabolized, pass through the gastrointestinal tract (GI) tract, or are excreted. Occasionally, tablets (eg, aspirin, iron, enteric-coated drugs) form large concretions (bezoars) in the GI tract, where they tend to remain, continuing to be absorbed and causing toxicity.

Symptoms and signs of poisoning vary depending on the substance (table). Also, different patients poisoned with the same substance may present with very different symptoms. However, 6 clusters of symptoms (toxic syndromes, or toxidromes) occur commonly and may suggest particular classes of substances table). Patients who ingest multiple substances are less likely to have symptoms characteristic of a single substance.

Symptoms typically begin soon after contact but, with certain poisons, are delayed. The delay may occur because only a metabolite is toxic rather than the parent substance (eg, methanol, ethylene glycol, hepatotoxins). Ingestion of hepatotoxins (eg, acetaminophen, iron, Amanita phalloides mushrooms) may cause acute liver failure that occurs one to a few days later. With metals or hydrocarbon solvents, symptoms typically occur only after chronic exposure to the toxin.

Ingested and absorbed toxins generally cause systemic symptoms. Caustics and corrosive liquids damage mainly the mucous membranes of the gastrointestinal (GI) tract, causing stomatitis, enteritis, or perforation. Some toxins (eg, alcohol, hydrocarbons) cause characteristic breath odors. Skin contact with toxins can cause various acute cutaneous symptoms (eg, rashes, pain, blistering); chronic exposure may cause dermatitis.

Inhaled toxins are likely to cause symptoms of upper airway injury if they are water-soluble (eg, chlorine, ammonia) and symptoms of lower airway injury and noncardiogenic pulmonary edema if they are less water-soluble (eg, phosgene). Inhalation of carbon monoxide, cyanide, or hydrogen sulfide gas can cause organ ischemia or cardiac or respiratory arrest. Eye contact with toxins (solid, liquid, or vapor) may damage the cornea, sclera, and lens, causing eye pain, redness, and loss of vision.

Some substances (eg, cocaine, phencyclidine, amphetamine) can cause severe agitation, which can result in hyperthermia, acidosis, and rhabdomyolysis.

Rhabdomyolysis is a clinical syndrome involving the breakdown of skeletal muscle tissue. Symptoms and signs include muscle weakness, myalgias, and reddish-brown urine, although this triad is present in less than 10% of patients. Diagnosis of rhabdomyolysis is by history and laboratory confirmation of elevated creatine kinase (CK) of typically greater than 5 times the upper limit of normal. Treatment is supportive with IV fluids as well as treatment of the inciting cause and any ensuing complications.

Diagnosis of poisoning

- Consideration of poisoning in patients with altered consciousness or unexplained symptoms
- History from all available sources
- Selective, directed testing

The first step of diagnosis of poisoning is to assess the overall status of the patient. Severe poisoning may require rapid intervention to treat airway compromise or cardiopulmonary collapse.

Poisoning may be known at presentation. It should be suspected if patients have unexplained symptoms, especially altered consciousness (which can range from agitation to somnolence to coma). If purposeful self-poisoning occurs in adults, multiple substances should be suspected.

History is often the most valuable tool. Because many patients (eg, preverbal children, suicidal or psychotic adults, patients with altered consciousness) cannot provide reliable information, friends, relatives, and rescue personnel should be questioned. Even seemingly reliable patients may

incorrectly report the amount or time of ingestion. When possible, the patient's living quarters should be inspected for clues (eg, partially empty pill containers, a suicide note, evidence of recreational drug use). Pharmacy and medical records may provide useful information. In potential workplace poisonings, coworkers and supervisors should be questioned. All industrial chemicals must have a material safety data sheet (MSDS) readily available at the workplace; the MSDS provides detailed information about toxicity and any specific treatment.

In many parts of the world, information about household and industrial chemicals can be obtained from poison control centers. Consultation with the centers is encouraged because ingredients, first-aid measures, and antidotes printed on product containers are occasionally inaccurate or outdated. Also, the container may have been replaced, or the package may have been tampered with. Poison control centers may be able to help identify unknown pills based on their appearance. The centers have ready access to toxicologists. The telephone number of the nearest center is often listed with other emergency numbers in the front of the local telephone book;

Physical examination sometimes detects signs suggesting particular types of substances (eg, toxidromes, breath odor, presence of topical drugs, needle marks or tracks suggesting injected drug use, stigmata of chronic alcohol use).

Even if a patient is known to be poisoned, altered consciousness may be due to other causes (eg, central nervous system infection, head trauma, hypoglycemia, stroke, hepatic encephalopathy, Wernicke encephalopathy), which should also be considered. Attempted suicide must always be considered in older children, adolescents, and adults who have ingested a drug. Also, children often share found pills and substances; careful inquiry to identify additional potentially poisoned patients among playmates and siblings should be undertaken.

Treatment of poisoning

- Supportive care
- Activated charcoal for serious oral poisonings
- Occasional use of specific antidotes or dialysis
- Only rare use of gastric emptying

Seriously poisoned patients may require assisted ventilation or treatment of cardiovascular collapse. Patients with impaired consciousness may require continuous monitoring or restraints. Consultation with a poison control center is recommended for any poisonings except the mildest and most routine.

Initial stabilization

- Maintain airway, breathing, and circulation
- IV naloxone
- IV dextrose and thiamine
- IV fluids, sometimes vasopressors

Airway, breathing, and circulation must be maintained in patients suspected of a systemic poisoning. Patients without a pulse or blood pressure require emergency cardiopulmonary resuscitation.

If patients have apnea or compromised airways (eg, foreign material in the oropharynx, decreased gag reflex), an endotracheal tube should be inserted. If patients have respiratory depression or hypoxia, supplemental oxygen or mechanical ventilation should be provided as needed.

IV naloxone (*in age dependent doses*; 2 mg in adults; 0.1 mg/kg in children; doses as high as 10 mg may be necessary in some cases) should be tried in patients with apnea or severe respiratory depression while maintaining airway support. In opioid addicts, naloxone may precipitate withdrawal, but withdrawal is preferable to severe respiratory depression. If respiratory depression persists despite use of naloxone, endotracheal intubation and continuous mechanical ventilation are required. If naloxone relieves respiratory depression, patients are monitored; if respiratory depression recurs, patients should be treated with another bolus of IV naloxone or endotracheal intubation and mechanical ventilation. Using a low-dose continuous naloxone infusion to maintain respiratory drive without precipitating withdrawal has been suggested but in reality can be very difficult to accomplish.

IV dextrose (50 mL of a 50% solution for adults; 2 to 4 mL/kg of a 25% solution for children) should be given to patients with altered consciousness or central nervous system (CNS) depression, unless hypoglycemia has been ruled out by immediate bedside determination of blood glucose.

Thiamine (100 mg IV) is given with or before glucose to adults with suspected thiamine deficiency (eg, alcoholics, undernourished patients).

IV fluids are given for hypotension. If fluids are ineffective, invasive hemodynamic monitoring may be necessary to guide fluid and vasopressor therapy. The first-choice vasopressor for most poison-induced hypotension is norepinephrine 0.5 to 1 mg/min IV infusion, but treatment should not be delayed if another vasopressor is more immediately available.

Topical decontamination

Any body surface (including the eyes) exposed to a toxin is flushed with large amounts of water or saline. Contaminated clothing, including shoes and socks, and jewelry should be removed. Topical patches and transdermal delivery systems are removed.

Activated charcoal

Charcoal is usually given, particularly when multiple or unknown substances have been ingested. Use of charcoal adds little risk (unless patients are at risk of vomiting and aspiration) but has not been proved to reduce overall morbidity or mortality. When used, charcoal is given as soon as possible. Activated charcoal adsorbs most toxins because of its molecular configuration and large surface area. Multiple doses of activated charcoal may be effective for substances that undergo enterohepatic recirculation (eg, phenobarbital, theophylline) and for sustained-release preparations. Charcoal may be given at 4- to 6-hour intervals for serious poisoning with such substances unless bowel sounds are hypoactive. Charcoal is ineffective for caustics, alcohols, and simple ions (eg, cyanide, iron, other metals, lithium).

The recommended dose is 5 to 10 times that of the suspected toxin ingested. However, because the amount of toxin ingested is usually unknown, the usual dose is 1 to 2 g/kg, which is about 10 to 25 g for children < 5 years and 50 to 100 g for older children and adults. Charcoal is given as a slurry in water or soft drinks. It may be unpalatable and results in vomiting in 30% of patients. Administration via a gastric tube may be considered, but caution should be used to prevent trauma caused by tube insertion or aspiration of charcoal; potential benefits must outweigh risks. Activated charcoal should probably be used without sorbitol or other cathartics, which have no clear benefit and can cause dehydration and electrolyte abnormalities.

Gastric emptying

Gastric emptying, which used to be well-accepted and seems intuitively beneficial, should not be routinely done. It does not clearly reduce overall morbidity or mortality and has risks. Gastric emptying is considered if it can be done within 1 hour of a life-threatening ingestion. However, many poisonings manifest too late, and whether a poisoning is life threatening is not always clear. Thus, gastric emptying is seldom indicated and, if a caustic substance has been ingested, is contraindicated.

If gastric emptying is used, gastric lavage is the preferred method. Gastric lavage may cause complications such as epistaxis, aspiration, or, rarely, oropharyngeal or esophageal injury. Syrup of ipecac has unpredictable effects, often causes prolonged vomiting, and may not remove

substantial amounts of poison from the stomach. Syrup of ipecac may be warranted if the ingested agent is highly toxic and transport time to the emergency department is unusually long.

For gastric lavage, tap water is instilled and withdrawn from the stomach via a tube. The largest tube possible (usually > 36 French for adults or 24 French for children) is used so that tablet fragments can be retrieved. If patients have altered consciousness or a weak gag reflex, tracheal intubation should be done before lavage to prevent aspiration. Patients are placed in the left lateral decubitus position to prevent aspiration, and the tube is inserted orally. Because lavage sometimes forces substances farther into the gastrointestinal (GI) tract, stomach contents should be aspirated and a 25-g dose of charcoal should be instilled through the tube immediately after insertion. Then aliquots (about 3 mL/kg) of tap water are instilled, and the gastric contents are withdrawn by gravity or syringe. Lavage continues until the withdrawn fluids appear free of the substance; usually, 500 to 3000 mL of fluid must be instilled. After lavage, a 2nd 25-g dose of charcoal is instilled.

Whole-bowel irrigation

This procedure flushes the GI tract and theoretically decreases GI transit time for pills and tablets. Irrigation has not been proved to reduce morbidity or mortality. Irrigation is indicated for any of the following:

- Some serious poisonings due to sustained-release preparations or substances that are not adsorbed by charcoal (eg, heavy metals)
- Drug packets (eg, latex-coated packets of heroin or cocaine ingested by body packers)
- A suspected bezoar

A commercially prepared solution of polyethylene glycol (which is nonabsorbable) and electrolytes, as sometimes used to cleanse the bowel for colonoscopy, is given at a rate of 1 to 2 L per hour for adults or at 25 to 40 mL/kg/h for children until the rectal effluent is clear; this process may require many hours or even days. The solution is usually given via a gastric tube, although some motivated patients can drink these large volumes.

Alkaline diuresis

Alkaline diuresis enhances elimination of weak acids (eg, salicylates, phenobarbital). A solution made by combining 1 L of 5% D/W with three 50-mEq (50-mmol/L) ampules of sodium bicarbonate and 20 to 40 mEq (20 to 40 mmol/L) of potassium can be given at a rate of 250 mL/h in adults and 2 to 3 mL/kg/h in children. Urine pH is kept at > 8, and potassium must be repleted.

Hypernatremia, alkalemia, and fluid overload may occur but are usually not serious. However, alkaline diuresis is contraindicated in patients with renal insufficiency.

Dialysis

Common toxins that may require dialysis or hemoperfusion include

- Ethylene glycol
- Lithium
- Methanol
- Salicylates
- Theophylline

These therapies are less useful if the poison is a large or polar molecule, has a large volume of distribution (ie, if it is stored in fatty tissue), or is extensively bound to tissue protein (as with digoxin, phencyclidine, phenothiazines, or tricyclic antidepressants). The need for dialysis is usually determined by both laboratory values and clinical status. Methods of dialysis include hemodialysis, peritoneal dialysis, and lipid dialysis (which removes lipid-soluble substances from the blood), as well as hemoperfusion (which more rapidly and efficiently clears specific poisons..

Specific antidotes

Chelating drugs are used for poisoning with heavy metals and occasionally with other drugs. IV fat emulsions in 10% and 20% concentrations and high-dose insulin therapy have been used to successfully treat several different cardiac toxins (eg, bupivacaine, verapamil).

Ongoing supportive measures

Most symptoms (eg, agitation, sedation, coma, cerebral edema, hypertension, arrhythmias, renal failure, hypoglycemia) are treated with the usual supportive measures.

Drug-induced hypotension and arrhythmias may not respond to the usual drug treatments. For refractory hypotension, dopamine, epinephrine, other vasopressors, an intra-aortic balloon pump, or even extracorporeal circulatory support may be considered.

For refractory arrhythmias, cardiac pacing may be necessary. Often, torsades de pointes can be treated with magnesium sulfate 2 to 4 g IV, overdrive pacing, or a titrated isoproterenol infusion.

Seizures are first treated with benzodiazepines. Phenobarbital and propofol have been used when benzodiazepines are ineffective. Severe agitation must be controlled; benzodiazepines in large

doses, other potent sedatives (eg, propofol), or, in extreme cases, induction of paralysis and mechanical ventilation may be required.

Hyperthermia is treated with aggressive sedation and physical cooling measures rather than with antipyretics. Organ failure may ultimately require kidney transplantation or liver transplantation.

Hospital admission

General indications for hospital admission include altered consciousness, persistently abnormal vital signs, and predicted delayed toxicity. For example, admission is considered if patients have ingested sustained-release preparations, particularly of drugs with potentially serious effects (eg, cardiovascular drugs). If there are no other reasons for admission, if indicated laboratory test results are normal, and if symptoms are gone after patients have been observed for 4 to 6 hours, most patients can be discharged. However, if ingestion was intentional, patients require a psychiatric evaluation.

Key points

- Poisoning is distinguished from hypersensitivity and idiosyncratic reactions, which are unpredictable and not dose-related, and from intolerance, which is a toxic reaction to a usually nontoxic dose of a substance.
- Recognizing a toxidrome (eg, anticholinergic, muscarinic cholinergic, nicotinic cholinergic, opioid, sympathomimetic, withdrawal) can help narrow the differential diagnosis.
- Toxicity may be immediate, delayed (eg, acetaminophen, iron, *Amanita phalloides* mushrooms causing delayed hepatotoxicity), or occur only after repeated exposure.
- Maximize recognition of poisoning and identification of the specific poison by considering poisoning in all patients with unexplained alterations in consciousness and by searching thoroughly for clues from the history.
- Consider other causes (eg, central nervous system infection, head trauma, hypoglycemia, stroke, hepatic encephalopathy, Wernicke encephalopathy) if consciousness is altered, even if poisoning is suspected.
- Use toxicology testing (eg, drug immunoassays) selectively because it can provide incomplete or incorrect information.
- Treat all poisoning supportively and use activated charcoal for serious oral poisoning and other methods selectively.