1 INITIAL EVALUATION OF THE PATIENT: VITAL SIGNS AND TOXIC SYNDROMES

For more than 200 years, health care providers have attempted to standardize their approach to the assessment of patients. At the New York Hospital in 1865, pulse rate, respiratory rate, and temperature were incorporated into the bedside chart and called "vital signs." It was not until the early part of the 20th century that blood pressure determination also became routine. Additional components of the present standard emergency assessment, such as oxygen saturation by pulse oximetry, capillary blood glucose, and pain severity, are sometimes considered vital signs. Although they are essential components of the clinical evaluation and are important considerations throughout this text, they are not discussed in this chapter but can be found in other relevant sections.

In the practice of medical toxicology, vital signs play an important role beyond assessing and monitoring the overall status of a patient, because they frequently provide valuable physiologic clues to the toxicologic etiology and severity of an illness. Table 1–1 presents the normal vital signs for various age groups. Published normal values likely have little relevance for an acutely ill or anxious patient in the emergency setting, yet that is precisely the environment in which abnormal vital signs must be identified and addressed. Descriptions of vital signs as "normal" or "stable" are too nonspecific to be meaningful and therefore should never be accepted as defining normalcy in an individual patient. Only a complete assessment of a patient can determine whether or not a particular vital sign is truly clinically normal in the particular clinical setting. **No patient should be considered too agitated, too young, or too gravely ill for the practitioner to obtain a complete set of vital signs; indeed, these patients urgently need a thorough evaluation.**

TABLE 1–1 Normal Vital Signs by Age[a]

Age	Systolic BP (mm Hg)	Diastolic BP (mm Hg)	Pulse (beats/min)	Respirations (breaths/min)
Adult	120	80	50–90	16–24
16 years	≤120	<80	80	16–30
12 years	119	76	85	16–30
10 years	115	74	90	16–30
6 years	107	69	100	20–30
4 years	104	65	110	20–30
4 months	90	50	145	30–35
2 months	85	50	145	30–35
Newborn	65	50	145	35–40

[a]The normal rectal temperature is defined as 95.0°F to 100.4°F (35°–38°C) for all ages. For children 1 year of age or younger, these values are the mean values for the 50th percentile. For older children, these values represent the 90th percentile at a specific age for the 50th percentile of weight in that age group.

These respiration values were determined in the emergency department and may be environment and situation dependent.

BP = blood pressure.

The vital signs must be recorded as accurately as possible on arrival and repeated periodically as clinically indicated to identify trends. Meticulous attention to both the initial and repeated determinations of vital signs is of extreme importance in identifying a pattern of changes suggesting a particular xenobiotic or group of xenobiotics. The value of serial monitoring of the vital signs is demonstrated by the patient who presents with anticholinergic toxicity and receives the antidote, physostigmine. In this situation, it is important to recognize when tachycardia becomes bradycardia (eg, anticholinergic syndrome followed by cholinergic syndrome due to physostigmine excess).

The assessment starts by analyzing diverse information, including vital signs, history, and physical examination. Mofenson and Greensher coined the term toxidromes from the words *toxic syndromes* to describe the groups of signs and symptoms that consistently result from particular toxins. These syndromes are usually best described by a combination of the vital signs and clinically apparent end-organ manifestations. Table 1–2 describes the most typical toxidromes. This table includes only vital signs that are thought to be characteristically abnormal or pathognomonic and directly related to the toxicologic effect of the xenobiotic. A detailed analysis of each sign, symptom, and toxic syndrome can be found in the pertinent chapters throughout the text. In this chapter, the most typical toxic syndromes are considered to enable the appropriate assessment and differential diagnosis of a poisoned patient. In considering a toxic syndrome, the reader should always remember that the actual clinical manifestations of a poisoning are far more variable than the syndromes described in Table 1–2, especially when coingestants are ingested.

BLOOD PRESSURE

Xenobiotics cause hypotension by four major mechanisms: decreased peripheral vascular resistance, decreased myocardial contractility, dysrhythmias, and depletion of intravascular volume (Table 1–3). Hypertension from xenobiotics is caused by CNS sympathetic overactivity, increased myocardial contractility, increased peripheral vascular resistance, or a combination thereof.

TABLE 1–2 Toxic Syndromes

	Vital Signs								
Group	*BP*	*P*	*R*	*T*	*Mental Status*	*Pupil Size*	*Peristalsis*	*Diaphoresis*	*Other*
Anticholinergics	–/↑	↑	±	↑	Delirium	↑	↓	↓	Dry mucous membranes, flush, urinary retention
Cholinergics	±	±	±	–	Normal to depressed	±	↑	↑	Salivation, lacrimation, urination, diarrhea, bronchorrhea, fasciculations, paralysis
Ethanol or sedative–hypnotics	↓	↓	↓	–/↓	Depressed, agitated	±	↓	–	Hyporeflexia, ataxia
Opioids	↓	↓	↓	↓	Depressed	↓	↓	–	Hyporeflexia
Serotonin toxicity	↑	↑	–/↑	↑	Normal to agitated delirium	–/↑	↑	↑	Clonus, tremor, seizures
Sympathomimetics	↑	↑	↑	↑	Agitated	↑	–/↑	↑	Tremor, seizures, diaphoresis
Withdrawal from ethanol or sedative–hypnotics	↑	↑	↑	↑	Agitated, disoriented, hallucinations	↑	↑	↑	Tremor, seizures, diaphoresis
Withdrawal from opioids	↑	↑	–	–	Normal, anxious	↑	↑	↑	Vomiting, rhinorrhea, piloerection, diarrhea, yawning

↑ = increases; ↓ = decreases; ± = variable; – = change unlikely; BP = blood pressure; P = pulse; R = respirations; T = temperature.

PULSE RATE

Extremely useful clinical information can be obtained by evaluating the pulse rate (Table 1–4). The normal heart rate for adults was defined by consensus studies suggesting that 95% of the population has bradycardia and tachycardia thresholds of 50 beats/min and 90 beats/min, making absolute definitions unrealistic, particularly in the ED. Because pulse rate is the net result of a balance between sympathetic (adrenergic) and parasympathetic (muscarinic and nicotinic) tone, many xenobiotics that exert therapeutic or toxic effects or cause pain syndromes, hyperthermia, or volume depletion also affect the pulse rate. The inability to differentiate easily between sympathomimetic and anticholinergic xenobiotic effects by vital signs alone illustrates the principle that no single vital sign abnormality can definitively establish a toxicologic diagnosis.

TABLE 1–3 Common Xenobiotics That Affect the Blood Pressure

Hypotension	*Hypertension*
α_1-Adrenergic antagonists	α_1-Adrenergic agonists
α_2-Adrenergic agonists (central)	α_2-Adrenergic agonists (central) (early)
β-Adrenergic antagonists	α_2-Adrenergic antagonists
β_2-Adrenergic agonists	Ergot alkaloids
Angiotensin-converting enzyme inhibitors	Ethanol and sedative–hypnotic withdrawal
Angiotensin receptor blockers	Lead (chronic)
Antidysrhythmics	Monoamine oxidase inhibitors
Calcium channel blockers	(overdose early and drug–food
Cyanide	interaction)
Cyclic antidepressants	Nicotine (early)
Ethanol and other alcohols	Phencyclidine
Iron	Sympathomimetics
Methylxanthines	
Nitrates and nitrites	
Nitroprusside	
Opioids	
Phenothiazines	
Phosphodiesterase-5 inhibitors	
Sedative–hypnotics	

RESPIRATORY RATE

Although respirations are typically assessed initially for rate alone, careful observation of the depth and pattern is essential (Table 1–5). Hyperventilation means an increase in minute ventilation above normal and it may result from tachypnea, hyperpnea, or both. When hyperventilation results solely or predominantly from hyperpnea, clinicians may miss this important finding entirely, instead erroneously describing such a hyperventilating patient as normally ventilating or even hypoventilating if bradypnea is also present. Similarly hypoventilation means a decreased minute ventilation and can result from bradypnea or hypopnea or both.

TEMPERATURE

Temperature evaluation and control are critical, yet our ability to recognize abnormal temperatures by clinical examination is limited. The risks of inaccuracy are substantial when an oral temperature is taken in a tachypneic patient, an axillary temperature or a temporal artery temperature is taken in any patient (especially those found outdoors), or a tympanic temperature is taken in a patient with cerumen impaction.

TABLE 1–4 Common Xenobiotics That Affect the Pulse Rate

Bradycardia	*Tachycardia*
α_2-Adrenergic agonists (central)	α_1-Adrenergic antagonists
β-Adrenergic antagonists	Anticholinergics
Baclofen	Antipsychotics
Calcium channel blockers	β-Adrenergic agonists
(nondihydropyridine)	Cyclic antidepressants
Carbamates	Disulfiram–ethanol interaction
Cardioactive steroids	Ethanol and sedative–hypnotic withdrawal
Ciguatoxin	Iron
Ergot alkaloids	Methylxanthines
γ-Hydroxybutyric acid	Phencyclidine
Opioids	Sympathomimetics
Organic phosphorus compounds	Thyroid hormone
Synthetic cannabinoids	Thiamine deficiency
	Yohimbine

TABLE 1–5 Common Xenobiotics That Affect Respiration

Bradypnea	*Tachypnea*
α_2-Adrenergic agonists (central)	Cyanide
Botulinum toxin	Dinitrophenol and congeners
Carbamates	Epinephrine
Elapidae venom	Ethylene glycol
Ethanol and other alcohols	Hydrogen sulfide
γ-Hydroxybutyric acid	Methanol
Magnesium	Methemoglobin producers
Neuromuscular blockers	Methylxanthines
Opioids	Nicotine (early)
Organic phosphorus compounds	Pulmonary irritants
Sedative–hypnotics	Salicylates
Tetanospasmin	Sympathomimetics
Tetrodotoxin	

TABLE 1–6 Common Xenobiotics That Affect Temperature[a]

Hyperthermia	*Hypothermia*
Anticholinergics	α_2-Adrenergic agonists (central)
Chlorophenoxy herbicides	Anesthetics (general and intravenous)
Dinitrophenol and congeners	Cannabinoids
Malignant hyperthermia[a]	Carbon monoxide
Monoamine oxidase inhibitors	Ethanol
Neuroleptic malignant syndrome[a]	γ-Hydroxybutyric acid
Phencyclidine	Hypoglycemics
Salicylates	Opioids
Sedative–hypnotic or ethanol withdrawal	Sedative–hypnotics (particularly barbiturates)
Serotonin toxicity[a]	Thiamine deficiency
Sympathomimetics	
Thyroid hormone	

[a]Xenobiotic-related syndromes.

Obtaining **rectal temperatures** (T_r) using a nonglass probe is essential for safe and accurate temperature determinations in agitated individuals and is considered the standard method of temperature determination in this textbook.

Hypothermia (T_r <95.0°F; <35°C) and hyperthermia (T_r >100.4°F; >38°C) are common manifestations of toxicity. Severe or significant hypothermia and hyperthermia, unless immediately recognized and managed appropriately, may result in grave complications and inappropriate or inadequate resuscitative efforts. Life-threatening hyperthermia (T >106°F; >41.1°C) from any cause may lead to extensive rhabdomyolysis, myoglobinuric kidney failure, and direct liver and brain injury and must therefore be identified and corrected immediately. Hypothermia is probably less of an immediate threat to life than hyperthermia, but it requires rapid appreciation, accurate diagnosis, and skilled management because it may suggest energy failure. Table 1–6 is a representative list of xenobiotics that affect body temperature.

2 PRINCIPLES OF MANAGING THE ACUTELY POISONED OR OVERDOSED PATIENT

OVERVIEW

For more than 5 decades, medical toxicologists and poison information specialists have used a clinical approach to poisoned or overdosed patients that emphasizes treating the patient rather than treating the poison. Too often in the past, patients were initially ignored while attention was focused on the ingredients listed on the containers of the product(s) to which they presumably were exposed. However, astute clinicians must always be prepared to administer a specific antidote immediately in instances when nothing else will save a patient, such as with cyanide poisoning. Moreover, after resuscitative antidotes are given, all poisoned or overdosed patients benefit from an organized, rapid clinical management plan also known as a toxicological risk assessment.

With the widespread availability of accurate rapid bedside testing for capillary blood glucose, pulse oximetry for oxygen saturation, and end-tidal CO_2 monitors, clinicians can safely provide rational, individualized approaches to determine the need for, and in some instances more precise amounts of, dextrose, thiamine, naloxone, and oxygen. Likewise, appreciation of the potential for significant adverse effects associated with all types of gastrointestinal (GI) decontamination interventions and recognition of the absence of clear evidence-based support of efficacy have led to abandoning of syrup of ipecac-induced emesis, an almost complete elimination of orogastric lavage, and a significant reduction in the routine use of activated charcoal. The value of whole-bowel irrigation (WBI) with polyethylene glycol electrolyte solution (PEG-ELS) appears to be much more specific and limited than originally thought, and some of the limitations and (uncommon) adverse effects of activated charcoal are now more widely recognized (Chap. 3). However, as with many issues in clinical medicine, properly selected procedures performed in properly selected patients can lead to an acceptable risk-benefit profile. Routine exclusion of GI decontamination procedures is not optimal and can lead to suboptimal care manifested as increased toxic effects and prolonged use of health care resources. Similarly, interventions to eliminate absorbed xenobiotics from the body are now much more narrowly defined or, in some cases, have been abandoned. Multiple-dose activated charcoal (MDAC) is useful for select but not all xenobiotics. Ion trapping in the urine is only beneficial, achievable, and relatively safe when the urine can be maximally alkalinized in a limited number of cases (Antidotes in Brief: A5). Finally, the roles of hemodialysis, hemoperfusion, and other extracorporeal techniques are now much more specifically defined (Chap. 4). Thus, this chapter represents our current efforts to formulate a logical and effective approach to managing a patient with probable or actual toxic exposure.

The management of most patients with toxicologic clinical syndromes cannot be based on specific antidotal therapies but rather relies on the application of directed supportive or pharmacologic care. Table 2–1 provides a recommended stock list of antidotes and therapeutics for the treatment of poisoned or overdosed patients. Consensus antidote stocking guidelines exist as well.

MANAGING ACUTELY POISONED OR OVERDOSED PATIENTS

Rarely, if ever, are all of the circumstances involving a poisoned patient known. The history may be incomplete, unreliable, or unobtainable; multiple xenobiotics may be involved; and even when a xenobiotic etiology is identified, it may not be easy to determine whether the problem is an overdose, an allergic or idiosyncratic reaction, or a drug–drug interaction. The patient's presenting signs and symptoms may force an intervention at a time when there is almost no information available about the etiology of the patient's condition (Table 2–2).

Initial Management of Patients with a Suspected Exposure

The clinical approach to the patient potentially exposed to a xenobiotic begins with the recognition and treatment of life-threatening conditions, including airway compromise, breathing difficulties, and circulatory problems such as hemodynamic instability and serious dysrhythmias. After the "ABCs" (airway, breathing, and circulation) are addressed, the patient's level of consciousness should be assessed because it helps determine the techniques to be used for further management of the exposure.

Management of Patients with Altered Mental Status

Figure 2–1 provides an approach to these patients. Within the first 5 minutes of managing a patient with an altered mental status (AMS), five therapeutic interventions should be administered if indicated and not contraindicated:

1. Supplemental oxygen to treat xenobiotic-induced hypoxia
2. Hypertonic dextrose: 0.5 to 1.0 g/kg of $D_{50}W$ for an adult or a more dilute dextrose solution ($D_{10}W$ or $D_{25}W$) for a child; the dextrose is administered as an IV bolus as specific or empiric therapy for documented or suspected hypoglycemia when rapid confirmation is unavailable (Antidotes in Brief: A8)
3. Thiamine (100 mg IV for an adult; usually unnecessary for a child) to prevent Wernicke encephalopathy in patients at risk (Antidotes in Brief: A27)
4. Naloxone (0.04 mg IV with upward titration) for an adult or child with opioid-induced respiratory compromise (Antidotes in Brief: A4)
5. Rectal temperature and initiation of appropriate cooling or warming measures if hyperthermia or hypothermia are present

TABLE 2–1 Antidotes and Therapeutics for the Treatment of Poisonings and Overdoses[a]

Therapeutics[b]	*Indications*
Acetylcysteine (p. 66)	Acetaminophen and other causes of hepatotoxicity
Activated charcoal (p. 22)	Adsorbent xenobiotics in the GI tract
Antivenom (*Centruroides* spp) (p. 615)	Scorpion envenomation
Antivenom (*Crotalinae*) (p. 658)	Crotaline snake envenomations
Antivenom *(Micrurus fulvius)* (p. 658)	Coral snake envenomations
Antivenom (*Latrodectus mactans*) (p. 613)	Black widow spider envenomations
Antivenom (*Synanceja* spp) (p. 624)	Stonefish envenomation
Atropine (p. 586)	Bradydysrhythmias, cholinesterase inhibitors (organic phosphorus compounds, physostigmine) muscarinic mushrooms (*Clitocybe, Inocybe*) ingestions
Benzodiazepines (p. 401)	Seizures, agitation, stimulants, ethanol and sedative–hypnotic withdrawal, cocaine, chloroquine, organic phosphorus compounds
Botulinum antitoxin (Heptavalent) (p. 114)	Botulism
Calcium chloride, calcium gluconate (p. 532)	Fluoride, hydrofluoric acid, ethylene glycol, CCBs, hypermagnesemia, β-adrenergic antagonists, hyperkalemia
L-Carnitine (p. 195)	Valproic acid: hyperammonemia
Cyanide kit (nitrites, p. 693; sodium thiosulfate, p. 693)	Cyanide
Cyproheptadine (p. 364)	Serotonin toxicity
Dantrolene (p. 346)	Malignant hyperthermia
Deferoxamine (p. 166)	Iron, aluminum
Dextrose in water (50% adults; 20% pediatrics; 10% neonates) (p. 181)	Hypoglycemia
Digoxin-specific antibody fragments (p. 319)	Cardioactive steroids
Dimercaprol (British anti-Lewisite [BAL]) (p. 457)	Arsenic, mercury, gold, lead
Diphenhydramine (p. 351)	Dystonic reactions, allergic reactions
DTPA (p. 726) (calcium trisodium pentetate)	Radioactive isotopes; americium, curium, plutonium
Edetate calcium disodium (calcium disodium versenate, $CaNa_2EDTA$) (p. 488)	Lead, other selected metals
Ethanol (p. 550)	Ethylene glycol, methanol, diethylene glycol
Flumazenil (p. 381)	Benzodiazepines
Folinic acid (p. 217)	Methotrexate, methanol
Fomepizole (p. 548)	Ethylene glycol, methanol, diethylene glycol
Glucagon (p. 301)	β-Adrenergic antagonists, CCBs
Glucarpidase (p. 220)	Methotrexate
Hydroxocobalamin (p. 691)	Cyanide
Idarucizumab (p. 285)	Dabigatran
Insulin (p. 331)	β-Adrenergic antagonists, CCBs, hyperglycemia
Iodide (SSKI) (p. 724)	Radioactive iodine (I^{131})
Lipid emulsion (p. 331)	Local anesthetics
Magnesium sulfate injection (p. 271)	Cardioactive steroids, hydrofluoric acid, hypomagnesemia, ethanol withdrawal, torsade de pointes
Methylene blue (1% solution) (p. 701)	Methemoglobinemia, ifosfamide, vasoplegic syndrome, shock
Naloxone (p. 90)	Opioids, clonidine
Norepinephrine	Hypotension
Octreotide (p. 184)	Insulin secretagogue–induced hypoglycemia
Oxygen (Hyperbaric) (p. 683)	Carbon monoxide, cyanide, hydrogen sulfide
D-Penicillamine (p. 473)	Copper
Phenobarbital (p. 418)	Seizures, agitation, stimulants, ethanol and sedative–hypnotic withdrawal
Phentolamine (p. 399)	Vasoconstriction: cocaine, MAOI interactions, epinephrine, and ergot alkaloids
Physostigmine (p. 206)	Anticholinergics
Polyethylene glycol electrolyte lavage solution (p. 25)	Decontamination
Pralidoxime (p. 588)	Acetylcholinesterase inhibitors (organic phosphorus compounds and carbamates)
Protamine (p. 291)	Heparin anticoagulation
Prussian blue (p. 508)	Thallium, cesium
Pyridoxine (vitamin B_6) (p. 262)	Isoniazid, ethylene glycol, gyromitrin-containing mushrooms
Sodium bicarbonate (p. 104)	Ethylene glycol, methanol, salicylates, cyclic antidepressants, methotrexate, phenobarbital, quinidine, chlorpropamide, class I antidysrhythmics, chlorophenoxy herbicides, sodium channel blockers
Starch (p. 516)	Iodine
Succimer (p. 485)	Lead, mercury, arsenic
Thiamine (vitamin B_1) (p. 412)	Thiamine deficiency, ethylene glycol, chronic ethanol consumption ("alcoholism")
Uridine triacetate (p. 223)	Fluorouracil, capecitabine
Vitamin K_1 (p. 289)	Warfarin or rodenticide anticoagulants

[a]Each emergency department should have the vast majority of these antidotes immediately available; some of these antidotes may be stored in the pharmacy, and others may be available from the Centers for Disease Control and Prevention, but the precise mechanism for locating each one must be known by each staff member.

[b]A detailed analysis of each of these antidotes is found in the text in the Antidotes in Brief section on the page cited to the right of each antidote or therapeutic listed.

CCB = calcium channel blocker; DTPA = diethylenetriaminepentaacetic acid; EDTA = ethylenediamine tetraacetic acid; GI = gastrointestinal; MAOI = monoamine oxidase inhibitor; SSKI = saturated solution of potassium iodide.

TABLE 2–2 Clinical and Laboratory Findings in Poisoning and Overdose

Agitation	Anticholinergics,[a] hypoglycemia, phencyclidine, sympathomimetics,[b] synthetic cannabinoid receptor agonists, withdrawal from ethanol and sedative–hypnotics
Alopecia	Alkylating agents, radiation, selenium, thallium
Ataxia	Benzodiazepines, carbamazepine, carbon monoxide, ethanol, hypoglycemia, lithium, mercury, nitrous oxide, phenytoin
Blindness or decreased visual acuity	Caustics (direct), cisplatin, cocaine, ethambutol, lead, mercury, methanol, quinine, thallium
Blue skin	Amiodarone, FD&C #1 dye, methemoglobinemia, silver
Constipation	Anticholinergics,[a] botulism, lead, opioids, thallium (severe)
Deafness, tinnitus	Aminoglycosides, carbon disolfide, cisplatin, loop diuretics, macrolides, metals, quinine, quinolones, salicylates
Diaphoresis	Amphetamines, cholinergics,[c] hypoglycemia, opioid withdrawal, salicylates, serotonin toxicity, sympathomimetics,[b] withdrawal from ethanol and sedative–hypnotics
Diarrhea	Arsenic and other metals, boric acid (blue-green), botanical irritants, cathartics, cholinergics,[c] colchicine, iron, lithium, opioid withdrawal, radiation
Dysesthesias, paresthesias	Acrylamide, arsenic, ciguatera, cocaine, colchicine, thallium
Gum discoloration	Arsenic, bismuth, hypervitaminosis A, lead, mercury
Hallucinations	Anticholinergics,[a] dopamine agonists, ergot alkaloids, ethanol, ethanol and sedative–hypnotic withdrawal, LSD, phencyclidine, sympathomimetics,[b] tryptamines
Headache	Carbon monoxide, hypoglycemia, MAOI–food interaction (hypertensive crisis), serotonin toxicity
Metabolic acidosis (elevated anion gap)	Methanol, uremia, ketoacidosis (diabetic, starvation, alcoholic), paraldehyde, metformin, iron, isoniazid, lactic acidosis, cyanide, protease inhibitors, ethylene glycol, salicylates, toluene
Miosis	Cholinergics,[c] clonidine, opioids, phencyclidine, phenothiazines
Mydriasis	Anticholinergics,[a] botulism, opioid withdrawal, sympathomimetics[b]
Nystagmus	Barbiturates, carbamazepine, carbon monoxide, dextromethorphan, ethanol, lithium, MAOIs, phencyclidine, phenytoin, quinine, synthetic cannabinoid receptor agonists
Purpura	Anticoagulant rodenticides, corticosteroids, heparin, pit viper venom, quinine, salicylates, anticoagulants, levamisole
Radiopaque ingestions	Arsenic, halogenated hydrocarbons, iodinated compounds metals (eg, iron, lead), potassium compounds
Red skin	Anticholinergics,[a] boric acid, disulfiram, hydroxocobalamin, scombroid, vancomycin
Rhabdomyolysis	Carbon monoxide, doxylamine, HMG-CoA reductase inhibitors, sympathomimetics,[b] *Tricholoma equestre mushrooms*
Salivation	Arsenic, caustics, cholinergics,[c] clozapine, ketamine, mercury, phencyclidine, strychnine
Seizures	Bupropion, camphor, carbon monoxide, cyclic antidepressants, *Gyromitra* mushrooms, hypoglycemia, isoniazid, methylxanthines, ethanol and sedative–hypnotic withdrawal
Tremor	Antipsychotics, arsenic, carbon monoxide, cholinergics,[c] ethanol, lithium, mercury, methyl bromide, sympathomimetics,[b] thyroid hormones
Weakness	Botulism, diuretics, magnesium, paralytic shellfish, steroids, toluene
Yellow skin	APAP (late), pyrrolizidine alkaloids, β carotene, amatoxin mushrooms, dinitrophenol

[a]Anticholinergics, including antihistamines, atropine, cyclic antidepressants, and scopolamine.

[b]Sympathomimetics, including adrenergic agonists, amphetamines, cocaine, and ephedrine.

[c]Cholinergics, including muscarinic mushrooms; organic phosphorus compounds and carbamates, including select Alzheimer disease drugs and physostigmine; and pilocarpine and other direct-acting xenobiotics.

APAP = acetaminophen; HMG-CoA = 3-hydroxy-3-methyl-glutaryl-CoA; LSD = lysergic acid diethylamide; MAOI = monoamine oxidase inhibitor.

Further Evaluation of All Patients with Suspected Xenobiotic Exposures

Vital signs should be obtained serially and a full physical examination should be performed. Toxicologic etiologies of abnormal vital signs and physical findings are summarized in Tables 1–1 to 1–6. Toxic syndromes, sometimes called "toxidromes," are summarized in Table 1–2.

Typically, in the management of patients with toxicologic emergencies, there is both a necessity and an opportunity to obtain various diagnostic studies and ancillary tests interspersed with stabilizing the patient's condition, obtaining the history, and performing the physical examination. For most patients with unintentional exposures or intended self-harm the routine use of laboratory testing is of limited value. Specifically, urine and serum drug screens add little if anything to clinical management and are often misleading or misinterpreted. Rather targeted laboratory testing is preferred as guided by the history and physical examination.

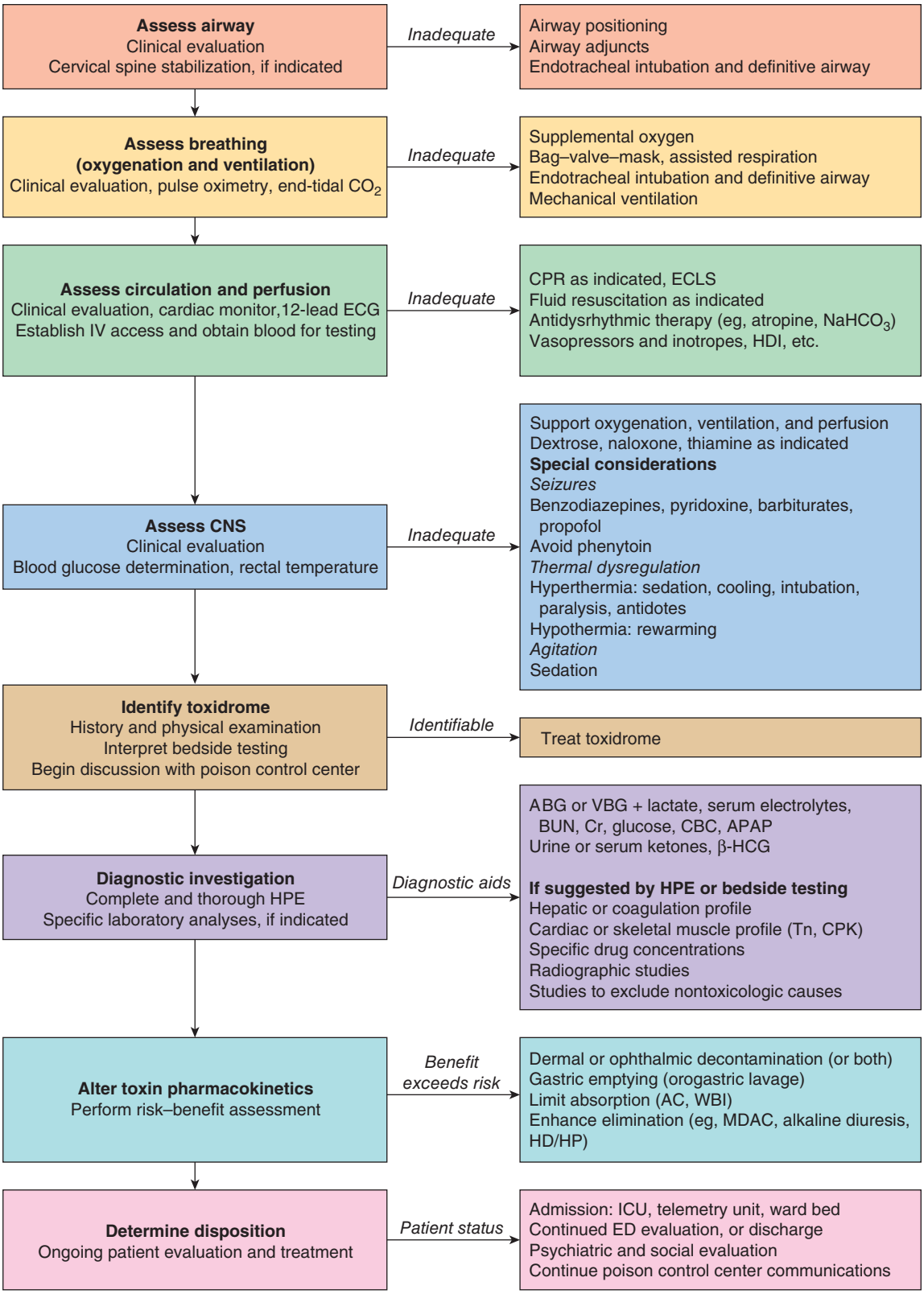

FIGURE 2–1. This algorithm is a basic guide to the management of poisoned patients. A more detailed description of the steps in management may be found in the accompanying text. This algorithm is only a guide to actual management, which must, of course, consider the patient's clinical status. ABG = arterial blood gas; AC = activated charcoal; APAP = acetaminophen; β-HCG = β-human chorionic gonadotropin; CBC = complete blood count; CNS = central nervous system; CPK = creatine phosphokinase; CPR = cardiopulmonary resuscitation; Cr, creatinine; ECG = electrocardiograph; ECLS = extracorporeal life support; HD = hemodialysis; HDI = high-dose insulin; HP = hemoperfusion; HPE = history and physical examination; ICU = intensive care unit; MDAC = multiple-dose activated charcoal; Tn = troponin; VBG = venous blood gas; WBI = whole-bowel irrigation.

The Role of Gastrointestinal Decontamination

A series of highly individualized treatment decisions regarding limiting the exposure to the xenobiotic follow the initial stabilization and assessment of the patient. As noted previously and as discussed in detail in Chap. 3, evacuation of the GI tract or administration of activated charcoal can no longer be considered standard or routine toxicologic care for most patients.

Eliminating Absorbed Xenobiotics from the Body

Discussions of the indications for and techniques of manipulating urinary pH (ion trapping), diuresis, hemodialysis, hemoperfusion, continuous renal replacement therapy, and exchange transfusion are found in Chap. 4. Alkalinization of the urinary pH with sodium bicarbonate is used to enhance salicylate elimination (other xenobiotics are discussed in Chap. 4), and sodium bicarbonate also prevents toxicity from methotrexate (Antidotes in Brief: A5). If extracorporeal elimination is contemplated, hemodialysis is used for patients who overdose with salicylates, methanol, ethylene glycol, lithium, valproic acid, and other xenobiotics that are either dialyzable or cause fluid and electrolyte abnormalities. Plasmapheresis and exchange transfusion are used to eliminate xenobiotics with large molecular weights that are not dialyzable.

AVOIDING PITFALLS

The history alone is not a reliable indicator of which patients require naloxone, hypertonic dextrose, thiamine, and oxygen. Instead, the need for these therapies should be evaluated and performed if indicated (unless specifically contraindicated) only after a clinical assessment for all patients with AMS. Attributing an AMS to alcohol because of an odor on a patient's breath is potentially misleading. Small amounts of alcohol or alcoholic beverage congeners generally produce the same breath odor as do intoxicating amounts. Conversely, even when an extremely high blood ethanol concentration is confirmed by laboratory analysis, it is dangerous to ignore other possible causes of an AMS. Because some individuals with an alcohol use disorder are alert with ethanol concentrations in excess of 500 mg/dL, a concentration that would result in coma and possibly apnea and death in a nontolerant person, finding a high ethanol concentration does not eliminate the need for further search into the cause of a depressed level of consciousness.

ADDITIONAL CONSIDERATIONS IN MANAGING PATIENTS WITH A NORMAL MENTAL STATUS

As in the case of patients with AMS, vital signs must be obtained and recorded. If the patient is alert, talking, and in no respiratory distress, all that remains to document are the respiratory rate and rhythm. Because the patient is alert, additional history should be obtained, keeping in mind that information regarding the number and types of xenobiotics ingested, time elapsed, prior vomiting, and other critical information may be unreliable. Speaking to a friend or relative of the patient may provide an opportunity to learn useful and reliable information regarding the exposure, the patient's frame of mind, a history of previous exposures, and the type of support that is available if the patient is discharged from the ED. At times, it is essential to initially separate the patient from any relatives or friends to obtain greater cooperation from the patient and avoid violating confidentiality and because the interpersonal anxiety may interfere with therapy.

APPROACHING PATIENTS WITH INTENTIONAL EXPOSURES

Initial efforts at establishing rapport with the patient by indicating to the patient concern about the events that led to the ingestion and the availability of help after the xenobiotic is removed (if such procedures are planned) often facilitate management. If GI decontamination is deemed beneficial, the reason for and nature of the procedure should be clearly explained to the patient together with reassurance that after the procedure is completed, there will be ample time to discuss his or her concerns and provide additional care.

SPECIAL CONSIDERATIONS FOR MANAGING PREGNANT PATIENTS

In general, a successful outcome for both the mother and fetus depends on optimum management of the mother. Proven effective treatment for a potentially serious toxic exposure to the mother should never be withheld based on theoretical concerns regarding the fetus.

Physiologic Factors

A pregnant woman's total blood volume and cardiac output are elevated through the second trimester and into the later stages of the third trimester. This means that signs of hypoperfusion and hypotension manifest later than they would in a woman who is not pregnant, and when they do, uterine blood flow may already be compromised. Maintaining the patient in the left-lateral decubitus position helps prevent supine hypotension resulting from impairment of systemic venous return by compression of the inferior vena cava.

Use of Antidotes

Limited data are available on the use of antidotes in pregnancy. In general, antidotes should not be used if the indications for use are equivocal. On the other hand, antidotes should not be withheld if they have the potential to reduce potential maternal morbidity and mortality as the health of the fetus is directly linked to that of the mother.

MANAGEMENT OF PATIENTS WITH CUTANEOUS EXPOSURE

In all of these cases, the principles of management are as follows:

1. Avoid secondary exposures by wearing protective (rubber or plastic) gowns, gloves, eye protection, and shoe covers. Cases of serious secondary poisoning have occurred in emergency personnel after prolonged skin contact with xenobiotics such as organic phosphorus compounds on the victim's skin or clothing.
2. Remove the patient's clothing, place it in plastic bags, and then seal the bags.
3. Wash the patient with soap and copious amounts of water twice regardless of how much time has elapsed since the exposure.

4. Make no attempt to neutralize an acid with a base or a base with an acid. Further tissue damage may result from the heat generated by the exothermic reaction.
5. Avoid using any greases or creams because they will only keep the xenobiotic in close contact with the skin and ultimately make removal more difficult.

Special Considerations: SC1 discusses the principles of preventing dermal absorption.

MANAGEMENT OF PATIENTS WITH OPHTHALMIC EXPOSURES

The eyes should be irrigated with the eyelids fully retracted for no less than 20 minutes. To facilitate irrigation, an anesthetic should be used, and the eyelids should be kept open with an eyelid retractor. An adequate irrigation stream is obtained by running 1 L of 0.9% sodium chloride through regular IV tubing held a few inches from the eye or by using an irrigating lens. Checking the eyelid fornices with pH paper strips is important to ensure adequate irrigation; the pH should normally be 6.5 to 7.6 if accurately tested, although when using paper test strips, the measurement will often be near 8.0. SC1 describes the management of toxic ophthalmic exposures in more detail.

IDENTIFYING PATIENTS WITH NONTOXIC EXPOSURES

The following general guidelines for determining that an exposure is either nontoxic or minimally toxic will assist clinical decision making:

1. Identification of the product and its ingredients is possible.
2. None of the United States Consumer Product Safety Commission's "signal words" (CAUTION, WARNING, or DANGER) appear on the product label.
3. The route of exposure is known.
4. A reliable approximation of the maximum exposure quantity is able to be made.
5. Based on the available medical literature and clinical experience, the potential effects related to the exposure are expected to be benign or at worst self-limited and not likely to require the patient to access health care.
6. The patient is asymptomatic or has developed the maximal expected self-limited toxicity.
7. Adequate time has occurred to assess the potential for the development of toxicity.

For any patient in whom there is a question about the nature of the exposure, it is not appropriate to consider that exposure nontoxic. All such patients, and all patients for whom the health care provider is unsure of the risks associated with a given exposure, should be referred either to the regional poison control center or health care facility for further evaluation.

DISPOSITION OF PATIENTS

The poison control center must determine the need for direct medical care in a hospital or whether the patient has had a nontoxic exposure (discussed earlier) and can be managed at home. In the ED, many patients are discharged after their evaluation and treatment and after psychiatric and social services evaluations are obtained as needed. Among clinically ill poisoned patients, the decision is generally simplified based on the relative abilities of the various units within the medical facility. Critical care units expend the highest level of resources to assure both intensive monitoring and the provision of timely care and are necessary for patients who are currently ill or currently stable but likely to decompensate. See Table 2–3 for a description of patients best suited

TABLE 2–3 Define the Indications for Intensive Care Unit Admission

Patient Characteristics	*Xenobiotic Characteristics*	*Capabilities of the Inpatient or Observation Unit*
Does the patient have any signs of serious end-organ toxicity?	Are there known serious sequelae (eg, cyclic antidepressants, CCBs)?	Does the admitting health care team appreciate the potential seriousness of a toxicologic emergency?
Are the end-organ effects progressing?	Can the patient deteriorate rapidly from its toxic effects?	Is the nursing staff:
Are laboratory data suggestive of serious toxicity?	Is the onset of toxicity likely to be delayed (eg, modified-release preparation, slowed GI motility, or delayed toxic effects)?	Familiar with this toxicologic emergency?
Is the patient a high risk for complications requiring ICU intervention?	Does the xenobiotic have effects that will require cardiac monitoring?	Familiar with the potential for serious complications?
Seizures	Is the amount ingested a potentially serious or potentially lethal dose?	Is the staffing adequate to monitor the patient?
Unresponsive to verbal stimuli	Are xenobiotic concentrations rising?	What is the ratio of nurses to patients?
Level of consciousness impaired to the point of potential airway compromise	Is the required or planned therapy unconventional (eg, large doses of atropine for treating overdoses of organic phosphorus compounds; or high dose insulin for CCB overdose)?	Are time-consuming nursing activities required and realistic?
PCO_2 >45 mm Hg	Does the therapy have potentially serious adverse effects?	Can a safe environment be provided for a suicidal patient?
Systolic blood pressure <80 mm Hg (in an adult)	Is there insufficient literature to describe the potential human toxic effects?	Can a patient have suicide precautions and monitoring with a medical floor bed?
Cardiac dysrhythmias (ventricular dysrhythmias, high-grade conduction abnormalities)	Are potentially serious coingestants likely (must take into account the reliability of the history)?	Can a one-to-one observer be present in the room with the patient?
Abnormal ECG complexes and intervals (QRS duration ≥0.10 seconds; QT interval prolongation)		Can the patient be restrained or sedated?
Refractory or recurrent hypoglycemia		
Is the patient at high risk for complications such as aspiration pneumonitis, anoxic brain injury, rhabdomyolysis, or compartment syndrome?		
Does the patient have preexisting medical conditions that could predispose to complications?		
Alcohol or drug dependence		
Liver disease		
Acute kidney injury or chronic kidney disease		
Heart disease		
Pregnancy: Is the xenobiotic or the antidote teratogenic?		
Is the patient suicidal?		

CCB = calcium channel blocker; ECG = electrocardiogram; GI = gastroinestinal; ICU = intensive care unit.

for admission to a critical care unit. Determining the optimal disposition for a poisoned patient requires an evaluation of the nature of the exposure, the patient, and the capabilities of the community and the institution. Most often such decisions are made conservatively and cautiously, given the unpredictable nature of human poisoning.

ENSURING AN OPTIMAL OUTCOME

The best way to ensure an optimal outcome for the patient with a suspected toxic exposure is to apply the principles of basic and advanced life support in conjunction with a planned and stepwise approach toxicologic risk assessment. Always bear in mind that a toxicologic etiology or co-etiology for any abnormal conditions necessitates modifying whatever standard approach is typically brought to the bedside of a severely ill patient. Involvement of the expertise of a poison control center, a medical toxicologist, or a clinical toxicologist can help direct both diagnosis and management strategies to improve the efficiency of the patient's care and the outcome. The thoughtful combination of stabilization, general management principles, and both empiric and specific treatment when indicated will result in successful outcomes in the majority of patients with actual or suspected exposures.