Chapter 22, Toxicology

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1. Introduction to Toxicology and Poisoning

- **toxicology** is the study of toxic or poisonous substances [5].
- A **poison** is any substance that can damage body structures or impair body function through chemical action [6].
- A **toxin** is a poisonous substance produced by bacteria, animals, or plants [7].
  - toxins act by changing normal cell metabolism or destroying cells [8].
  - toxins can have either acute (fast) or chronic (slower) effects [8].
- **substance abuse** is misusing any substance to produce a desired effect [9].
  - overdosing is a common complication, occurring when a patient takes a toxic dose [9].
- acute poisonings affect over 2 million people annually [4].
- chronic poisonings are more common [4].
- Deaths from poisonings are fairly rare [5].
  - Child deaths from poisoning have decreased since the 1960s due to child-resistant caps [5].
  - Adult deaths from chronic poisoning are rising due to drug abuse [5].
- Recognizing that a poisoning has occurred is your primary responsibility [10].
- Pay attention to your surroundings for your own safety to avoid exposure [10].
  - Even small amounts of some poisons can cause considerable damage or death [11].
- If you suspect toxic substance ingestion or exposure, notify medical control immediately [12].

- Begin emergency treatment at once [12].

Poisoning Type	Onset	Duration
Acute	Sudden onset [4]	Fast effects [8]
Chronic	Longer-term [4]	Slower effects [8]

2. Routes of Poison Exposure

- How you treat poisoning depends on how the poison entered the body [17].
- There are four main routes of poison entry [17].
  - inhalation [18]
  - absorption (surface contact) [18]
  - ingestion [18]
  - injection [18]
- All four routes can lead to life-threatening conditions [18].

Route	Description	Initial Emergency Actions
Inhalation	Breathing in poisonous substances [18]	Move patient to fresh air [18]. Provide supplemental oxygen [19]. Call Hazmat for toxic gas [19]. Immediate transport [20]. Suction available [21].
Absorption	Contact with skin or mucous membranes [18]	Avoid self-contamination [25]. Remove substance and contaminated clothing [25]. Flush and wash skin (brush dry powder first) [26]. Irrigate eyes [28]. Hazmat assistance [29]. Decontaminate thoroughly [29]. Prompt transport [30]. Obtain material safety data sheet [31].
Ingestion	Swallowing poisonous substances [18]	Treat signs and symptoms [36]. Notify poison control and medical control [36]. Protect airway if altered mental status [37]. Consider preventing further absorption (e.g., activated charcoal) [37].

Injection	Entry via needle or bite [18]	Monitor airway, provide high flow oxygen [40]. Be alert for nausea and vomiting [40]. Remove rings/watches/bracelets from injection site [41]. Cannot be diluted or removed in the field [38]. Prompt transport [38].

3. Patient Assessment in Poisoning Emergencies

- Patient assessment for toxins begins with scene size-up [42].
- Scene size-up involves standard precautions [43].
  - Look for clues like odors, bottles, syringes, pills, or chemicals [43].
  - Check for missing medication or drug paraphernalia [44].
  - Be aware of potential drug labs [44].
  - Keep an open mind and avoid mistaken conclusions [44].
- Primary assessment determines the patient's condition severity [45].
  - Obtain a general impression [45].
  - Assess level of consciousness and life threats [45].
  - Do not assume a conscious patient is stable [45].
- Assess the ABCs and D [46].
  - Airway and Breathing: Ensure an open airway and adequate ventilation [46].
    - Provide oxygen therapy for difficulty breathing [47].
    - Consider airway adjuncts for unresponsive patients [47].
    - Have suction ready as patients are susceptible to vomiting [48].
  - Circulation: Assess pulse and skin condition [49]. Variations depend on the substance [49].
  - Transport decision: Prompt transport for patients with altered ABCs or a poor general impression [50].
    - Hazardous material exposures require thorough decontamination by Hazmat before transport [51].
- History taking is next, if the patient is responsive [52].
  - Investigate the chief complaint [52].
  - Obtain a sample history [53].

    - Ask specific questions about the substance: what, when, how much, over what period, interventions used, and patient weight [54].
    - If the patient is unresponsive, get history from other sources [53].
- Secondary assessment focuses on the exposure route or affected body area [56].
    - Review all body systems to identify systemic problems [57].
    - Obtain a complete set of baseline vital signs [58].
    - Changes in consciousness, pulse, respirations, blood pressure, and skin indicate serious issues [58].
- Reassessment is continuous [59].
    - Continually check ABCs adequacy [59].
    - Repeat vital signs and compare to baseline [59].
    - Evaluate intervention effectiveness [60].
    - Take vital signs every 15 minutes for stable patients, every 5 minutes for unstable patients or those who ingested a harmful dose [60].

4. General Treatment and Activated Charcoal

- General treatment principles involve supporting the ABCs [61]. This is the most important task [61].
- Contact medical control or a poison center to discuss treatment [62].
- Manage airborne exposures with oxygen [62].
- Remove contact exposures with copious water, unless contraindicated [62].
- Consider activated charcoal for ingested poisons [62].
- activated charcoal binds to specific toxins [64].
    - It prevents toxin absorption in the body [64].
    - toxins are carried out in the stool [65].
- activated charcoal is not indicated for certain ingestions [66].
    - These include alkali poisons, cyanide, ethanol, iron, lithium, methanol, mineral acids, or organic solvents [67].
- Patients with a decreased level of consciousness should not receive activated charcoal because they cannot protect their airway [68].
- activated charcoal often comes as a pre-mixed suspension, typically 50 grams per bottle [69].

- The usual dose is one gram per kilogram of body weight for adults or children [69].
- Always call medical control for pre-approval before administering activated charcoal [70].
- Shake the bottle vigorously to mix [71].
- Convince the patient to drink it, but never force them [71].
- Record the time of administration [72].
- If the patient refuses, document the refusal and your attempts to counsel them [72].
- Transport the patient for further evaluation [72].
- Side effects of activated charcoal include constipation and black stools [73].
- If the patient vomits after taking charcoal, the dose may need to be repeated [74].

Indication	**Contraindication**
Ingestion of certain toxins	Ingestion of alkali poison, cyanide, ethanol, iron, lithium, methanol, mineral acids, or organic solvents [67]
Prevent toxin absorption	Decreased level of consciousness (unable to protect airway) [68]
Toxins carried out in stool	

5. Specific Types of Poisons and Their Management

- tolerance is when a person needs increasing amounts of a substance to achieve the same result [76]. This builds up over time [212].
- addiction is an overwhelming desire to continue using a substance, often increasing the dose [77].
- Safety awareness and standard precautions are crucial when caring for drug abusers [78].
  - Known drug abusers have a high incidence of serious infections like HIV and hepatitis [79].
  - The drug user, not the drug, can pose the greatest threat [80].

- **Alcohol** is a central nervous system depressant, sedative, and hypnotic [85].
  - It dulls senses, slows reflexes, and reduces reaction time [87].
  - It can cause aggressive behavior and lack of coordination [88].
  - Binge drinking (occasional heavy use) can be very damaging [84].
  - Severe acute ingestion can cause hypoglycemia [90]. Check blood sugar levels [90].
  - Alcohol increases the effects of other drugs [91].
  - Provide respiratory support for severe CNS depression [92]. Emesis can result from respiratory depression [93].
  - Alcohol withdrawal can cause hallucinations or delirium tremens (DTs) [94].
    - DTs include agitation, restlessness, fever, sweating, tremors, confusion, delusions, or seizures [95].
    - Withdrawal symptoms can occur after stopping or reducing alcohol intake [96].
  - Provide transport, reassurance, care, and emotional support for withdrawal [96]. Withdrawal is as dangerous as too much alcohol [96].
- **opiates** are narcotics that produce sleep and altered consciousness [98].
  - They are used for pain relief [99].
  - Prescription opiates are commonly abused [100]. Physical dependence can develop from medical prescriptions [101].
  - opiates are CNS depressants and cause severe respiratory depression [101] . This can lead to cardiac arrest [101].
  - tolerance develops quickly; users may need massive doses [102].
  - Nausea and vomiting are common [104]. Hypotension can occur [104]. Seizures are uncommon but possible [104].
  - Patients are typically sedated, unconscious, cyanotic with pinpoint pupils [105].
  - naloxone (Narcan) reverses opiate/opioid overdose effects [105]. It can be given IV, IM, or IN [106].
  - EMTs often administer naloxone intranasally (IN) [107]. Use it for agonal respirations or apnea due to opioids [108].
  - Ask bystanders if naloxone was given before your arrival [111].
- **Sedative-Hypnotic Drugs** (barbiturates, benzodiazepines) are CNS depressants that alter consciousness [112].
  - They are easily obtained and relatively cheap [112].

    - Effects are similar to alcohol; patients may be drowsy, peaceful, or intoxicated [113].
    - Taken orally, sometimes dissolved or injected [115].
    - tolerance develops quickly, requiring larger doses [116].
    - Can be used as "knockout drugs" [117].
    - Treatment: Ensure patent airway, assist ventilations, and provide prompt transport [118].
- **abused inhalants** are agents inhaled rather than ingested or injected [119].
    - Include acetone, glue, cleaning compounds, paint thinners, lacquers, gasoline, Freon [121].
    - Commonly abused by teenagers [123].
    - Effects range from drowsiness to coma and seizures [123].
    - Hydrocarbon solvents make the heart hypersensitive to adrenaline [123]. Keep patients from struggling or exerting themselves [123].
    - Provide oxygen and transport [123].
    - hydrogen sulfide is a highly toxic, odorless, flammable gas with a rotten egg smell [124]. It affects lungs and CNS [125]. Used in "detergent suicides" [125].
        - Be alert for warning signs, containers, buckets in enclosed vehicles [125]. Wait for Hazmat to declare the scene safe [125].
        - Signs include nausea, vomiting, confusion, dyspnea, loss of consciousness, seizures, shock, coma, cardiopulmonary arrest [126].
        - After decontamination, management is supportive: monitor respiratory and cardiovascular function, provide rapid transport [127].
- **Central Nervous System Stimulants (sympathomimetics)** mimic the sympathetic nervous system [129].
    - They cause hypertension, tachycardia, and dilated pupils [130].
    - Produce an excited state [131].
    - Examples: amphetamines, methamphetamines, MDMA (ecstasy/Molly), cocaine [131].
    - Cocaine can be absorbed through mucous membranes or skin [132]. Effects last less than an hour [132]. Smoking cocaine (crack) gives the fastest and most potent effect [133].
    - Acute overdose is an emergency due to high risk of seizures, cardiac dysrhythmias, and stroke [133].
    - Patients may have hallucinations or paranoia [134].

    - Law enforcement may need to restrain the patient [134]. Do not leave unattended during transport [135].
    - Provide prompt transport, supplemental oxygen, and be ready to suction [135].
- **bath salts** are synthetic drugs similar to MDMA [136].
    - Sold as bath salts to evade legal restrictions [139].
    - Produce euphoria, increased mental clarity, and sexual arousal [140]. Users often snort it [140]. Effects can last 48 hours [140].
    - Adverse effects: teeth grinding, appetite loss, muscle twitching, lip smacking, confusion, GI issues, paranoia, headache, elevated heart rate, hallucinations [141].
    - Keep the patient calm and transport [141]. Consider advanced life support; chemical restraint may be needed for safe transport [142].
- **marijuana** contains thc, which produces the high [143].
    - Inhaling smoke causes euphoria, relaxation, drowsiness [144].
    - Impairs short-term memory and complex thinking [145].
    - High doses can cause depression, confusion, hallucinations, anxiety, paranoia [146].
    - Often used to introduce other drugs [148].
    - Edibles (baked goods, candies with thc) can cause cannabinoid hyperemesis syndrome [149].
        - This is extreme nausea and vomiting in chronic users, relieved only by hot showers/baths [150].
    - Synthetic marijuana (spice) mimics thc effects but can have powerful and unpredictable outcomes [151]. Effects range from euphoria to loss of consciousness [151].
- **Hallucinogens** alter sensory perceptions [152].
    - LSD (acid) is a classic example [153].
    - Cause visual hallucinations, intensify vision/hearing, separate user from reality [153].
    - A "bad trip" can include hypertension, tachycardia, anxiety, paranoia [154].
    - Care is similar to sympathomimetic overdose: use a calm, professional manner [155].
    - Provide emotional support [156]. Avoid restraints unless the patient is in danger [157].

    - Watch the patient carefully; never leave unattended during transport [158]. Request advanced life support if appropriate [158].
- **Anticholinergic Agents** block parasympathetic nerves [159].
    - Classic signs: "hot as a hare, blind as a bat, dry as a bone, red as a beet, and mad as a hatter" [160].
    - Common examples: atropine, Benadryl, gypsum weed, Elavil [160].
    - Difficult to distinguish from sympathomimetic overdose; both can cause agitation, high heart rate, dilated pupils [160].
    - Tricyclic antidepressants have significant anticholinergic effects [161]. Death can be rapid (normal to seizure/death in 30 mins) [161].
    - Immediate transport is crucial [161]. Consider calling advanced life support [161].
- **Cholinergic Agents** overstimulate parasympathetic functions [162].
    - Include nerve gas (chemical warfare) and organophosphate insecticides [162].
    - Signs are easy to remember using mnemonics "DUMBELS" or "SLUDGE M" [164].
        - DUMBELS: Diarrhea, Urination, Miosis, Bradycardia, Emesis, Lacrimation, Seizures [164].
        - SLUDGE M: Salivation, Lacrimation, Urination, Defecation, Gastric upsets, Emesis, Muscle twitching [165].
    - Anticholinergics have the exact opposite effects [166].
    - Avoiding self-exposure is the most important consideration [167]. Decontamination is a priority [167]. hazmat teams often provide decontamination [168].
    - After decontamination, priorities are decreasing mouth/trachea secretions and providing airway support [168].
    - Antidote kits exist for cholinergic agents, e.g., DuoDote auto-injector [169].
    - DuoDote contains atropine and pralidoxime [170]. Use for known nerve agent/organophosphate exposure with symptoms [170]. You may need to use it on yourself [170].
- **Miscellaneous Drugs** include various classifications [171].
    - Cardiac medicines: Accidental or intentional overdose [171]. Children may think they are candy; older adults may forget doses [171]. Symptoms vary by medication [172]. Contact poison control ASAP [172].

- Aspirin: Ingesting too much can cause nausea, vomiting, hyperventilation, ringing in ears [173]. Patients may have anxiety, confusion, tachypnea, hyperthermia, and be in danger of seizures [174].
- Acetaminophen: Overdose is common and serious, whether accidental or intentional [175].
- Alcohols (methyl or ethyl glycol) are more toxic than drinking alcohol [175]. They cause severe tachypnea, blindness, renal failure, and potentially death [175].
- **Food Poisoning**: Caused by bacteria or toxins [176].
  - Salmonella bacterium causes severe GI symptoms (nausea, vomiting, abdominal pain, diarrhea) within 72 hours [176]. Proper cooking and kitchen cleanliness prevent it [178].
  - Staphylococcus bacteria grow quickly in unrefrigerated leftovers and produce toxins [179]. Symptoms start suddenly (nausea, vomiting, diarrhea) within 2-12 hours [181].
  - Botulism is the most severe form, resulting from improperly canned food [182]. Bacterial spores grow and produce a toxin [184]. Symptoms are neurologic: blurred vision, weakness, difficulty speaking/breathing [185]. It can be fatal; symptoms develop within 24 hours to 4 days [186].
  - Do not try to determine the specific food poisoning cause in acute cases [187]. Gather history and transport promptly [187]. Take suspected food if multiple people are ill [188].
- **Plant Poisonings**: Tens of thousands of cases annually [189]. Many household plants are poisonous [190].
  - Effects vary: local skin irritation, effects on circulatory/GI/CNS systems [191].
  - Impossible to memorize all poisonous plants and effects [192].
  - Assess airway and vital signs [193]. Notify poison control for plant identification assistance [193]. Take the plant with you to the hospital [193].

Type	Key Characteristics/Effects	Management Highlights

Alcohol	CNS depressant, sedative/hypnotic; dulled senses, slowed reflexes, lack of coordination; withdrawal (DTs)	Respiratory support if needed; reassure patient during withdrawal, provide care and support [92]
Opiates	CNS depressant; severe respiratory depression, pinpoint pupils, sedation; tolerance develops quickly	Naloxone (Narcan) to reverse effects, especially for respiratory depression [105]
Sedative-Hypnotics	CNS depressant; alter consciousness, drowsy/intoxicated state; tolerance develops quickly	Ensure patent airway, assist ventilations, prompt transport [118]
Abused Inhalants	Inhaled; drowsiness to coma, seizures; heart hypersensitive to adrenaline (hydrocarbons); rotten egg smell (hydrogen sulfide)	Keep patients calm, provide oxygen, transport [123]. For hydrogen sulfide, wait for Hazmat, monitor respiratory/cardiovascular function, rapid transport [125]
Sympathomimetics (CNS St.)	Mimic sympathetic nervous system; hypertension, tachycardia, dilated pupils, excited state, paranoia; high seizure/stroke risk	Restrain if needed (law enforcement), do not leave unattended, prompt transport, oxygen, ready suction [134]
Bath Salts	Synthetic stimulant; euphoria, clarity, arousal; adverse effects include paranoia, elevated heart rate	Keep patient calm, transport, consider advanced life support/chemical restraint [141]
Marijuana	Contains THC; euphoria, relaxation, drowsiness; impaired memory; high doses cause paranoia/hallucinations;	Keep patient calm, transport [141]. (Management for hyperemesis: hot showers/baths - not EMT action) [150]

	Cannabinoid Hyperemesis Syndrome	
Hallucinogens	Alter sensory perceptions, visual hallucinations, separate from reality; "bad trip" with anxiety/paranoia	Use calm/professional manner, emotional support, transport; avoid restraints unless necessary, do not leave unattended [156]
Anticholinergics	Block parasympathetic nerves; "hot, blind, dry, red, mad"; rapid death possible with tricyclic antidepressants	Immediate transport, consider advanced life support backup [161]
Cholinergics	Overstimulate parasympathetic; "DUMBELS" / "SLUDGE M" signs; nerve gas/insecticides	Prioritize decontamination (Hazmat), decrease secretions, airway support; use antidote kits (DuoDote) if available [167]
Miscellaneous Drugs	Cardiac meds (vary); Aspirin (GI, hyperventilation, confusion, seizures); Acetaminophen (serious); Alcohols (severe organ damage); Food poisoning (GI, neurologic-botulism); Plants (local/systemic effects)	Contact poison control; assess ABCs/vitals; gather history; prompt transport; take suspected food/plant if possible [172]

6. Case Studies and Review Questions

- Understanding key questions for poisoning assessment is important [198]. Asking **why** a patient intentionally overdosed is the least pertinent EMT question [198].
- If a patient vomits after ingesting a substance, collect the vomit to bring to the hospital and look for pill fragments [200].

- When caring for a surface contact poisoning, the first priority is to avoid contaminating yourself [204].
- Most poisonings occur via ingestion, accounting for about 80% of cases [205].
- activated charcoal dosage is calculated based on patient weight in kilograms [206]. The dose is one gram per kilogram [206]. To convert pounds to kilograms, divide by 2.2 [206]. A 55-pound child needs about 25 grams [206].
- When a person needs increasing amounts of a substance to achieve the same effect over time, this is called developing **tolerance** [210].
- Binge drinking does not increase a sense of awareness; it typically causes a **dull** sense of awareness [213].
- An unconscious patient with slow and shallow respirations, slow/weak pulse, and constricted (pinpoint) pupils is consistent with an **opioid** overdose [215]. This patient would likely need naloxone [217].
- The mnemonic "DUMBELS" helps recall the signs and symptoms of a **cholinergic** drug overdose [218]. The "E" in DUMBELS stands for emesis (vomiting) [218].
- Food poisoning is almost always caused by eating foods containing **bacteria**, such as salmonella [218].