

# Toxicology / Poisoning



Dr.  
Mohammed Ismael Dawood  
Assistant Professor of Medicine

# Principles of Toxicology



4 principles to consider with all ingestions:

- Resuscitation (ABCD3EFG).
- Screening (toxidrome? clinical clues?).
- Decrease absorption of drug.
- Increase elimination of drug.

## **Resuscitation : “ABCD3EFG” of Toxicology**

- basic axiom of care is symptomatic and supportive treatment
- address underlying problem only once patient is stable

**A** Airway (consider stabilizing C-spine).

**B** Breathing.

**C** Circulation.

**D1** Drugs.

ACLS as necessary to resuscitate the patient.

Universal antidotes (DONT).

**D2** Draw bloods.

**D3** Decontamination (decrease absorption).

**E** Expose (look for specific toxidromes)/examine the patient

**F** Full vitals, ECG monitor, foley, x-rays

**G** Give specific antidotes and treatments

### **Further Steps following ABCD3EFG**

- Reassess
- Call Poison Information Centre + Police paper.
- Obtain corroborative history from family, bystanders.

## **D1 – Universal Antidotes:**

These treatments that will not harm patients and may be essential

- ❑ **Dextrose** (glucose) • give to any patient presenting with altered LOC • measure blood glucose prior to glucose administration if possible IV.
- ❑ **Oxygen** • do not deprive a hypoxic patient of oxygen no matter what the antecedent medical history. • if depression of hypoxic drive, intubate and ventilate • exception: paraquat or diquat (herbicides) inhalation or ingestion (oxygen radicals increase morbidity)
- ❑ **Naloxone** (central  $\mu$ -receptor competitive antagonist, shorter half-life than naltrexone) • antidote for opioids: administration is both diagnostic and therapeutic (1 min onset of action) • used for the undifferentiated comatose patient.
- ❑ **Thiamine** (Vitamin B1) • 100 mg IV/IM with IV/PO glucose to all patients • given to prevent/treat Wernicke's encephalopathy • a necessary cofactor for glucose metabolism (may worsen Wernicke's encephalopathy if glucose given before thiamine), but do not delay glucose if thiamine is unavailable. • must assume all undifferentiated comatose patients are at risk.

**D1=**  
**Universal Antidotes:**  
**DONT**  
**D**extrose  
**O**xygen  
**N**aloxone  
**T**hiamine (must give  
BEFORE dextrose)

## D2 = Draw Bloods

### □ Essential tests:

- CBC, electrolytes, BUN/Cr, glucose, INR/PTT, osmolality
- ABGs, O<sub>2</sub> saturation.
- ASA, acetaminophen, Ethanol levels.

### □ Potentially useful tests:

- Drug levels – this is NOT a serum drug screen (e.g. digoxin, iron).
- Ca<sup>2+</sup>, Mg<sup>2+</sup>, PO<sub>4</sub><sup>3-</sup>.
- Protein, albumin, lactate, ketones, liver enzymes, CK – depending on drug and clinical features.

### Serum Drug Levels:

- treat the patient, not the drug level.
- negative toxicology screen does not rule out a toxic ingestion.

Increased AG: “**GOLDMARK**” (\* = toxic)

Glycols\* (ethylene glycol, propylene glycol)

Oxoproline (metabolite of acetaminophen)\*

L-lactate

D-lactate (acetaminophen, short bowel syndrome, propylene glycol infusions for lorazepam & phenobarbital)

Methanol\*

ASA\*

Renal failure

Ketoacidosis (DKA, EtOH\*, starvation)

Increased osmolar gap: “**MAE DIE**” (if it ends in “-ol”, it will likely increase the osmolar gap)

Methanol

Acetone

Ethanol

Diuretics (glycerol, mannitol, sorbitol)

Isopropanol

Ethylene glycol

**Table 31. Use of the Clinical Laboratory in the Initial Diagnosis of Poisoning**

Test	Finding	Selected Causes
ABG	Hypoventilation (high pCO <sub>2</sub> ) Hyperventilation (low pCO <sub>2</sub> )	CNS depressants (opioids, sedative-hypnotic agents, phenothiazines, EtOH) Salicylates, CO, other asphyxiants
Electrolytes	AG metabolic acidosis Hyperkalemia Hypokalemia	“ <b>GOLDMARK</b> ”: see <a href="#">Table 30</a> Digitalis glycosides, fluoride, potassium Theophylline, caffeine, β-adrenergic agents, soluble barium salts, diuretics, insulin
Glucose	Hypoglycemia	Oral hypoglycemic agents, insulin, EtOH, ASA
Osmolality and Osmolar Gap	Elevated osmolar gap	“ <b>MAE DIE</b> ”: see <a href="#">Table 30</a>
ECG	Wide QRS complex Prolonged QT interval Atrioventricular block	TCAs, quinidine, other class Ia and Ic antidysrhythmic agents Terfenadine, astemizole, antipsychotics, hydroxychloroquine Ca <sup>2+</sup> antagonists, digitalis glycosides, phenylpropanolamine, hydroxychloroquine
Abdominal X-Ray	Radiopaque pills or objects	“ <b>CHIPES</b> ”: Calcium, Chloral hydrate, CCl <sub>4</sub> , Heavy metals, Iron, Potassium, Enteric coated Salicylates, and some foreign bodies
Serum Acetaminophen	Elevated level (>140 mg/L or 1000 μmol/L 4 h after ingestion)	May be only sign of acetaminophen poisoning



**Anion Gap**  
= Na<sup>+</sup> – Cl<sup>-</sup> – HCO<sub>3</sub><sup>-</sup>  
Normal AG ≤12 mM/L



**Osmolar Gap**  
= [(2 x Na<sup>+</sup>) + Glu + Urea] - Measured Osmolality  
Normal <10

## **D3 – Decontamination and Enhanced Elimination:**

### **Ocular Decontamination**

- saline irrigation to neutralize pH; alkali exposure requires ophthalmology consult

### **Dermal Decontamination**

- wear protective gear
- remove clothing, brush off toxic agents, irrigate all external surfaces

## **Gastrointestinal Decontamination:**

### **• Single dose activated charcoal:**

- adsorption of drug/toxin to activated charcoal decreases toxin bioavailability
- contraindications: unprotected airway, late presentation after ingestion (1-2 h post ingestion), small bowel obstruction, poor toxin adsorption
- odourless, tasteless, prepared as slurry with H<sub>2</sub>O.

### **• Whole bowel irrigation (occasionally used):**

- 500 mL/h (child) to 2000 mL/h (adult) of polyethylene glycol solution by mouth until clear effluent per rectum start slow (500 mL in an adult) and aim to increase rate hourly as tolerated
- indications awake, alert, can be nursed upright, with an NG tube who cannot tolerate drinking it, or intubated and airway protected
- recent toxin ingestion
- contraindications evidence of ileus, perforation, or obstruction

### **• Multidose activated charcoal:**

- may be used for: carbamazepine, phenobarbital, quinine, theophylline for toxins which undergo enterohepatic recirculation
- removes drug that has already been absorbed by drawing it back into GI tract
- various regimens: 12.5 g (1/4 bottle) PO q1 h or 25 g (1/2 bottle) PO q2 h until non-toxic



## **Lipid Emulsification:**

- New therapy used in cardiogenic shock due to toxins.
- May be used for: anesthetics (e.g. lidocaine),  $\beta$ -blocker/calcium channel blocker, atypical antidepressant overdose.
- Initial bolus lipid solution 20% 1.5 mL/kg over 3 min then infusion of 0.25 mL/kg/min.

## **Urine Alkalinization:**

- May be used for: ASA, methotrexate, phenobarbital, chlorpropamide.
- Weakly acidic substances can be trapped in alkaline urine (pH >7.5) to increase elimination.

# **Hemodialysis:**

- Indications/criteria for hemodialysis:

- toxins that have high water solubility, low protein binding, low molecular weight, adequate concentration gradient, small volume of distribution, or rapid plasma equilibration.
- clinical deterioration despite maximal medical support.

- Useful for the following toxins:

Methanol

Ethylene glycol

Salicylates

Lithium

Phenobarbital

Chloral hydrate (trichloroethanol)

- Others include theophylline, carbamazepine, valproate, methotrexate

## **E – Expose and Examine the Patient:**

- Vital signs (including temperature), skin (needle tracks, colour), mucous membranes, pupils, odours, and CNS.
- Head-to-toe survey including:
  - C-spine.
  - Signs of trauma, seizures (incontinence, “tongue biting,” etc.), infection (meningismus), or chronic alcohol/drug misuse (track marks, nasal septum erosion).
  - Feel the patient’s axillae; in the average patient, should be somewhat moist (if dry, may indicate anticholinergic toxicity).
- Mental status.

**Table 32. Specific Toxidromes**

Toxidrome	Overdose Signs and Symptoms	Examples of Drugs
<b>Anticholinergic</b>	Hyperthermia Dilated pupils Dry skin Vasodilation Agitation/hallucinations Ileus Urinary retention Tachycardia	"Hot as a hare" "Blind as a bat" "Dry as a bone" "Red as a beet" "Mad as a hatter" "The bowel and bladder lose their tone and the heart goes on alone"
<b>Cholinergic</b>	<b>"DUMBELS"</b> Diaphoresis, Diarrhea, Decreased BP Urination Miosis Bronchospasm, Bronchorrhea, Bradycardia Emesis, Excitation of skeletal muscle Lacrimation Salivation, Seizures	Antidepressants (e.g. TCAs) Cyclobenzaprine (Flexeril®) Carbamazepine Antihistamines (e.g. diphenhydramine) Antiparkinsonians Antipsychotics Antispasmodics Belladonna alkaloids (e.g. atropine)
<b>Extrapyramidal</b>	Dysphonia, dysphagia Rigidity and tremor Motor restlessness, crawling sensation (akathisia) Constant movements (dyskinesia) Dystonia (muscle spasms, laryngospasm, trismus, oculogyric crisis, torticollis)	Natural plants: mushrooms, trumpet flower Anticholinesterases: physostigmine Insecticides (organophosphates, carbamates) Nerve gases
<b>Hemoglobin Derangements</b>	Increased respiratory rate Decreased LOC Seizures Cyanosis unresponsive to O <sub>2</sub> Lactic acidosis	Major tranquilizers Antipsychotics
<b>Opioid, Sedative/ Hypnotic, EtOH</b>	Hypothermia Hypotension Respiratory depression (opioid) Dilated or constricted pupils (pinpoint in opioid) CNS depression	CO poisoning (carboxyhemoglobin) Drug ingestion (methemoglobin, sulfmethemoglobin)
<b>Sympathomimetic</b>	Increased temperature CNS excitation (including seizures) Tachycardia, HTN N/V Diaphoresis Dilated pupils	EtOH Benzodiazepines Opioids (morphine, heroin, fentanyl, etc.) Barbiturates GHB ("G," "liquid gold")
<b>Serotonin Syndrome</b>	Mental status changes, autonomic hyperactivity, neuromuscular hyperactivity, hyperthermia, diarrhea, HTN	Amphetamines, caffeine, cocaine, LSD, phencyclidine Ephedrine and other decongestants Thyroid hormone Sedative or EtOH withdrawal
		MAOI, TCA, SSRI, opiate analgesics Cough medicine, weight reduction medications

Note: ASA poisoning and hypoglycemia mimic sympathomimetic toxidrome

**F – Full Vitals, ECG Monitor, Foley, X-Rays:**

**G – Give Specific Antidotes and Treatments:**

**Urine Alkalinization Treatment for ASA Overdose:**

- Urine pH >7.5
- Fluid resuscitate first, then 3 amps NaHCO<sub>3</sub>/L of D5W at 1.5x maintenance
- Add 20-40 mEq/L KCl if patient is able to urinate

**Table 34. Specific Antidotes and Treatments for Common Toxins\***

Toxin	Treatment	Considerations
Acetaminophen	Decontaminate (activated charcoal) N-acetylcysteine	Often clinically silent; evidence of liver/renal damage delayed >24 h Toxic dose >200 mg/kg (>7.5 g adult) Monitor drug level 4 h post-ingestion; also liver enzymes, INR, PTT, BUN, Cr Hypoglycemia, metabolic acidosis, encephalopathy poor prognosis Dialysis may be required to manage in very high overdoses
Acute Dystonic Reaction	Benztropine: 1-2 mg IM/IV then 2 mg PO 3 d OR Diphenhydramine 1-2 mg/kg IV, then 25 mg PO QID x3 d	Benzotropine (Cogentin®) has euphoric effect and the potential for misuse
Anticholinergics	Consider decontamination (activated charcoal) Supportive care	Special antidotes available; consult Poison Information Centre
ASA	Consider decontamination (activated charcoal) Alkalinize urine; want urine pH >7.5	Monitor serum pH and drug levels closely Monitor K <sup>+</sup> level; may require supplement for urine alkalinization Hemodialysis may be needed if intractable metabolic acidosis, very high levels, or end-organ damage (i.e. unable to diurese)
Benzodiazepines	Consider decontamination (activated charcoal) Flumazenil (only use in iatrogenic overdose (operative oversedation) due to extensive contraindications (mixed overdose, Hx of EtOH, seizures)) Supportive care	
β-blockers	Consider decontamination (activated charcoal, consider whole bowel irrigation for extended-release ingestion) IV glucagon, IV calcium chloride, IV high-dose insulin (with dextrose), IV lipid emulsification	
Calcium Channel Blockers	Consider decontamination (activated charcoal, consider whole bowel irrigation for extended-release ingestion) IV glucagon, IV calcium chloride, IV high-dose insulin (with dextrose), IV intralipid	Order ECG, electrolytes (especially Ca <sup>2+</sup> , Mg <sup>2+</sup> , Na <sup>+</sup> , K <sup>+</sup> )

<b>Cocaine</b>	Decontaminate (activated charcoal) if oral Aggressive supportive care	$\beta$ -blockers are contraindicated in acute cocaine toxicity Intralipid for life-threatening symptoms Consider benzodiazepines for any major side effect of cocaine overdose (agitation, hypertension, tachycardia, etc.)
<b>CO Poisoning</b>	See <i>Inhalation Injury, ER47</i> Supportive care 100% O <sub>2</sub> ; may require hyperbaric O <sub>2</sub>	Order ECG, VBG. Consider lactate and troponin depending on specific presentation
<b>Cyanide</b>	Hydroxocobalamin 5 g IV (Cyanokit™)	Consider in all patients found in a fire
<b>Digoxin</b>	Consider decontamination (activated charcoal) Digoxin-specific antibody fragments 10-20 vials IV if acute; 3-6 if chronic 1 vial (40 mg) neutralizes 0.5 mg of toxin	Use for life-threatening dysrhythmias unresponsive to conventional therapy, 6 h serum digoxin >12 nmol/L, initial K <sup>+</sup> >5 mmol/L, ingestion >10 mg (adult)/>4 mg (child) Common dysrhythmias include VFib, VTach, and conduction blocks
<b>Ethanol</b>	Thiamine 100 mg IM/IV Manage airway and circulatory support	Mouthwash = 70% EtOH; perfumes and colognes = 40-60% EtOH Order serum EtOH level and glucose level; treat glucose level appropriately
<b>Ethylene Glycol/ Methanol</b>	Fomepizole (4-methylpyrazole) 15 mg/kg IV load over 30 min, then 10 mg/kg q12 h OR Ethanol (10%) 10 mL/kg over 30 min, then 1.5 mL/h	CBC, electrolytes, glucose, ethanol level Consider hemodialysis
<b>Heparin</b>	Protamine sulfate 25-50 mg IV	For unfractionated heparin overdose only
<b>Insulin IM/SC/ Oral Hypoglycemic</b>	Glucose IV/PO/NG tube Glucagon: 1-2 mg IM (if no access to glucose)	Glyburide carries highest risk of hypoglycemia among oral agents Consider octreotide for oral hypoglycemics (50-100 $\mu$ g SC q6 h) in these cases; consult local Poison Information Centre
<b>MDMA</b>	Consider decontamination (activated charcoal) Supportive care	Monitor CK; treat rhabdomyolysis with high flow fluids: aggressive external cooling for hyperthermia Review medical history if possible for serotonergic use
<b>Opioids</b>	See <i>Universal Antidotes, ER49</i>	
<b>TCA's</b>	Consider decontamination (activated charcoal) Aggressive supportive care NaHCO <sub>3</sub> bolus for wide QRS/seizures	Flumazenil antidote contraindicated in combined TCA and benzodiazepine overdose Also consider cardiac and hypotension support, seizure control Intralipid therapy
<b>Organophosphate</b>	100% O <sub>2</sub> + endotracheal intubation Atropine Pralidoxime (2-PAM)	Succinylcholine

\* Call local Poison Information Centre for reporting of cases, specific doses, and treatment recommendations. Most toxicology cases should involve communication with your local Poison Information Centre

**Thanks for your attention**