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REVIEW

Toxicological Chain of Survival (TCS): An integral approach to the intoxicated patient. Narrative review

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Abstract. Intoxications are a frequent cause for consultation and admission in emergency medical services. Treating these patients is a challenge both diagnostically and therapeutically, where some critical circumstances may determine the prognosis. A structured search was conducted in the PubMed/Medline database, for articles discussing how intoxications were handled in emergency medical services published between March 2005 and December 2023. A combination of the following keywords was used to perform the search: "intoxication", "poisoning", "management", "emergency", and "patient". All reviews, clinical trials, observational studies, and case reports related to handling intoxicated patients were considered. Lastly, articles in the authors' databases were included, as well as reference books and gray literature. 42 articles that met the selection criteria were chosen. Upon review of the literature, a Toxicological Chain of Survival (TCS) was devised, a basic diagnostic and therapeutic algorithm that can be useful for the first responder.

Key words: *Intoxication; Poisoning; Management; Antidotes; Antagonists.*

Intoxications are a frequent cause for consultation in emergency medical services. Treating the intoxicated patient is a challenge both diagnostically and therapeutically, this approach is key to determine the prognosis. During 2022, in the United States (USA) alone, 2.064.875 cases of poisoning were reported. In Mexico the annual number is estimated to be around 13.600.[1-5] Mortality rates are varied and they depend on the causative agent, intentionality, age, and comorbidity.[1]

This review includes information regarding general treatment of the poisoned patient; emphasizing on the medical history, physical examination, toxidromes, and both general and specific treatment. A diagnostic and therapeutic algorithm within the framework of the Toxicological Chain of Survival or TCS (Fig. 1) is proposed.

MATERIALS AND METHODS

A structured search was conducted in the PubMed/Medline database, for articles discussing how intoxications were handled in emergency medical services published between March 2005 and December 2023. A combination of the following keywords was used to perform the search: "intoxication", "poisoning", "management", "emergency", and "patient". All reviews, clinical trials, observational studies, and case reports related to handling intoxicated patients were considered. Literature not related to human health, in a language other than English or Spanish, or which did not propose any relevant information for this study, was excluded.

The PubMed/Medline search returned 167 results, 130 f which were excluded and 37 articles meeting the selection criteria were considered. Lastly, 5 articles from the authors' personal databases were included, as well as reference books and gray literature.

DISCUSSION

Medical history

Even when there is only a suspicion that it may be a case

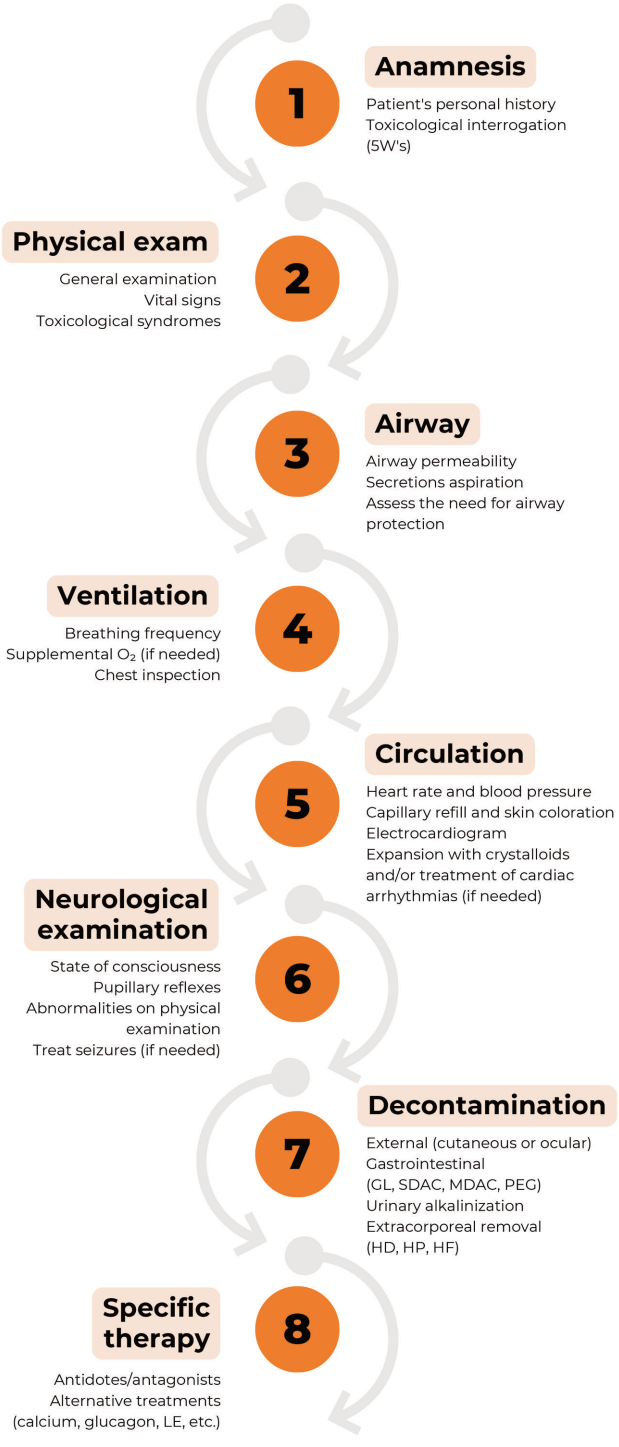

Figure 1. Toxicological Chain of Survival (TCS).

of poisoning, the diagnosis and therapy approaches must be simultaneous, as the patient's prognosis largely depends on these.[2,4] A detailed medical history must be included, where the patient is questioned not only regarding personal background, but also everything related to the intoxication, including motivation (accidental or voluntary), probable causative agents and their format, ingested dose and/or exposure time, as well as signs and symptoms.

The toxicological history can be summarized into five questions known as the "5W", which allow the physician to more easily determine the context of the intoxication (Table 1). When the patient cannot (or will not) cooperate, the person with them can provide valuable information on the medical background of the patient, where they were, which potentially toxic products were in the house, etc. The original package must always be requested (medicine tablets, chemical products, etc.). If unavailable, they must be retrieved from the place where the intoxication took place. This allows medical personnel to perform only the necessary studies.

A directed questioning must be conducted and, should it provide no relevant information, the physician will make use of the physical examination and complementary tests (general and specific) to conclude a suspected diagnosis.

Physical examination

It is vital to perform a comprehensive check of the patient, including a thorough physical examination, monitoring of the vital signs, measuring of pupillary responses, and neurological investigation. Therefore, allowing the physician to identify the commonly named "toxidromes": *sympathomimetic, anticholinergic, cholinergic, sedative-hypnotic, opiate*, *hallucinogenic, neuroleptic malignant*

TABLE 1. The 5Ws of the intoxicated patient's medical history.

Who	Patient's characteristics (sex, age, and personal background)
Whose	Check if the substance belonged to the patient or somebody else, so as to determine if exposure is acute, subacute, acute on chronic or chronic.
What	Determine which substance caused the intoxication, its dosage and format (solid, liquid or gaseous) and exposure route (cutaneous, intraocular, oral, parenteral or other)
When	Ask the date and time of day on which the exposure took place, and/or the last time the patient was acting normally
Why	Ask if the exposure was accidental or voluntary (malicious or suicide attempt)

syndrome, and *serotonin syndrome*. They may not always be present, and they frequently present themselves partially or simultaneously, as with cases of polysubstance use. The main characteristics of each toxidrome are summarized in Table 2.[6]

The inspection of the skin and mucosa is especially relevant in cases involving caustic substances (acid, alkaline and oxidizing substances), which produce chemical burns and hypoxia, such as methemoglobinemia, which causes the skin around the mouth, fingers or on the entire body to acquire a blueish tone due to a change in the way oxygen is transported and utilized. As detailed in Table 2, sweating and dry skin are typical for some intoxications. Lastly, the physical examination may reveal signs of violence (trauma), self-harm and sexual abuse.

Apprehensive patients pose a challenge when conducting a physical examination. Temporary physical restraint may be required to begin the examination, as well as sedation (benzodiazepines is the treatment of choice). It is recommended to approach these patients in a calm environment free of auditory stimulus, especially if the patient is suffering from hallucinations, so as to not trigger them. When dealing with children, the presence of their parents throughout the care process is vital.

Additional medical tests

Additional medical tests, both general (routine laboratory tests, ECG, imaging, among others) and specific (such as blood and urine toxicology screens) to be performed will depend on the nature of the toxic substance and the exposure to it.[1-3] In Table 3, the main toxicology screenings and the biological samples required to test for them are enumerated. A lack of availability of specialized laboratories that perform these screenings may be a limiting factor, but in these cases,

TABLE 2. Toxidromes.

Toxidrome	Clinical characteristics	Xenobiotics
Sympathomimetic	Agitation, mydriasis, tachycardia, high blood pressure, hyperthermia	Amphetamines, cocaine, ephedrine, phenylephrine, pseudoephedrine
Anticholinergic	Mydriasis, dry skin and mucous membranes, tachycardia, urinary retention, ileus, agitation, delusion	Antihistamines, tricyclic antidepressants, atropine, belladona, scopolamine
Cholinergic	Miosis, hypersalivation, bradycardia, bronchospasm, diarrhea, urinary incontinence, fasciculations, convulsions, coma, low blood pressure	Organophosphorus compounds, carbamates, pilocarpine, muscarine
Sedative-hypnotic	Somnolence, ataxia, dysarthria, obnubilation, coma	Benzodiazepines, barbiturates, alcohol, propofol, gamma-hydroxybutyric acid (GHB)
Opiate	Miosis, respiratory depression, bradycardia, constipation, sedation	Heroin, morphine, codeine, oxycodone, methadone, tramadol
Hallucinogenic	Visual and auditory hallucinations, sensory distortion, paranoia, anxiety, psychosis	Lysergic acid diethylamide (LSD), psilocybin, mescaline, N,N-dimethyltryptamine (DMT), phencyclidine (PCP)
Neuroleptic malignant syndrome	Fever, muscle rigidity ("lead pipe"), dysautonomia, delirium (hyperactive or hypoactive), elevated creatine kinase (CPK) levels	Antipsychotics (haloperidol, quetiapine, risperidone, etc.) and antiemetics
Serotonin syndrome	Clonus, agitation, diaphoresis, tremor, mydriasis, tachycardia, diarrhea, hyperthermia, convulsions, hyperreflexia	Antidepressants, tryptophan, amphetamine, cocaine, tramadol, fentanyl, LSD, lithium, mirtazapine, lamotrigine, ondansetron

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it should be ensured that the samples are outsourced to a high complexity center.

The time of collection of the sample is not only relevant for the diagnostic, but also for the treatment. For example, when the presence of acetaminophen is determined, the sample should be collected between 4 to 24 hours after the exposure to be able to plot the results in the Rumack–Matthew nomogram, which will predict the risk of liver toxicity and, therefore, enable the physician to administer its antidote (N-acetylcysteine).

It is also a good practice to request the analysis of beta subunit (beta-hCG) in women of childbearing age, as well as to guarantee the chain of custody in cases where abuse or maliciousness are suspected.

Medical approach

Airway. Advanced airway management may be necessary for respiratory (ventilation/blood gas levels) and/or neurological reasons. For the latter, the Glasgow Coma Scale (GCS) is used, a score ≤ 8 signaling the need to secure the airway by means of intubation.[7] Nevertheless, in cases of poisoning, this procedure (stemming from the recommendations for patients with traumatic brain injury) may be wrong. In 2010, Kapur et al. found that out of all the patients that visited the emergency ward diagnosed with intoxication, 39% suffered inadequate care and up to 58% experienced improper airway management, which led to more adverse results or a worse prognosis.[8] For these reasons, two indications justify securing the airway:

a. Respiratory failure. Described as a failure in ventilation, oxygenation or both.

b. Imminent risk of bronchial aspiration. It may arise due to irregular airway protective reflexes, apnea or rostrocaudal deterioration that alters the breathing pattern.

If these indications are not present, intoxicated patients should not be intubated based solely on the GCS. Many xenobiotics produce alterations of consciousness without warranting advanced airway management. For certain patients, it is expected that once the toxicant has been metabolized, normal brain function is resumed. Conversely, when dealing with patients that sustained trauma, a GCS score ≤ 8 does warrant intubation.[8-10] In most cases, it suffices with keeping the airway clear by suctioning secretions. When the airway needs to be protected, it is important to determine which drugs will be used in the intubation procedure, taking into account the toxicants that caused the intoxication and the drug interaction.[8]

Ventilation. Assisted respiration should be performed with low-flow systems in order to maintain optimal oxygen saturation and arterial blood oxygen tension (PaO_2) levels. Other devices may be necessary in certain cases, such as carbon monoxide (CO) poisoning, where 100% oxygen is provided with a non-rebreather mask. For these cases, high-flow nasal cannula and continuous positive airway pressure (CPAP) have been tested, both being equally effective.[8,11-13] The administration of oxygen as a routine procedure without indications supporting it can also be detrimental in some cases. Such is the case of the herbicide paraquat, whose mechanism of toxicity is the production of oxygen free radicals, and therefore the supply of oxygen (above a certain threshold) may worsen the patient's medical condition by increasing the risk of pulmonary fibrosis.

Blood circulation and cardiotoxicity. In 2003 in the USA, cardiovascular drugs ranked 15th on the list of agents that caused most intoxications, and 5th in causes of death among these patients.[4] Electrocardiographic abnormalities caused by certain xenobiotics can be produced *directly* or *indirectly* by metabolic disorders. This requires different therapeutic approaches depending on the cause of the irregularity.[4,14,15]

TABLE 3. Main toxicology screenings and biological samples required to test for them.

Sample	Toxicology screenings
Urine	Cocaine metabolites, cannabinoids, amphetamines, benzodiazepines, opioids, barbiturates and hydrocarbons; heavy metals (mercury and chromium)
Serum/Plasma	Anticonvulsants (e.g.: diphenylhydantoin, valproic acid, phenobarbital and carbamazepine), tricyclic antidepressants, lithium, iron, methotrexate, alcohols (ethanol, methanol and glycol), salicylates, acetaminophen, butyrylcholinesterase (BuChE) and cyanide
Whole blood	Lead, erythrocyte acetylcholinesterase (AChE), carboxyhemoglobin (COHb), methemoglobin (MetaHb) and sulfhemoglobin (SulfHb)

Many cardiovascular effects are produced by drugs that are not prescribed for cardiopathies.[16-18]

The cardiotoxic mechanism of these drugs may be diverse, so in the interest of simplifying their investigation, they can be divided into 5 groups based on their effect on myocardial action potential: 1) K^{+1} channel blockers, 2) Na^{+1} channel blockers, 3) Na^{+1}/K^{+1}/ATPase pump blockers, 4) Ca^{+2} channel blockers and 5) β-adrenergic blockers. Another classification would be based on the electrocardiographic abnormalities they can cause, the most common being bradyarrhythmias or tachyarrhythmias, QRS complex and QT interval abnormalities, blocks, among others. It is important to mention that certain drugs can belong to more than one group. In Table 4 all the different groups are summarized based on their mechanism on the membrane action potential and electrocardiographic abnormalities.[4,14-19] Different xenobiotics can also cause myocardial ischemia, as detailed in Table 5.[1] QT interval prolongation poses a greater threat to life, since it can trigger lethal ventricular arrhythmias.[16,18,19]

TABLE 4. Main groups of xenobiotics that produce cardiac arrhythmias, their main characteristics and treatment.

Group	Mechanism	Electrocardiographic manifestation	Progression Risk	Treatment	Drugs
K^{+1} channel blockers	Action potential prolongation	Prolonged QT interval >440 ms in men >460 ms in women	Polymorphic ventricular tachycardia	2 - 4 gr Mg^{+2} sulfate bolus	Antihistamines Antipsychotics Chloroquine Cisapride Citalopram Class IA, IC, III antiarrhythmics Tricyclic antidepressants Fluoroquinolones Macrolides Tacrolimus Venlafaxine
Na^{+1} channel blockers	Slower phase 0 of the action potential	Wide QRS complex Nodal rhythm	Asystole Ventricular tachycardia Ventricular fibrillation	Sodium bicarbonate if QRS >100ms, 1 - 2 mEq/kg bolus (keep pH< 7.55)	Amantadine Carbamazepine Chloroquine Class IA, IC antiarrhythmics Citalopram Cocaine Tricyclic antidepressants Diltiazem Diphenhydramine Hydroxychloroquine Propranolol Verapamil
Na^{+1}/K^{+1}/AT Pase pump blockers	Positive inotropic (↑ intracellular Ca+2) ↓ AV conduction	Stimulating activity: supraventricular and ventricular extrasystole, tachyarrhythmia Suppressing activity: sinus bradycardia, bundle branch blocks, AV blocks	Combination of blocks and tachyarrhythmias	Symptomatic arrhythmias: digoxin-specific antibodies AV blocks: atropine; if patient does not respond to atropine: pacemaker	Digitalin and digitalis-derived drugs
Ca^{+2} channel blockers	↓ contractility ↓ conduction ↓ cardiac output	Sinus bradycardia AV Blocks Wide QRS complex	Asystole	Atropine Ca^{+2} gluconate 60 mg/kg/dose	Calcium antagonists
β-adrenergic blockers	β-receptor competitive antagonism: ↓contractility ↓ heart rate ↓ AV conduction	Sinus bradycardia AV blocks	Wide QRS complex (with propranolol a QRS >100ms is associated to a risk of convulsions)	Calcium (1 Ca^{+2} chloride ampoule or 3 Ca^{+2} gluconate ampoules) Glucagon (0.1mg/kg bolus + 0.1mg/k/h infusion) Pacemaker	β-adrenergic blockers

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As detailed in Table 4, treatment will depend on the xenobiotic and the abnormality it produces. Over the past few years, lipid emulsions were used as a last line of treatment for cardiotoxicity. The toxicodynamic mechanism of lipid emulsion includes causing a "lipid sink" that traps lipophilic drugs, the adjustment of the drug tissue distribution, and the interaction with the cell membrane to antagonize toxic results. It is used to treat toxicity by calcium blockers, beta-blockers, cocaine, and tricyclic antidepressants, among others. Its administration is via a lipid emulsion bolus of 1.5ml/kg of weight at 20% followed by a 0.25-0.5 ml/k/min infusion.[15]

Neurological examination. The first approach to an intoxicated patient must include a neurological exam in order to determine the degree to which the central nervous system (CNS) and/or peripheral nervous system (PNS) are affected. This includes, among others, the assessment of the state of consciousness, the pupils, the presence of nystagmus, and the evaluation of osteotendinous reflexes.[20] Imaging, electroencephalograms and other tests may be necessary to complete the examination.

Decontamination procedures. External and/or gastrointestinal (GI) decontamination can prevent absorption and systemic effects produced by different substances.[20] The main route of exposure to toxic substances is oral, which forces all healthcare professionals to be familiar with the indications and contraindications of each emergency treatment.[21]

External decontamination. In cases of external contamination (skin or eyes), the removal of clothing and water wash is recommended. It should last 10-15 minutes, without filling the bathtub as that may cause the toxicant to come in contact with vulnerable areas previously unexposed, such as the eyelids and genitalia. The use of neutralizing solutions (such as acids or alkalis) is contraindicated, as they can produce reactions that may worsen the patient's medical condition.[22-24]

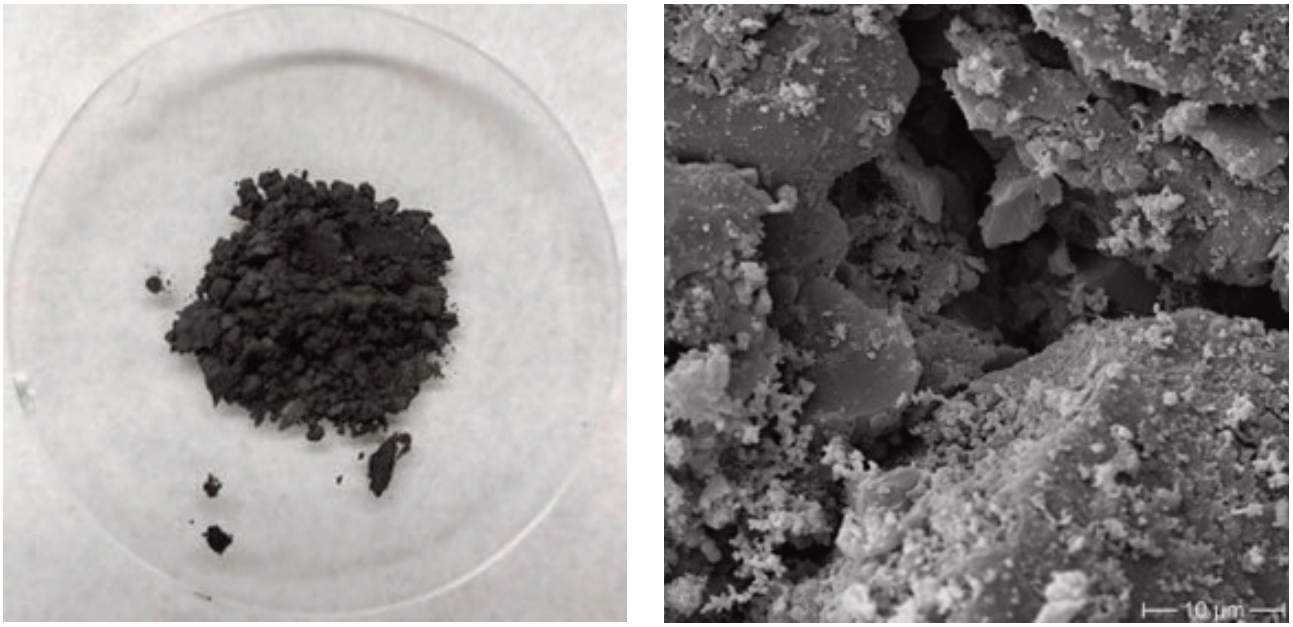
Gastrointestinal decontamination. The aim is to prevent the absorption of any toxins that were ingested by using activated charcoal (AC), gastric lavage (GL), cathartics, and whole bowel irrigation (WBI). As previously mentioned, the patient's state of consciousness must be assessed, given that any alteration may contraindicate using these therapeutic methods unless the airway is protected. This procedure for GI decontamination should only be performed under clinical prescription. Emesis is still indicated for veterinary patients, but contraindicated in humans due to the risk of pulmonary aspiration.[20,21]

a. Gastric lavage. Indications: There is no research backing up the use of GL over AC. Although it is usually performed within the first hour of exposure when the patient has ingested a "potentially lethal" substance, it should not be prescribed as a routine treatment. *Contraindications:* unprotected airway, caustic substances, hydrocarbons and patients with risk of bleeding or perforation (recent surgery, anatomic or pathological abnormality, coagulopathy, etc.). *Technique:* aspirate the GI contents and administer saline. Children 10 ml/kg, adults 150-250 ml per lavage, waiting for 1 minute before aspirating again and repeating the process until the fluid is clear. *Complications:* aspiration pneumonia, laryngospasm, hypoxia, arrhythmia, perforation of the digestive tract and electrolyte imbalance.[25]

b. Single-dose activated charcoal (SDAC). Indications: it is recommended to treat the ingestion of a "potentially toxic" substance within the first hour of exposure in most cases. The mechanism of action of AC is based on its ability to absorb substances on its surface, preventing GI tract absorption. It also prevents circulation of substances with enterohepatic metabolism. Nevertheless, not all substances can be absorbed by AC: e.g., alcohols, metals, hydrocarbons, and caustic substances.[26,27] Fig. 2 shows the macroscopic and microscopic characteristics of the AC.[28,29] *Contraindications:* unprotected airway, caustic substances, hydrocarbons, patients with intestinal obstruction (absolute contraindication) or decreased peristalsis (relative contraindication). *Technique:* AC can be diluted in any liquid (e.g. water, cola, etc.) and administered orally or via a nasogastric tube. It can be mixed with sorbitol (not recommended for children due to the elevated risk of electrolyte imbalance). *Dose:* 0.5-1 g/kg, maximum 25-50 g; teenagers and adults 1g/kg, maximum 100 g. C*omplications:* usually associated with inadequate use or technique of AC administration, tracheal pulmonary aspiration being the most relevant. Nausea and emesis have been reported in some cases after administration, especially when administered with sorbitol.[30,31]

TABLE 5. Substances that can cause myocardial ischemia.

Toxicant
Cocaine
Amphetamine
Nicotine
Carbon monoxide
Antipsychotics
Tricyclic antidepressant



(a) (b)

Figure 2. Activated charcoal. General appearance (a) and view from a scanning electron microscope – SEM (b) (Credits: Aariuser and Mydriasis respectively).

Multidose activated charcoal (MDAC). Indications: potentially lethal doses of carbamazepine, dapsone, quinine, theophylline, caffeine, aspirin, and diphenylhydantoin. Three mechanisms are involved in these cases: interruption of enterohepatic circulation, enabling of transluminal diffusion from the body to the intestinal lumen (gut dialysis), followed by excretion, and decrease of absorption of extended or delayed release drugs. *Contraindications:* similar to SDAC. *Technique:* administered in a similar way to SDAC, but its administration with cathartics like sorbitol is not recommended. *Dose:* there is no optimal dose accepted; generally, the same dose as SDAC is administered every 4 hours. Some treatment regimes suggest administering every 2 hours, but no method has been proven more effective than the other. *Complications:* similar to SDAC. Multidose administration may produce constipation and intestinal obstruction, therefore making frequent checks of the abdominal circumference and peristalsis crucial.[30,32]

c. Cathartics. There are two types of cathartics: saline or osmotic. *Indications:* nowadays they are not recommended, since while they can increase the rate at which the toxic is excreted, they do not prevent its absorption. In cases where its administration is deemed appropriate, it is recommended to use a single dose to prevent complications. The concomitant administration of AC and cathartics is also discouraged. *Contraindications:* patients lacking peristaltic sounds, recent abdominal trauma, intestinal obstruction, intestinal perforation, caustic substances, dehydration, low blood pressure and/or electrolyte imbalance. Cathartics with magnesium are contraindicated in patients suffering from nephropathy or heart block. *Technique:* administered orally or via a nasogastric tube. *Dose:* sorbitol (at 70%): 1-2 ml/kg of bodyweight in a single administration. Used at 35% for children. Magnesium hydroxide: 0.5 to 1 ml/kg/dose. *Complications:* nausea, abdominal pain, emesis, temporary low blood pressure and electrolyte imbalance.[33]

d. Whole bowel irrigation. WBI is the administration of polyethylene glycol (PEG). *Indications:* it should not be performed as a routine procedure; however, it can be adequate when the patient has ingested extended-release drugs, with an enteric coating or that cannot be absorbed by activated charcoal (lithium, potassium, iron), foreign bodies containing lead and body-packers/stuffers. *Contraindications:* ileus, intestinal obstruction, hemodynamic instability or intractable vomiting. *Technique:* with the patient in the semi-Fowler's position, the PEG is administered via a nasogastric tube. *Dose:* children between 9 months to 6 years of age: 500 ml/hr., children between 6-12: 1000 ml/hr. and adults: 1500 to 2000 ml/hr. If the patient develops emesis the administration rate should be decreased 50% for 30-60 minutes and then resumed. The treatment should persist until the effluent is clear. *Complications:* nausea, abdominal pain, emesis, angioedema, and anaphylactoid reaction.[34]

TABLE 6. Main antidotes and antagonists according to the xenobiotic consumed.

Antidote/antagonist	Xenobiotic
Fab fragments	Digitalin and digitalis-derived drugs
Atropine	OPCs (organophosphorus compounds) Carbamates Amitraz Physostigmine Mushrooms (Clitocybe, Inocybe)
Methylene blue	Methemoglobin
Calcium	Calcium blockers β-blockers Magnesium Hydrofluoric acid
D-penicillamine	Copper Lead Mercury
Deferoxamine	Iron
Dimercaprol/BAL (British anti-Lewisite)	Arsenic Lead Mercury Gold
EDTA (Edetate calcium disodium)	Lead
Ethanol	Methanol Glycols
Fomepizole	Methanol Glycols
Flumazenil	Benzodiazepines
Glucagon	β-blockers Calcium blockers Tricyclic antidepressants
Hydroxocobalamin	Cyanide
Sodium hyposulfite	Cyanide
N-acetylcysteine	Acetaminophen
Naloxone	Opioids
Amyl nitrite	Cyanide
Sodium nitrite	Cyanide
L-carnitine	Valproic acid
Leucovorin	Methotrexate
Pyridoxine	Isoniazid
Octreotide	Sulfonylurea
Vitamin K_1	Warfarin Superwarfarins

Enhanced elimination. *Alkalinization of urine. Mechanism of action and indications:* the creation of "ion traps", which based on the capacity of ionizing that some toxins have, helps prevent renal reabsorption which in turn eases their excretion. However, this process is more effective with certain substances such as weak acids, which are excreted faster with an alkaline pH (7.50). Salicylates are a classic example.[14,15] It is also used to treat long-acting barbiturate poisoning and methotrexate poisoning to prevent nephrotoxicity. *Precautions:* when this procedure is used, serum sodium levels must be closely monitored, with a maximum limit of 155 mEq/L, as well as serum pH to prevent alkalemia by exceeding a pH of 7.55. Likewise, serum potassium levels must be carefully observed, as there is a risk of hypokalemia.[35,36] *Dose:* the recommended dose of sodium bicarbonate for this procedure is a 1-2 mEq/kg of bodyweight bolus, followed by a 100-150 mEq infusion of sodium bicarbonate in a dextrose solution at 5%. The rate of infusion must be titrated until a urinary pH of 7.5-8 (monitoring every 6 hours) is reached, controlling serum pH and potassium levels.[36]

Extracorporeal techniques. In order to successfully eliminate a xenobiotic with extracorporeal therapy, certain quantities of it must be present in the interstitial fluid. To measure this, the volume of distribution (VD) is used: xenobiotics with a VD of less than 1-1.5 l/kg can be successfully eliminated with extracorporeal procedures, whereas if the VD is more than that, the efficacy of the treatment will be impaired. The plasma protein binding percentage also plays a significant role: if it is higher than 80% the therapeutic effect will be unsatisfactory.[37-39]

The best-known extracorporeal technique is hemodialysis (HD). Nevertheless, there are other procedures; for example, continuous renal replacement therapy, hemofiltration (HF), hemoperfusion (HP) and therapeutic plasma exchange.[37-39] The most common intoxications that respond well to extracorporeal therapy are those caused by salicylates, barbiturates, carbamazepine, lithium, metformin, phenytoin, thallium, theophylline, valproic acid and some toxic alcohols.[37,40] An accessible source of indications for these treatments are the recommendations of The Extracorporeal Treatments in Poisoning Workgroup (EXTRIP), which can be found online.

Specific therapy. It pertains to those drugs that can counteract the effect of a toxin by bonding directly to it (antidotes) or by interacting with the receptors that the xenobiotic would bind to (and preventing said binding), or producing an effect opposed to the effect the toxin has (antagonist). Despite there being comprehensive lists of both antidotes and antagonists, their practical use is rather limited due to several reasons: lack of availability, contraindications, and their adverse effects. Nowadays, only few antidotes and antagonists are deemed useful in clinical practice, detailed below (Table 6).[41,42]

CONCLUSIONS

The approach of a poisoned patient poses a challenge regarding diagnosis and treatment, both to the general physician and the specialist. The TCS proposes a systematic sequence of steps that allow for an organized medical approach, prioritizing the safety of the patient. It is important to highlight that many procedures that used to be performed in clinical practice are nowadays found to lack supporting evidence and their routine use is discouraged. While possible, it is best to seek advice from a toxicology specialist in order to complement the poisoned patient's care.

Conflicts of interest
The authors declare no conflicts of interest.

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