Chapter 16

ACUTE POISONING IN PEDIATRICS

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Childhood poisoning is defined as a set of signs and symptoms triggered by acute exposure to chemical substances in excessive or inappropriate doses. Common in medical emergencies, poisonings can occur through ingestion, absorption, inhalation, or application of substances that come into contact with the body in harmful quantities (Lee *et al.*, 2019). The main

causes of poisoning in children and adolescents include medications, cleaning products, and pesticides (Vilaça; Volpe; Ladeira, 2019). It's crucial to note that most poisonings are preventable, often resulting from improper storage of items outside their original packaging, frequently without caps, in accessible places like kitchen cabinets or bedrooms (Mintegi *et al.,* 2019).

The incidence of accidental poisonings is higher in boys aged 0 to 5 years, while intentional poisonings are more common in girls aged 11 to 17 years (Vilaça; Volpe and Ladeira, 2019). These data underscore the impact of poisonings as a public health problem, with morbidity, mortality, and hospitalizations increasing significantly with age. The correlation between the prevalence of intentional poisonings and suicide is notable, especially involving psychotropic medications like benzodiazepines and opioids, often prescribed for psychiatric disorders and chronic pain (Land *et al.*, 2020). These drugs, due to their low lethal dose and easy accessibility in both hospital and outpatient settings, present a significant challenge for reducing these rates, requiring restrictive legislation and multidisciplinary approaches to understand the psychodynamic aspects of this life stage.

In the context of accidental poisonings, it is crucial to consider cases where poisoning may be asymptomatic, with lead being a notable toxin. Lead, found in paints, household dust, contaminated water, and soil, has no biological function in the body and is associated with neurocognitive and behavioral dysfunctions in child development. Although many cases are asymptomatic, symptoms like headache, abdominal pain, anorexia, and constipation indicate an emergency requiring immediate hospitalization of the child (Mayans, 2019).

The diagnosis of pediatric poisoning is based on the initial clinical evaluation through a detailed history. Emergency services must be updated on managing these situations, using nationally unified guidelines, protocols, and toxicological-pharmacological information systems (Kazanasmaza; Kazanasmaza; Çalıkb, 2019). Treatment mainly aims to provide clinical and hemodynamic support to the patient, identifying the toxidrome to determine the need for decontamination with antidotes or dilution through volume replacement (Mayans *et al.*, 2019; Kazanasmaza *et al.*, 2019; Lee *et al.*, 2019).

EPIDEMIOLOGY

Acute poisoning is a global problem that is quite common in pediatric age. It is estimated that accidental poisonings cause about 45,000 annual deaths in children and adolescents, with an incidence of 1.8 per 100,000 inhabitants (Vilaça; Volpe; Ladeira, 2019). Recent data indicate that approximately 32.6% of poisoned children worldwide are under 3 years old, and 44.2% are under 5 years old (Soave *et al.*, 2022).

Nationally, studies show that most accidents occur at home, especially among boys under four years old, with medications and cleaning products being the main substances involved (Vilaça; Volpe and Ladeira, 2019). According to Gokalp (2019), 46.6% of accidental poisoning cases involve cleaning products, and 38% involve medications.

Although fatal childhood poisonings have significantly decreased in recent decades (Mintegi *et al.*, 2019), they remain a frequent cause of emergency consultations. A general trend in the prevalence and incidence of acute pediatric poisoning over time can be observed, considering variables such as environment, mode of poisoning, and type of toxic substance. Most cases of acute pediatric poisoning in emergency care occur unintentionally at home, through oral ingestion of medications and cleaning products (Vilaça; Volpe; Ladeira, 2019). Factors such as increased medical prescriptions for adults, work fatigue associated with reduced caregiver vigilance in the afternoon and evening, and improper storage of substances contribute to these events (Soave *et al.*, 2022).

According to Lee *et al.* (2019), pediatric poisoning can be classified as unintentional, predominantly occurring in children under 5 years old due to longer stays at home, and intentional, more common in adolescents, often associated with suicidal or recreational practices, with a higher incidence among female adolescents (Soave *et al.*, 2022). Unintentional poisonings are often related to the consumption of medications, cleaning products, pesticides, cosmetics, and plants (Lee *et al.*, 2019), due to the accessibility of these substances and children's imitative behavior. It is the responsibility of caregivers to ensure the safety of these locations using secure packaging and proper storage (Gokalp, 2019). In the case of unintentional drug poisonings, the most commonly involved drugs are benzodiazepines, analgesics, and antiepileptics (Vilaça; Volpe and Ladeira, 2019).

It is important to note that although acute pediatric poisoning represents a serious medical emergency, it rarely results in death or prolonged hospitalization, both nationally and globally (Vilaça; Volpe and Ladeira, 2019; Mintegi *et al.*, 2019). This can be attributed to the low lethality of predominant substances like medications and chemicals. Another relevant aspect is the significant change in pediatric poisoning patterns when considering the adolescent age group, with intentional cases predominating among female adolescents. This distribution varies globally, with distinct incidence peaks, being more common in North America and the Western Pacific regions (Mintegi *et al.*, 2019).

DIAGNOSIS

Acute poisoning is one of the most common emergencies in children and a significant cause of accidental injuries due to its rapid onset and serious harm to child health. As highlighted by the World Health Organization (WHO), poisoning is among the top five causes of accidents in children (Zhang; Huo; Jing and Dong, 2024). Ghannoum and Roberts (2023) emphasize that proper and rapid management of poisonings can reduce both the severity and duration of the condition. Special vigilance is essential for adolescents, especially those who may intentionally ingest illicit drugs or alcohol, including investigating suicide attempts. For young children, particularly under 1 year old, attention should be paid to the possibility of forced ingestion or intentional poisoning, also assessing the potential for child abuse.

The initial approach should prioritize early diagnosis, patient stabilization, and investigation of the involved toxic agent. These steps are crucial for clinical evolution and outcomes and include obtaining a detailed clinical history, thorough physical examination, and performing complementary and toxicological tests, as discussed by Velez, Shepherd, and Goto (2020).

It is essential to quickly identify potentially lethal toxic agents and those with a delayed onset of clinical toxicity for appropriate interventions and complication prevention, as highlighted by Ghannoum and Roberts (2023). Managing the poisoned child depends on the time of exposure, detection of involved toxins, and clinical presentation, which is crucial for decisions like gastrointestinal decontamination and administration of antidotal therapy when indicated.

The clinical history should be meticulously collected, preferably involving witnesses of the exposure or family members. It is crucial to inquire about pre-existing medical conditions and medication use to investigate potential cases of unintentional overdose. Additionally, detailed information about the toxic exposure, including involved substances, mode of exposure, correlation with presented signs and symptoms, and any expected laboratory findings of acute poisoning, must be obtained, as described by Velez, Shepherd, and Goto (2020).

Acute poisonings in pediatrics present a diversity of signs and symptoms, varying according to the involved toxic agent and the exposure route. As discussed by Hon, Hui, and Leung (2021), anticholinergic poisoning can trigger a range of peripheral and central manifestations, including tachycardia, hyperthermia, non-reactive mydriasis, dry mucous membranes, gastrointestinal effects, and neurological symptoms like delirium, confusion, and visual hallucinations.

On the other hand, carbon monoxide exposure in children, as described in the same study, can start with symptoms like headache, dizziness, and malaise. High COHb levels can cause more severe symptoms such as vomiting, visual disturbances, confusion, and even loss of consciousness.

Additionally, cholinergic poisoning, as observed by Hon, Hui, and Leung (2021), manifests with a wide range of symptoms, including bradycardia, bronchorrhea, lacrimation, excessive salivation, gastrointestinal hyperactivity, and miosis, along with central symptoms like seizures and coma in severe cases. Cyanide poisoning, as highlighted by Wong and Baum (2019), is characterized by signs like tachypnea, tachycardia, abdominal pain, and confusion.

Cannabis poisoning, as discussed by Wong and Baum (2019), can result in neurological manifestations like drowsiness and coma, along with cardiovascular, respiratory, and gastrointestinal symptoms. Children exposed to pesticides, as observed by Zhang, Huo, Jing, and Dong (2024), often present symptoms like vomiting, abdominal pain, and neurological disturbances, demonstrating the diversity in clinical presentation of these

conditions. This variety of symptoms underscores the diagnostic complexity of pediatric poisonings and the crucial importance of a comprehensive and individualized clinical approach to managing these cases to minimize harm and optimize clinical outcomes.

Early diagnosis of acute poisoning in pediatrics plays a crucial role in effective management and reducing severe complications. According to Velez *et al.* (2020), the initial assessment should be quick and comprehensive, focusing on patient stabilization and identifying the involved toxic agent. This includes securing the airway, assessing breathing and circulation, and monitoring vital signs to identify early manifestations of toxicity. Detailed physical examination is essential to detect specific symptoms, such as stridor and salivation, indicative of significant esophageal damage after caustic agent ingestion, as described by Niedzielski *et al.* (2020).

Additionally, flexible nasolaryngoscopy and endoscopy are crucial tools for evaluating laryngeal and esophageal injuries, respectively, allowing precise diagnosis of the injury degree and planning appropriate treatment. Early esophageal endoscopy is recommended within the first 24 to 48 hours after caustic ingestion unless contraindications like suspected perforation or epiglottis swelling are present, as evidenced by the practice described by Niedzielski *et al.* (2020).

In cases of unknown ingestion, as mentioned by Wong and Baum (2019), it is prudent to perform an electrocardiogram, a serum toxicology panel, and a urine drug screen, especially to identify co-ingestions that may influence clinical management. This multidisciplinary approach in early diagnosis not only improves clinical outcomes but also guides the implementation of specific therapeutic measures for each case of acute poisoning in children.

As conceptualized by Velez *et al.* (2020), toxic exposure should be considered in the differential diagnosis of children presenting with acute onset of multi-organ dysfunction, altered mental state, respiratory or cardiac impairment, unexplained metabolic acidosis, seizures, or a puzzling clinical picture. Signs like hypoglycemia, hypoxemia, and shock can have various clinical causes besides acute poisoning and should be investigated and ruled out. It is crucial to recognize and address any trauma or underlying condition before initiating any toxic agent decontamination.

According to the study described by Wong and Baum (2019), the differential diagnosis for acute cannabis exposure is broad due to the variety of nonspecific neurological symptoms, such as altered behavior, lethargy, or coma, which can mimic conditions like postictal states, encephalitis, or sepsis. This emphasizes the importance of a detailed clinical history and exclusion of other causes of symptoms before confirming the diagnosis of cannabis poisoning.

Regarding new diagnostic techniques, neuron-specific enolase (NSE) is used to assess neurological changes in unexplained poisoning cases. NSE alterations are particularly useful as sensitive and specific biomarkers for brain injuries associated with drug poisoning, as evidenced by Zhang, Huo, Jing, and Dong (2024).

TREATMENT

Acute poisonings in pediatrics present a wide variety of etiological agents, each capable of triggering severe symptoms that can lead to death. Therefore, early diagnosis and recognition of the involved substance are extremely important to initiate appropriate therapeutic management as quickly as possible (Hon; Hui and Leung, 2021).

To initiate the management of any poisoning case, whether mild or severe, a thorough assessment of the patient's vital signs is fundamental. This includes checking the airway, breathing, circulation, and neurological function. Based on the identified signs, initial measures should be instituted individually and protocolarily. The main goal of these measures is to ensure the patient's hemodynamic stability and optimize renal function to improve the elimination of the ingested toxic agent. Possible interventions include orotracheal intubation, ventilatory support, fluid administration, inotropes, vasopressors, and specific medications such as benzodiazepines for controlling seizures and agitation. According to Das *et al.* (2020), these approaches are fundamental for effective initial management.

Urgent gastrointestinal decontamination aims to reduce the absorption of the poison in the body, thus improving the patient's prognosis and recovery. Before initiating this procedure, it is crucial to prevent aspiration in patients at risk, especially those with vomiting, decreased consciousness level, or seizures, through orotracheal intubation when indicated. The most common routes for gastrointestinal decontamination are nasogastric or orogastric, as guided by Das *et al.* (2020).

Activated charcoal is often used as the method of choice for gastrointestinal decontamination, ideally administered within two hours after poison ingestion. In cases of large exposures, the dose can be repeated every 2 to 4 hours. However, it is ineffective against acids, alcohols, metal ions like lithium and iron, as evidenced in scientific literature. In situations of highly toxic exposure or contraindication to activated charcoal, total intestinal irrigation with isotonic solution, such as polyethylene glycol, administered enterally in high volume (1L/h) until clear rectal effluent, can be chosen (Das *et al.*, 2020). This measure is essential for specific cases where traditional gastrointestinal decontamination is inadequate.

Antidotes are proven effective measures in the treatment of poisonings, characterized as direct or indirect agonists or antagonists of a specific poison. The use of these agents varies according to the type of ingested toxin and is generally indicated in cases of confirmed toxicity or high concentration of the identified agent. The dosage must be individually adjusted based on the patient's clinical response. Below is a table of the main antidotes frequently used in clinical practice (Das *et al*., 2020):

Table 1.0: Antidotes are essential to neutralize the specific toxic effects of each agent.

Toxic Agent	Antidote
Acetaminophen	N-acetylcysteine
Anticholinergic medications	Physostigmine for significant delirium
Anticholinesterase insecticides	Atropine and possibly pralidoxime or obidoxime
β-adrenergic antagonists	Epinephrine, insulin-dextrose infusion
Benzodiazepines	Flumazenil
Calcium channel blockers	Calcium, insulin-dextrose infusion
Carbon monoxide	Oxygen
Cyanide	Hydroxocobalamin and/or thiosulfate
Dabigatran	Idarucizumab
Digoxin	Digoxin Fab antitoxin, atropine
Envenomation (e.g., snake, spider)	Antivenom
Ethylene glycol/methanol	Ethanol or fomepizole
Iron	Deferoxamine
Isoniazid	Pyridoxine
Methotrexate	Folinic acid, glucarpidase
Opioids	Naloxone
Methemoglobinemia induced by toxins	Methylene blue
Salicylates	Bicarbonate
Sulfonylureas	Octreotide, glucose
Tricyclic antidepressants	Bicarbonate
Valproic acid	L-carnitine
Warfarin	Vitamin K

Source: Das *et al.*, 2020.

Urine alkalinization involves raising urine pH to facilitate the excretion of weak acidic poisons like salicylates, phenobarbital, and chlorpromazine. It is performed by administering sodium bicarbonate in bolus followed by 5% dextrose infusion. This technique requires strict monitoring due to the risk of complications like hypokalemia and hypernatremia (Das *et al.*, 2020). Intestinal dialysis is a technique using multiple doses of activated charcoal to interrupt enterohepatic circulation or perform passive retro-diffusion from intestinal capillaries. It is effective against poisons like carbamazepine, phenobarbital, and quinine, and can also be applied to colchicine and salicylates (Das *et al.*, 2020).

Extracorporeal Treatments:

1. **Hemodialysis:** A widely used method that removes poisons through a semipermeable membrane, suitable for toxins with a molecular weight above 10,000 Da. It is also indicated for correcting metabolic imbalances and replacing renal function (Das *et al.*, 2020).
2. **Hemofiltration:** Similar to hemodialysis, but allows the removal of larger poisons (up to 50,000 Da) using convection or solute and solvent drag (Das *et al.*, 2020).
3. **Hemoperfusion:** Uses activated charcoal or resins to adsorb poisons from the blood but has disadvantages like requiring intense anticoagulation and lower availability compared to hemodialysis (Das *et al.*, 2020).
4. **Continuous Renal Replacement Therapies (CRRTs):** Combines diffusion and convection for continuous removal of poisons, especially in intensive care units, though it is less efficient than hemodialysis and hemofiltration (Das *et al.*, 2020).
5. **Other Techniques:** Include peritoneal dialysis, therapeutic plasma exchange, and exchange transfusion, each with specific advantages and limitations for poison removal depending on the clinical case (Das *et al.*, 2020).

These approaches are fundamental for mitigating the harmful effects of acute poisoning, requiring careful evaluation to determine the best strategy according to the involved toxic agent and the patient's clinical condition.

The discussion on treating acute cannabis poisoning, it's a problem whose incidence is increasing in the pediatric population in states with decriminalization of recreational and medicinal cannabis use. The initial approach to the patient is based on supportive care. In cases where there is a risk of bronchoaspiration or apnea, especially in children, rapid orotracheal intubation followed by assisted mechanical ventilation should be considered. For lethargic patients, electrolyte, gasometry, and blood glucose evaluation are indicated. Fluid administration should be considered in the presence of signs of hypovolemia. Benzodiazepines are useful in cases of agitation, cannabis hyperemesis syndrome, or co-ingestion with cocaine and should be combined with measures such as reducing environmental stimuli. In severe cases, the use of flumazenil may be considered (Wong; Baum, 2019).

In cases where children have access to illicit drugs at home or pain medications like codeine, it is crucial to be alert for signs of opioid intoxication. Intravenous naloxone is indicated at an initial dose of 0.01 mg/kg, which can be repeated every 3-5 minutes until clinical response. Clinical observation for at least 24 hours is essential for patients with respiratory depression or reduced respiratory rate (Hon; Hui and Leung, 2021).

The incidence of antiepileptic drug poisoning has increased, but there are no specific guidelines for management, which is limited to support. Cardiological monitoring, comprehensive laboratory tests, and serum level measurement of the involved agent are recommended. Measures like gastric lavage and activated charcoal may be considered in recent poisonings but are less effective with carbamazepine. Extracorporeal techniques like hemodialysis are reserved for severe cases (Ferranti *et al.*, 2018).

In carbon monoxide exposure, initial therapy with 100% oxygen is fundamental, while the use of hyperbaric oxygen is controversial due to the scarcity of evidence. For cyanide poisoning, management includes sodium nitrite followed by sodium thiosulfate and hydroxocobalamin (Hon; Hui and Leung, 2021).

Poisoning by anticholinergics, cholinergics, benzodiazepines, and acetaminophen requires specific treatment. Physostigmine is recommended for anticholinergic poisoning, while atropine is used in cholinergic poisonings. Flumazenil may be necessary in benzodiazepine poisonings, except in cases of known seizure syndrome. N-acetylcysteine is crucial for acute acetaminophen toxicity (Hon *et al.*, 2021).

Acute poisoning by corrosive substances is common in young children due to accidental ingestion. Initial management includes stabilization of the airway, cardiovascular system, and neutralization of the substance. Subsequent therapy may involve intravenous fluid therapy and parenteral nutrition. The use of proton pump inhibitors and vitamin E has proven effective in some cases, while the use of steroids and prophylactic antibiotics is controversial (Niedzielski *et al.*, 2020; Das *et al.*, 2020).

Treating acute poisoning in children requires a specific and differentiated approach, focusing on general support and, when necessary, targeted therapeutic measures. Early diagnosis is crucial to initiate appropriate management and minimize complications. Proper patient stratification can reduce admissions to pediatric ICUs, providing significant improvements in clinical and emotional outcomes for patients and families (Patel *et al.*, 2018).

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