Pediatric Anesthesia and Critical Care Journal 2026;14(1):59-67
doi:10.14587/paccj.2026.10

PACCJ

Pediatric poisonings: analysis and clinical management

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Keypoints

Pediatric poisonings are frequent events but are rarely lethal, with early childhood representing the most vulnerable age group. Effective clinical management requires a multidisciplinary approach, in which careful history taking, targeted monitoring and, in some cases, decontamination are essential.

Abstract

Pediatric poisonings represent a significant global health issue, with important implications for children's well-being and healthcare resources. Toxic agents include drugs, household products, plants and substances of abuse, with exposure occurring mainly via the oral route. Early childhood is at major risk for accidental exposure, while intentional poisonings prevail in adolescents. Clinical management requires immediate stabilization, accurate history taking, targeted laboratory evaluation and timely use of antidotes. Prevention, through caregiver education and home safety, remains essential.

Keywords

Pediatric poisonings, drugs, household products, button batteries, clinical management, prevention.

Introduction[1-4]

Pediatric poisonings represent a relevant health issue, with significant clinical and organizational impact. They can derive from drugs, household products, plants and substances of abuse, with exposure occurring through ingestion inhalation and skin contact. Clinical variability depends on age, context and intentionality of exposure.

Studies show that children aged 1–5 years are at the highest risk of accidental exposures, mainly caused by the ingestion of drugs or accessible household products. Among adolescents, there is a consistent increase in intentional exposures, often related to self-harm attempts.

Most of toxic exposures in children occur in household context and via the oral route. Among the most frequently involved substances are cleaning products, everyday household items and cosmetics. Among drugs, analgesics, psychotropic drugs, and cardiovascular agents are the most common. In the majority of cases, poisonings only require home observation, with limited access to Emergency Department or hospital admission. Severe outcomes and deaths are relatively rare; however, some substances retain an high toxic potential, even in minimun amounts, making prevention and proper management of domestic accidents essential.

According to the data from the 22° Congress of the Italian Society of Toxicology (Società Italiana Tossicologia, SITOX – 2025), up to 200.000 intoxications per year are documented in Italy, half of which related to drugs. Caustic substances represent around 29-30% of pediatric poisonings.

Analysis[1-31]

Who? Most vulnerable age groups

Younger children (1-4 years) are particularly susceptible to accidental exposure, often related to exploratory curiosity that leads them to put unknown objects and substances in their mouths. Poisonings in this age group are mostly unintentional. On the other hand, among adolescents (13-19 years), intentional poisonings, often associated with self-harm acts or substance abuse, become predominant.

According to the annual report of American Association of Poison Control Centers (AAPCC), 99% of exposures in children under 6 years is unintentional, while 62% of exposures between 13 and 19 years is intentional, partly because of suicide attempts or substance abuse.

When and where? Exposure context

Pediatric poisonings can occur in various contexts, but the home remains the predominant setting, with 95% of cases happening within the household. Other risk locations include daycare centers and public spaces. The most common modality of exposure is oral, with accidental ingestion of drugs or potentially toxic substances, such as household cleaners, which are frequently involved in accidents among younger children. Contact or inhalation are other relevant exposure routes, although less frequent.

What? Toxic agents

The most common causes of poisonings include drugs (analgesics, sedatives, cardiovascular agents, antimalarials, calcium channel blockers, opioids, oral antidiabetics, antidepressants, benzodiazepines), household products (detergents, pesticides, cosmetics, essential oils), toxic plants. substances of abuse and button batteries (small batteries found in toys and electronic devices; they can cause necrosis of the esophageal mucosa and tracheoesophageal fistulas).

In Italy, recent studies, including the one conducted by the Regina Margherita Hospital in Turin, have shown that household cleaners represent one of the most common causes of poisoning in children, with a particularly high incidence among those aged 1 to 4 years. It is important to note that although most exposures do not lead to severe outcomes, some substances, even in small amounts, can be extremely dangerous, as is the case with essential oils, which are increasingly involved in pediatric exposures.

How? Modality of exposure

Poisonings in children can be distinguished in two main categories: involuntary and voluntary.

Involuntary exposures (typical of younger children) occur mainly due to children's natural curiosity, which often leads to the accidental ingestion of dangerous substances. Therapeutic errors made by relatives or caregivers should also be included in this category.

Voluntary exposures (more common in older age groups) are often related to self-harming behaviors or suicide attempts.

Understanding these exposure patterns is crucial for prevention and for the timely management of pediatric poisonings.

Why? Reasons or errors underlying poisonings

Reasons underlying pediatric poisonings are multiple. In younger children, exploratory curiosity is the main triggering factor.

The risk of therapeutic error in administering medications to children by parents or caregivers represents a significant and often underestimated problem. The most common causes include difficulty in correctly understanding dosages and instructions, the use of non-standardized measurement units (such as household teaspoons), confusion between medications with similar names or packaging, and a poor perception of the potential danger of commonly used drugs. In addition, the complexity of calculating pediatric dosages, often based on weight, can lead to excessive or insufficient administration. Fatigue,

haste, or managing multiple therapies at once can also increase the likelihood of error. For these reasons, it is essential to promote clear communication between healthcare professionals and families, provide simple instructions and appropriate measuring tools, and raise awareness about the importance of proper storage and identification of medications.

In adolescents, poisoning may be motivated by suicide attempts, substance abuse, or therapeutic errors. In particular, the rise in voluntary poisonings among adolescents, especially involving psychotropic substances, is a growing phenomenon that requires greater attention from healthcare professionals.

Clinical management

When a child is treated, even after a possible toxic exposure, the first objective is clinical stabilization. This means ensuring vital functions — airway, breathing, and circulation — and intervening if necessary with oxygen, fluids, or hemodynamic support. After supportive treatment, history-taking and any laboratory tests follow. Although many procedures are similar to those used in adults, the young patient requires special attention: their physiology, body fluid distribution, and metabolic pathways differ, and this can alter both clinical presentation and therapeutic response.

Monitoring and support of vital functions

An immediate assessment according to the A, B, C, D, E approach must be performed, along with placement of an adequate vascular access and the monitoring/support of vital parameters. Careful first-level multiparametric monitoring (blood pressure, ECG, heart rate, SpO_2, body temperature) is essential in clinical management.

Particular attention must be given to airway management; any ventilation and/or intubation procedures must be performed safely to reduce the risk of adverse events and various complications (aspiration, difficulty in ventilation/intubation, etc.).

Hemodynamic support (fluid therapy, pharmacological support) must also be ensured when needed.

Neurological status must be monitored carefully.

Depending on the child's clinical condition and its evolution, medical staff may need to evaluate and provide invasive vital-sign monitoring (invasive blood pressure, urinary catheterization, etc.).

History taking

Providing an accurate clinical history in suspected poisoning can be quite challenging. In children, exposure is often unwitnessed, making it difficult to identify or quantify the substance involved. In adolescents, on the other hand, there may be reluctance to disclose what was taken, making it essential to ask questions sensitively and thoughtfully. Moreover, if the patient is already symptomatic or cognitively altered, they may be unable to cooperate during the initial stages.

To gather the history as completely as possible, it is important to speak with the child (if able), as well as with witnesses, family members, or other social contacts. Questions should address the nature of the substance, the time elapsed since exposure, the route of contact (ingested, inhaled, injected, absorbed through the skin, mucous membranes, or eyes), and any other substances available—not only those the child uses, but also those used by other family members, including over-the-counter medications and supplements.

Another important factor to assess is where and how products and medications are stored at home: if they have been transferred into different containers such as pill organizers, unlabelled jars, or food bottles, the risk of accidental exposure increases significantly.

Gastrointestinal decontamination

Many pediatric poisonings do not require aggressive decontamination techniques: in most cases, the most important element is providing adequate clinical support. However, decontamination options do exist and should be evaluated case by case, ideally in consultation with the Poison Control Center.

Among gastrointestinal decontamination techniques, activated charcoal can be used and may be administered orally or via a nasogastric tube to adsorb the toxic substance; however, in children under six years of age its use

is very limited, and immediate consultation with the Poison Control Center is recommended to determine whether it is appropriate in the specific case. Another option is gastric lavage, which was once widely used but is now reserved for exceptional situations, as in pediatric patients it may carry more risks than benefits. Finally, catharsis consists of administering large amounts of a laxative solution and may help reduce intestinal absorption of certain substances.

In all situations, transport to the emergency department should not be delayed while waiting for decontamination.

Laboratory tests and urinary screening

Laboratory tests, including urine screenings for substances of abuse, can assist in diagnosis but must be interpreted with caution. Tests may produce false positives (due to cross-reactivity with other drugs) or false negatives (when the substance is present at too low a level or is not detected by the method used), and there is no urine test capable of detecting all potentially ingested substances, especially new or uncommon ones.

When using these tests, it is helpful to involve a pharmacologist or toxicologist to correctly interpret the results. However, clinical decisions should be based primarily on the patient's presentation: a symptomatic child should be treated according to their clinical signs, regardless of the urine screening results.

Main high risk drugs and substances and their management (Table 1)

Paracetamol

Paracetamol is one of the most commonly administered medications in children and, despite its safety profile at therapeutic doses, represents one of the main causes of pediatric overdose. Accidental ingestion of excessive doses can occur both due to errors in calculating the dosage based on the child's weight and from multiple administrations by parents or caregivers, especially when using different formulations (syrups, tablets, suppositories). Overdose can lead to severe liver toxicity, which may initially be asymptomatic and only manifest after several hours, complicating early diagnosis. The antidotal treatment consists of N-acetylcysteine (NAC), administered intravenously with a specific dosage and schedule. Raising caregiver awareness, proper labeling, and the use of precise measuring tools are essential strategies to reduce the risk of adverse events related to paracetamol.

Antimalarials

Chloroquine and hydroxychloroquine, commonly used for malaria but also in certain autoimmune diseases, have a very narrow therapeutic index in children. Even the ingestion of a single tablet can cause ventricular arrhythmias, heart block, cardiovascular collapse, or seizures.

In the emergency department, the approach includes continuous cardiac monitoring, infusion of glucose and saline solutions to support volume and manage potential electrolyte imbalances and use of atropine for bradycardia and diazepam for seizures.

Rapid intervention is crucial, given the potential for the toxicity to progress quickly.

Calcium Channel Blockers

Drugs such as amlodipine, nifedipine, verapamil, and diltiazem can cause marked vasodilation, reduced cardiac contractility, hypotension, and bradycardia in cases of overdose. These medications often come in adult dosages and can have significant effects in children.

Emergency management includes administration of calcium (gluconate or chloride) and glucagon to stimulate cardiac contractility; in more severe cases, high-dose insulin therapy (HIET) together with glucose.

Support with atropine or vasopressors is often required. For extended-release formulations, prolonged observation is essential, as adverse effects may appear with delay.

Opioids

Pediatric exposure to opioids (such as codeine, methadone, buprenorphine, fentanyl) is highly dangerous: even low doses can cause respiratory depression and coma. The antidote of choice is naloxone, which must be administered according to the child's weight (via intravenous, intramuscular, or intranasal route). At the same time, it is essential to provide respiratory support with oxygen,

monitor oxygen saturation, and, if necessary, prepare for assisted ventilation. After naloxone administration, prolonged monitoring may be useful because the antagonist's effect may wear off before the ingested opioid is eliminated, especially in the case of long–half-life substances such as methadone.

Sulfonylureas

Sulfonylureas, commonly used in the treatment of diabetes, can cause severe and delayed hypoglycemia even after the ingestion of a single tablet. In children, the reaction may appear hours after exposure.

Emergency department management includes intravenous glucose administration and continuous blood glucose monitoring; in cases of recurrent or prolonged hypoglycemia, the use of octreotide has been described to inhibit insulin release

Tricyclic antidepressants

Tricyclic antidepressants - such as amitriptyline, imipramine, and desipramin - have high toxicity in overdose, and in children even a single tablet may be enough to cause severe cardiac and neurological effects. Symptoms include arrhythmias (QRS widening), hypotension, seizures, delirium, and coma. Emergency treatment includes clinical and cardiac monitoring, advanced life-support measures when necessary, intravenous sodium bicarbonate (to counteract cardiac toxicity), and benzodiazepines (e.g., diazepam) for seizures.

Benzodiazepines

In cases of benzodiazepine overdose, children may present with marked drowsiness, ataxia, or hypotonia. Flumazenil is the specific antagonist, but its use must be considered carefully: there is a risk of seizures and arrhythmias, especially if the patient has also taken other anticonvulsant medications or tricyclic antidepressants. In milder cases, clinical observation and respiratory support, if needed, are often sufficient.

Selective Serotonin Reuptake Inhibitors (SSRIs)

In this case as well, accidental ingestion can lead to significant effects in children, considering that individual tablets contain adult dosages. Central nervous system alterations (somnolence, coma), autonomic changes (vital-sign abnormalities), and neuromuscular symptoms (tremors and seizures) may occur. In pediatric overdose, management is based on supportive care, with monitoring of vital functions, benzodiazepines if seizures occur, and ECG monitoring for possible QT prolongation.

Topical Anesthetics (lidocaine, benzocaine, etc.)

Benzocaine and lidocaine, often found in teething products or creams, can cause methemoglobinemia in children, with symptoms such as cyanosis and hypoxia despite normal pulse oximetry readings. When clinically significant methemoglobinemia is present, the antidote is methylene blue administered intravenously in a hospital setting. Cardiac and respiratory monitoring are also essential.

Caustic substances (acids, strong bases, detergents)

Corrosive substances do not have a specific antidote: treatment is essentially supportive. Vomiting should not be induced, as this may worsen the injury. If possible, the mouth or throat may be rinsed with water (without forcing swallowing), and analgesia and respiratory support should be provided. Optimal management includes instrumental diagnostics with CT of the chest and abdomen and staging of possible lesions with urgent esophagogastroscopy. In severe cases, surgical intervention may be required due to perforation or necrosis.

Button Batteries

Button batteries are an emerging problem. These small circular batteries, found in toys, remote controls, watches, and other devices, represent a growing danger for children. If ingested, they can cause very rapid tissue damage due to chemical and electrical mechanisms, with esophageal mucosal necrosis occurring within hours. Reported complications include ulcers, tracheoesophageal or esophageal–vascular fistulas, strictures, and vocal-cord paralysis. Early localization of the foreign body is essential to plan prompt and targeted endoscopic removal with the support of a surgical and anesthesia team.

General Considerations and Recommendations

Every case of suspected pediatric poisoning, even when it appears minor, requires prompt evaluation and, in some cases, hospital admission or observation in the emergency department. It is essential to involve a Poison Control Center as early as possible to obtain guidance on dosages, available antidotes, and specific protocols.

The emergency department should maintain an active stock of essential antidotes, with weight-adjusted pediatric dosing instructions and clear procedures for their administration.

Ongoing staff training on these emergencies is crucial: simulations, protocol updates, and familiarity with specific treatments can make a significant difference.

Discussion[1-31]

Pediatric poisonings represent a complex and potentially life-threatening issue, particularly in children under six years of age, who are characterized by low body weight, immature metabolism, and a natural tendency toward oral exploration.

As highlighted in the literature, even small amounts of substances commonly found at home, from medications to essential oils, can cause severe or even fatal toxic effects. This makes it essential for healthcare personnel to quickly recognize signs of poisoning and intervene promptly, even in the absence of clear information about the ingested agent.

Analysis of the available data shows that certain categories of drugs represent a particularly high risk. Antimalarials such as chloroquine and hydroxychloroquine, calcium-channel blockers, opioids, sulfonylureas, and tricyclic antidepressants, even in minimal quantities, can cause cardiovascular, respiratory, or neurological compromise.

Likewise, household substances such as acids, caustic bases, or button batteries can cause immediate or delayed damage, requiring prompt and often multidisciplinary clinical management.

History taking, although often limited or fragmented, remains central.

Accurate collection of information from patients, family members, or witnesses, combined with clinical observation and, when indicated, laboratory tests, helps guide appropriate clinical management. However, diagnostic tests such as urine drug screening have intrinsic limitations and do not replace direct clinical evaluation.

From a therapeutic point of view, clinical support remains the priority in most cases.

Gastrointestinal decontamination has limited indications and must be assessed on a case-by-case basis, while the use of specific antidotes, when available, requires expertise and timeliness.

The creation of practical tools, such as quick-reference emergency tables listing substances, antidotes, pediatric dosing, and safety notes, can greatly assist in facilitating rapid and safe decision-making.

Finally, the increasing availability of high-dose medications, extended-release formulations, and unconventional substances, such as molecules purchased online or supplements, makes pediatric poisonings a continually evolving phenomenon.

This underscores the importance of constant updates for healthcare professionals, as well as the need for targeted preventive strategies, such as parent education and proper medication storage.

The emergence of button batteries as a significant risk highlights how the domestic toxicological landscape is evolving.

In this specific case, targeted preventive strategies have been implemented, including caregiver education, child-resistant closures, safe storage recommendations, early intervention by poison control centers, and protocols for prompt endoscopic removal.

Substance Hired	Antidote Treatment	Pediatric Dose	Security Notes
Opioid	Naloxone	0,1 mg/kg IV/IM/SC, max 2 mg per dose; repeat every 2–3 min until response	Monitor breathing and level of consciousness; prepare assisted ventilation if necessary
Benzodiazepines	Flumazenil	0,01 mg/kg IV (max 0,2 mg per dose), owner slowly	Risk of seizures in mixed ingestions or epilepsy; continuous monitoring
SSRI	Symptomatic support	There is no specific antidote; activated charcoal if recent ingestion	Monitor ECG, seizures; pay attention to serotoninergic syndrome
Tricyclic antidepressants	IV Sodium bicarbonate	1–2 mEq/kg IV to correct QRS / acid-base	Continous cardiac monitoring; prepare for seizures management
Calcium Channel Blockers	Calcium gluconate, glucagon, high-dose insulin	Calcium gluconate 60 mg/kg IV, Glucagon 20–30 µg/kg IV bolus, Insulin 0,5–1 U/kg/h with glucose	Monitor blood glucose, blood pressure, ECG; hemodynamic support
Sulfonylureas	Glucose IV, Octreotide	Glucose 0,5–1 g/kg IV, Octreotide 1–5 µg/kg SC/IV	Continous blood glucose monitoring; recurrent risk of hypoglycemia
Local Anesthetics (lidocaine, benzocaine)	Methylene blue (methemoglobinemia)	1–2 mg/kg IV slowly, max 7 mg/kg	Monitor oxygenation and heart rhythm; administer only if methemoglobinemia is confirmed
Caustics acids-bases	Support, there is no antidote	Oral rinse, analgesics, CT scan, and urgent endoscopy	Do not induce vomiting; provide respiratory support if inhalation occurred; surgical intervention may be necessary
Chloroquine-Hydroxychloroquine	Diazepam, cardiac support	Diazepam 1–2 mg/kg IV (max 10 mg per dose) for seizures	Cardiac monitoring, pressure; risk of cardiac arrest ever for low doses
Paracetamol	N-acetylcysteine (NAC)	IV: 150 mg/kg in 15 min, then 50 mg/kg in 4 h, then 100 mg/kg in 16 h	Dose calculated on body weight; monitor hepatic function; start within 8h from ingestion
Methanol-Ethyleglicol	Fomepizole or Ethanol + hemodialysis.	Fomepizole 15 mg/kg IV, then 10 mg/kg ogni 12 h x2 doses, then 15 mg/kg every 12 h	Monitor metabolic acidosis; prepare dialysis if severe

Tab 1. Practical table for Emergency Department

Conclusion

The general assessment of pediatric poisonings highlights that even small amounts of common substances can have serious consequences in children. Effective management requires a multidisciplinary approach that combines initial stabilization, accurate collection of the clinical history, careful assessment of the clinical picture, targeted laboratory support, and, when indicated, timely use of antidotes.

Prevention, through parental awareness, safe storage of medications, and education on potentially toxic substances, represents a fundamental pillar in reducing risk. Practical tools, such as emergency reference tables, can assist medical personnel in making rapid decisions, improving both the safety and effectiveness of interventions.

Overall, the combination of clinical knowledge, organizational planning, and preventive strategies is key to effectively managing pediatric poisonings, ensuring maximum protection for the most vulnerable patients.

Accurate history-taking, immediate clinical support, and the selective use of decontamination techniques and specific antidotes represent the core of pediatric poisoning management. Continuous training for healthcare personnel and the adoption of effective preventive measures remain essential elements in reducing the incidence and severity of toxicological events in children.

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