

# Acute poisoning in children admitted to pediatric emergency department: a five-years retrospective analysis

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**Abstract.** *Background and aim:* to identify most frequent risk factors and to propose prevention strategies for the children admitted to Pediatric Emergency Department (PED) with acute poisoning. *Methods:* We performed a retrospective study in a tertiary care hospital, describing the frequency and nature of pediatric poisoning, clinical management and outcome. *Results:* We collected data of 436 children admitted for acute poisoning. The mean age was 30 months and 51.1% were male. Most poisoning incidents (90.1%) were unintentional and drug ingestion (39.4%) was the leading cause of poisoning. Acute poisoning happened at home in 83,7% of cases and the mother was the most frequent caregiver during the event in 61.5%. No died were reported. *Conclusion:* Our study showed that the two categories of patients at greatest risk for acute poisoning are children under 3 years and adolescents over 12 years. Adequate information campaigns about toxic substances are essential for children, adolescents and their parents. ([www.actabiomedica.it](http://www.actabiomedica.it))

**Key words:** Children; Pediatric; Poisoning; toxicology; personalized medicine

## Introduction

Acute poisoning (AP) is a clinical condition caused by the exposure in less than 24 hours to a toxic substance (1). It can be due to ingestion, inhalation or skin-contact with substances that should not be ingested or inhaled (detergents, plants, carbon monoxide, etc.) or that may be ingested, but harmful if introduced in excess (2–4). In most cases, these substances are minimally toxic and rarely can cause death or be life-threatening (3). Acute poisoning is a common problem in pediatric age worldwide: it involved 32.6% of children  $\leq 3$  years and 44.2% of children  $\leq 5$  years (5). It is the 4<sup>th</sup> cause of admission to Pediatric Emergency Department (PED) following by trauma, burns and drowning (6–7). Poisonings occurring in

the first 6 months of age are mainly caused by parents, while the other are accidental (8–9). However, in adolescents, poisonings are often part of suicidal behaviors and can be fatal or cause long-term damages (10–11).

Our study assesses the characteristics of children and adolescents admitted to PED with acute poisoning, describing the frequency, the type of poisoning, clinical management and outcome of these patients.

## Methods

We conducted a retrospective observational study of children with acute poisoning, admitted to the PED of a tertiary care hospital in Rome from September 2014 to September 2019. We included all children less

than 18 years of age admitted to PED for acute poisoning by toxic substances. Children with foreign body ingestion or food over-ingestion were excluded.

The main aim of the study was to describe the clinical and demographical characteristics of children with acute poisoning, describing the frequency, the type of poisoning, clinical management and outcome.

Patients were identified from the hospital computerized clinical record (GIPSE®). Clinical and demographic data were collected by paediatric specialists after being trained in a data collection form developed specifically for the study (Table 1 and 2).

For a more accurate analysis, we divided the toxic substances in 7 groups: medications, alcohol and substances of abuse, household supplies, corrosive, pesticides, plants and derivatives, gases and vapors.

Besides to analyze the incidence of acute poisoning for age, we identified the following categories: ≤2 years (early childhood), 3–5 years (preschool age), 6–12 years (age school children) and > 12 years (early adolescence).

Univariable summaries (means, medians, standard deviations) were provided for continuous variables (e.g., age, hours of ED stay) while frequency distributions summarized categorical variables (e.g., gender). Associations between variables were assessed with chi-square tests (for categorical variables). The statistical software package SPSS Version 21 was used for all analyses, and a p-value of less than 0.05 was considered statistically significant.

All participant gave their consent to participation to the study and also for the publication of anonymously results. This study was approved by the Institutional Review Board and Ethic Committee of our institution.

## Results

During the study period a total of 73225 children were admitted to our PED, 436 (0.6%) of them for acute poisoning. The mean age was 30 months ( $SD = 56.3$  months; 95%  $CI = 50.8–61.3$ ) and 223 (51.1%) were male (Table 1). According to age classification, children under the age of 2 years were the most affected (57%), followed by children between 3 and

5 years (19%), over 12 years (13%) and finally between 6 and 12 years of age (11%).

All the characteristics of the study population are summarized in Table 1. The curve of acute poisonings in the years considered is represented in Figure 1.

**Table 1.** Characteristics of children with acute poisoning admitted to Pediatric Emergency Department

	N°	%
<b>Gender</b>		
Male	223	51,1
Female	213	48,9
<b>Age</b>		
≤2 Aa	247	56,7
3-5 Aa	85	19,5
6-12 Aa	47	10,8
>12 Aa	57	13,1
<b>Site Of Poisoning</b>		
At Home	365	83,7
Away From Home	45	10,3
Undefined	26	6,0
<b>Season</b>		
Autumn (Sep-Nov)	118	27,1
Winter (Dec-Feb)	103	23,6
Spring (Mar-Apr-May)	124	28,4
Summer (Jun-Aug)	91	20,9
<b>Intentional</b>		
Yes	43	9,9
No	393	90,1
<b>Route Of Posoning</b>		
Ingestion	400	91,7
Inhalation	18	4,1
Contact	18	4,1
<b>Caregiver At Time Of Poisoning</b>		
Mother	267	61,2
Father	49	11,2
Parents	59	13,5
Grandfather/Grandmother	7	1,6
Other	7	1,6
Alone	18	4,1
Not Known	29	6,7

(continued)

**Table 1.** Characteristics of children with acute poisoning admitted to Pediatric Emergency Department (*continued*)

Symptoms		
Gastrointestinal	164	37,6
Neurological	42	9,6
Cardiorespiratory	32	7,3
Asymptomatic	212	48,6
Odor Of Poison		
Yes	57	13,1
No	379	86,9
Contact Poison Control Center		
Yes	262	60,1
No	174	39,9

Unintentional poisoning occurred in 393 (90.1%) of the children, whereas intentional poisoning in 43 of them (9.9%); related to the age, we did not found cases of acute intentional poisoning in children under 12 years, but a peak was observed in 16 years old adolescents (n=13, 30.2%) and in this group, female sex prevailed (n=39, 64%).

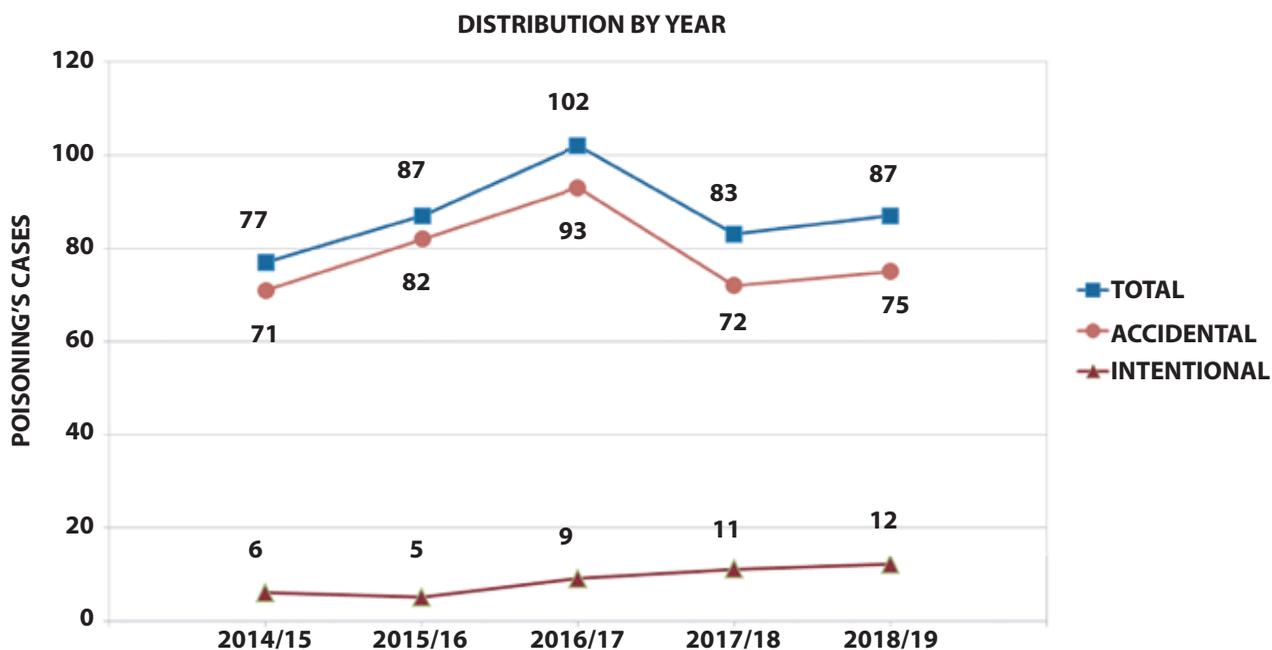
The visits were most frequent from 2.00 p.m. to 20.00 p.m. (n=184, 42%). Interestingly, 47.4% of patients over 12 years went to PED overnight (Table 2)

Besides, our data showed that 365 (83.7 %) poisoning accidents happened at home, 45 (10.3%) occurred outside and 26 (6%) were unrecorded. The caregiver at the time of acute poisoning was the mother in 268 cases (61.5%), and in 59 cases (13.5%) were present both parents. Less frequently patients were alone at home (18 cases, 4.1%).

Ingestion was the most common route of poisoning (91.8%), followed by inhalation and contact (4.1%). Besides, as for the type of substance, medications were most frequent (172, 39.4%), followed by household supplies (116, 26.6%) and corrosives (71, 16.3%); subsequently we found plants and derivatives (36, 8.3%), alcohol and substances of abuse (18, 4.1%), pesticides (16, 3.7%) and finally gases (9, 2.1%).

Subsequently, we divided the household supplies into low risk (67%) and high risk (33%), based on more or less harmful to the body (Table 3).

Our study showed that the main cause of acute poisoning in children of all age were medications, but in particular in adolescents over 12 years (47%, n=27).

**Figure 1.** Trend of acute poisonings in the years considered.

**Table 2.** Management of children with acute poisoning admitted to Pediatric Emergency Department

	N°	%
<b>Transportation</b>		
Ambulance	64	14,7
Helicopter Rescue	7	1,6
Own Vehicles	365	83,7
<b>Time Of admission to Ed</b>		
8:00-14:00	95	21,8
14:00-20:00	184	42,2
20:00-8:00	157	36,0
<b>Time spent in ED</b>		
<1 H	80	18,3
1-2 H	147	33,7
3-4h	63	14,4
>4 H	146	33,5
<b>Blood Examinations</b>		
Yes	197	45,2
No	239	54,8
<b>Instrumental Examinations</b>		
Yes	123	28,2
No	313	71,8
<b>Esophagogastroduodenoscopy (EGDS)</b>		
Yes	26	6,0
No	410	94,0
<b>Disposition</b>		
Home	259	59,4
Ward	63	14,4
Picu	22	5,0
Short Stay Observation (SSO)	92	21,1
<b>Therapy</b>		
Activated Carbon	38	8,7
Gastric lavage	10	2,3
Activated Carbon+Gastric lavage	14	3,2
None	376	86,2

Instead, household supplies were the toxic agents more involved in AP in children under 2 years of age (29.5%, n=73) and between 6 and 12 years of age (38%, n=18).

Upon clinical presentation at the ED, 212 (48.6%) children were asymptomatic; among other patients,

gastrointestinal symptoms (37.6%, n=164) were most common, followed by neurological symptoms (9.6 %, n=42) and respiratory (3.9%, 17). Odor of the poison was identified by doctors and/or caregivers in 57 (13%) children.

Regarding the performance of diagnostic tests, 222 (51%) had performed them: 99 (22.7%) only blood examinations, 25 (5.7%) only instrumental tests, while 98 (22.5%) had performed both. Instrumental tests included: ECG (22.5%), chest x-ray (5.5%), abdomen x-ray (1.6%), abdominal ultrasound, chest CT scan (only 3 cases); EGDS was performed in 24 patients (5.5%), most of them due to intoxication by corrosive substances.

The mean duration of ED stay was less than 4 hours and most patients were then discharged (59.4%); sixty-three (14.4%) patients required a hospital stay in pediatric or pediatric surgery ward, while 22 (5%) were admitted to the Pediatric Intensive Care Unit (PICU).

A statistically significant association was observed between age and symptoms presentation ( $p=0.0026$ ), with a worse clinical picture in older patients, and between symptoms and type of xenobiotic ( $p=0.00446$ ), with greater dangerousness in case of alcohol, substances of abuse, household supplies, corrosive and gases poisoning. The type of xenobiotic also correlated with age ( $p=0.03$ ), with an increased risk of intoxication by medications, household products, pesticides and plants and derivatives in under 2 years children and greater risk of intoxication by alcohol and substances of abuse in over 12 years adolescents. An increased risk of hospitalization (54%) was found in over 12 years patients ( $p=0.015$ ), with a greater risk of intentional exposure and developing serious clinical conditions in females ( $p=0.0038$ ) (Table 4). Moreover, a statistically significant association has been observed between the ingestion of medications ( $p=0.009$ ), alcohol and abuse substances ( $p=0.007$ ) and the performance of diagnostic tests. Instead, the relation between patients do not underwent exams and intoxication by household products was significant ( $p=0.00$ ).

With regard to the age of the patients, an association was found between children over 12 years of age and the execution of diagnostic tests ( $p=0.00$ ) (Table 5).

**Table 3.** Cases of ingestion of household supplies, stratified in high and low risk.

Household supply	Cases of ingestion		High risk substance		Low risk substance	
	n	%	n	%	n	%
<i>Detergents</i>	40	34.5	21	52.5	19	47.5
<i>Cosmetics and personal care products</i>	22	19.0	18	81.8	4	18.2
<i>Disinfectants</i>	19	16.5	9	47.4	10	56.3
<i>Oil and derivatives</i>	5	4.0	2	40.0	3	60.0
<i>Preservatives for clothing</i>	3	8.0	3	100.0	0	0.0
<i>Glues, paints and inks</i>	9	2.5	9	100.0	0	0.0
<i>Other</i>	18	15.5	15	83.3	3	16.7

**Table 4.** Analysis of intentional and unintentional poisoning among children

	Intentional (%)	Unintentional (%)	X2	Pvalue
<b>Gender</b>				
Male	13 (21.99)	210 (201.01)	8.35	0.0038
Female	30 (21.01)	183 (191.99)		
<b>Site Of Poisoning</b>				
At Home	22 (26.83)	250 (245.17)	2.85	0.24
Away From Home	20 (14.99)	132 (137.01)		
Undefined	1 (1.18)	11 (10.82)		
<b>Time spent in ED</b>				
<2 H	28 (29.22)	295 (293.78)	0.24	0.62
>= 2 H	10 (8.78)	87 (88.22)		
Undefined	5	11		
<b>Disposition</b>				
Home	25 (33.79) [2.29]	325 (316.21) [0.24]	22,2	<0.001
Ward	9 (6.08) [1.40]	54(56.92) [0.15]		
Picu	8 (2.12) [16.25]	14 (19.88) [1.74]		
Short Stay Observation (OOS)	17	85		

## Discussion

Our study shows that the rate of visits to the PED due to AP in children is 0.6%, according to other studies in the literature. This shows how AP is an important public health problem in the pediatric age. Although the mortality rate is very low, more than 50% of pediatric AP cases requires emergency department access, especially when therapeutic medications were involved (12, 13).

According to the literature (5), the highest incidence of AP occurred in the first 3 years of life, especially in children between 1 and 2 years (57%).

Aking et al. found that among 330 intoxicated children, 72% were younger than 5 (14). In another two studies, intoxications occurred in 64% of children younger than five (15), or mostly in children younger than six (16).

Unintentional ingestion is the most common cause of AP among younger children (17–19).

**Table 5.** Association of xenobiotics, age and symptoms with exams execution

	Patients underwent exams (n)	Patients do not underwent exams (n)	X <sup>2</sup>	P VALUE
<b>XENOBIOTICS</b>				
<i>Medications</i>	198 (75 %)	64 (25 %)	6.75	0.009
<i>Alcohol and substances of abuse</i>	15 (84 %)	3 (16 %)	7.18	0.007
<i>Household supplies</i>	33 (28 %)	83 (72 %)	18.99	0.000
<i>Corrosives</i>	43 (61 %)	28 (39 %)	2.17	0.14
<i>Pesticides</i>	6 (37 %)	10 (63 %)	1.14	0.28
<i>Plants and derivatives</i>	17 (47 %)	19 (53 %)	0.20	0.65
<i>Gases</i>	2 (23 %)	7 (77 %)	2.95	0.08
<b>AGE</b>				
<i>≤2 years</i>	111 (44 %)	136 (56 %)	2.25	0.13
<i>3–5 years</i>	39 (45 %)	46 (55 %)	0.72	0.39
<i>6–12 years</i>	23 (48 %)	24 (52 %)	0.06	0.79
<i>&gt;12 years</i>	49 (85 %)	8 (15 %)	25.01	0.00
<b>SYMPTOMS</b>				
<i>Asymptomatic</i>	97 (45 %)	115 (55 %)	1.52	0.21
<i>Symptomatic</i>	125 (56 %)	99 (44 %)	1.41	0.23

Children explore the world, taking different objects to the mouth and when these are toxic substances, a real AP occurs (20). The caregiver is responsible to secure the environment surrounding children in order to minimize all possible risks. For these reasons, we want to highlight the importance of the prevention: dangerous substances should not be easily accessible to children in order to avoid the risk of exposure. A recent study has shown that the removal of some risk factors, such as the inattention and the conservation of materials below 150 cm, would carry to the avoidance of 13 and 19% of children intoxications, respectively (21).

Gaw et al. showed that, with these measures, for children under 6 years old in the USA the rate of exposures decreased by 18.0% from 2015 to 2017 (22).

In children under 5 years of age, intoxications from some types of substances (medications or parts of cigarettes) often derive from the imitation of adult behaviors; this does not happen for non-toxic

pharmacological substances, given that children never see adults ingesting these substances (23).

Intentional ingestions are more frequent instead in adolescents, with a higher incidence in female ( $p=0,0038$ ). These intoxications have demonstrative and/or self-injurious purposes, but also recreational purposes. In our study in adolescents over 12 years, drug, alcohol and substances of abuse more frequently cause intentional ingestions. In addition, in this group we observed a worse clinical picture than that found in unintentional ingestion ( $p < 0.001$ ); these patients needed closer monitoring and even hospitalization.

Besides according to literature, most cases of AP in pediatric age happened at home (83,7%) (24) and the most common time when poisonings occur has been reported to be 8:00 a.m-6.00 p.m. or 6.00 p.m.-12.00 a.m. (24–26). We found that most poisoning occurred from 2.00 p.m to 8.00 p.m. (42.2%), followed by the time between 8.00 p.m. to 8.00 a.m. This may

be because in these time parents have mostly returned from work, are more tired and therefore less attentive to the care and control of the child. Besides during morning children are engaged in school activities, while they are certainly more “free” and therefore more exposed to the risks of poisoning during afternoon and evening.

The caregiver present with the child during the poisoning was represented by the mother (61.2%) or the father (11.2%) or both parents (13,5%). This cannot be considered a risk factor; an interesting prospective study should be conducted with the aim of analysing parent’s cultural level, socio-economic conditions, possible language barriers and lifestyle. Gielen AC et al. stated that aspects significantly linked to the number of injury avoidance practices implemented were family revenue, environmental barriers and habitation quality (27).

Medications ingestion was the leading cause of poisoning in children (39.4 %) according to the results of previous reports; neurological medications, especially benzodiazepines, kept in unprotected environment at home, were the most common causes of poisoning. Other medications involved were hormones, anti-inflammatory and antihypertensive agents (28). This can be related to the significant increase in drug prescriptions for adults, as demonstrated by Burghardt et al., and to a superficial management of the drug to be administered to the child (29). Although drug exposure is more frequent in all ages, it is higher in children between 3 and 5 years (46%) and in adolescents over 12 years (47.4%).

Household supplies, including cleaning substances, personal care products, and topical agents, are the most common non-pharmaceutical poisoning agents in our study. The easy-access packaging and colourful appearance of household supplies increase their danger to young children. Among these substances, caustic agents are the most dangerous because the ingestion of minimal doses can cause severe esophageal burns (3). Gas inhalation was equally dangerous from a clinical point of view but numerically less relevant in our sample (2.1% of gas vs 16.3 % of corrosive).

Analyzing the relationship between the age and symptoms, it emerged that symptomatic patients admitted to PED for AP was in 50% of children under

3 years, while it increased up to 72% among those over 12 years of age, demonstrating greater severity of exposure cases ( $p$  value  $<0.0026$ ). Furthermore, children over 12 years of age, needed hospitalization more frequently (54%), due to worse clinical condition and behavioural implications. However 48.6 % of our cases was asymptomatic at diagnosis and no death was observed.

The analysis of the observation time in PED showed that 66.5% of the cases spent less than 4 hours in PED and 5% required a hospitalization in PICU. This probably because the clinical severity of most cases was mild in our study, unlike what has been reported in other studies. In addition, more than half of the cases were asymptomatic; the most common symptoms were gastrointestinal, followed by neurological and respiratory ones.

As for the blood and instrumental tests performed by the emergency room pediatrician, we highlighted a statistically significant relationship ( $p <0.036$ ) between the presence of symptoms and tests performed. Although the absence of symptoms, for some classes of xenobiotics, particular attention was paid to the search for any damage not clinically detectable. This is one of the reasons why it is difficult to have guidelines on prescribing laboratory and instrumental tests in cases of intoxication of various substances.

Our study presents some limitations. First of all the retrospective nature of the study, that limits the collection of data. In addition, our study only includes cases of pediatric acute poisoning admitted to PED of a single center. So our conclusions can not be extended to all pediatric poisoning presenting in other settings, as primary care.

In conclusions, we have identified two particular categories of patients at risk: children under the age of 3 years and adolescents over the age of 12 years.

As for the former, the accessibility to xenobiotics especially at home and the main place of exposure, is the main risk factor for accidental exposure, together with the caregiver’s presence and his level of attention, which turns out to be more reduced in the afternoon-evening. In this age it is necessary to pay more attention to the medications and household supplies that were the most frequent xenobiotics to which children were exposed.

As regards adolescents over 12 years, exposure to toxics is mainly intentional and the risk factors are: female gender, psychiatric diseases, complex family dynamics. The most involved toxic substances are medications, alcohol and substances of abuse.

For these reasons it is essential that the pediatrician educates parents sensitively to prevent exposure to xenobiotics from the first check-ups, even before the child starts walking.

Furthermore, the use of adequate information campaigns, involving not only adolescents but also their families, is essential in order to increase awareness of the risks caused by toxic substances and provide a psychosocial support as part of the treatment of such adolescents.

**Conflict of Interest:** Each author declares that he or she has no commercial associations (e.g. consultancies, stock ownership, equity interest, patent/licensing arrangement etc.) that might pose a conflict of interest in connection with the submitted article.

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