Research Results in Pharmacology

Research Results in Pharmacology 8(3): 71–79
UDC616-099:615.03(075.8)
DOI 10.3897/rrpharmacology.8.85058

Research Article

Acute poisoning in children: Etiology, structure, treatment tactics and outcomes

Ekaterina S. Karpushkina[1], Olga A. Zhdanova[1], Galina A. Batishcheva[1]

1 *Voronezh State Medical University named after N.N. Burdenko, 10 Studencheskaya St., Voronezh 394036 Russia*

Corresponding author: Ekaterina S. Karpushkina (favi85@mail.ru)

Academic editor: Mikhail Korokin ♦ **Received** 10 April 2022 ♦ **Accepted** 16 August 2022 ♦ **Published** 13 September 2022

Citation: Karpushkina ES, Zhdanova OA, Batishcheva GA (2022) Acute poisoning in children: Etiology, structure, treatment tactics and outcomes. Research Results in Pharmacology 8(3): 71–79. https://doi.org/10.3897/rrpharmacology.8.85058

Abstract

Introduction: Acute poisoning is often observed in children and can have serious consequences since it is characterized by rapid development of symptoms and obvious disfunction of vital organs.

Materials and methods: Retrospective analysis of the case histories of the children with acute poisoning admitted to Voronezh Regional Children's Clinical Hospital No. 1 in 2016–2019 was carried out. Anamnesis, clinical and laboratory studies and effective treatment criteria were entered into electronic spreadsheets and served as the basis for a database on children's poisoning.

Results and discussion: Analysis of 183 case histories of children with intoxication aged 4 months to 17 years old was performed. Distribution per age showed bimodal peaks at 1–2 years and 13–14 years. Poisoning was accidental in 96.2% of the cases, and 3.8% of the adolescents reported suicide cases. In the group of young children, acute drug poisoning is more frequent in girls ($P < 0.05$). In the older groups, there is no gender difference in frequency of poisoning cases.

Early call for medical help is typical for the adolescent age group. Correlation between time of help-seeking and children's age is statistically significant (correlation coefficient $r = 0.38$, $P < 0.05$).

Conclusion: Study of poisoning issue in children will allow to carry out targeted preventive measures to reduce the number of poisoning cases, prevent their consequences and to determine the most rational modus operandi for medical personnel for effective and safe pharmacotherapy.

Graphical abstract

In pediatric practice, intoxication by poisons and drugs is among the most common reasons for seeking medical help and hospitalization in intensive care units. It is important to study and record dynamics, structure and frequency of acute poisoning with subsequent development of prevention and treatment methods.

Keywords

children, drugs, acute poisoning, pharmacotherapy.

Introduction

Acute poisoning is a serious public health issue and one of the causes of children's morbidity and mortality (Bellmann and Joannidis 2017; Shukla and Ghadigaonkar 2019). In pediatric practice, intoxication by poisons and drugs is among the most common reasons for seeking medical help and hospitalization in intensive care units. In Russia, there are some studies evidencing that frequency of poisoning among children has been increasing over the recent years, although not all cases have been registered since many patients are not hospitalized due to refusal of their parents or relatives (Luzhnikov and Suhodolova 2013; Kovalenko et al. 2019). Adolescents often take drugs or other chemicals deliberately for suicidal or other reasons (Helander et al. 2015; Goswami et al. 2021). Poisoning can lead to severe clinical manifestations, disability, and sometimes death since it is characterized by rapid development of symptoms and obvious disfunction of vital organs (Starkey et al 2016; Gummin et. al 2017; Díaz et al. 2018).

The aim of the study is determination of structure and frequency of occurrence of various types of poisoning in children of Voronezh region. It is important to study clinical manifestations of poisoning with subsequent development of prevention methods to reduce the number of children affected. Determination of a rational modus operandi for effective and safe pharmacotherapy is of current importance.

For emergency service doctors, it is often difficult to decide on the therapy for intoxication with drugs and psychoactive substances. A large number of standards, clinical and methodological recommendations to treat poisoning with various drugs makes it obligatory for a doctor to keep in mind a large amount of information regarding dosage adjustments, antidotes, prescription restrictions and contraindications by age. Lack of full and complex information on the diagnosis of poisoning and algorithms for selecting a therapy for certain combinations of symptoms leads to serious difficulties in prescribing detoxification therapy, loss of time and a decrease in the effectiveness of prescribed pharmacotherapy regimens.

A doctor's knowledge of the physiological effects of poisonous substances is important for accurate diagnosis and effective treatment and care of patients with poisoning (Kovalenko et al. 2019). It is necessary to carry out analytical screening of poisonings and develop personalized diagnostic and treatment schemes for emergency care in intensive care units.

Materials and methods

Study design

The study of the structure of acute exogenous poisoning in children of Voronezh region was carried out by means of a retrospective analysis of the case histories of hospital patients.

Inclusion criteria

The research included all the patients admitted to Voronezh Regional Children's Clinical Hospital No. 1 (VODKB No. 1) with poisoning in accordance with the following criteria:

- there is evidence of poisoning with drugs, psychotropic, narcotic, alcohol-containing drugs, carbon monoxide and household gas, combustion products, household chemicals, fertilizers, industrial poisons, mushrooms, and poisonous plants;
- the child is hospitalized for treatment or follow-up.

Exclusion criteria

The exclusion criteria were absence of accurate data on drug poisoning, as well as a severe somatic pathology in a child, which can affect the clinical picture of poisoning.

Study conditions

A retrospective analysis of the therapy for children with acute poisoning was carried out on the basis of Voronezh Regional Children's Clinical Hospital No. 1 in the period from 2016 to 2019, using the hospital records. All stages of the study complied with the legislation of the Russian Federation, international ethical standards approved by the Ethics Committee of the Federal State Budgetary Educational Institution of Higher Education "Voronezh State Medical University named after N.N. Burdenko" of the Ministry of Health of the Russian Federation (minutes No. 5 dated 31.12.19). Informed consent was obtained from the legal representatives of young patients for use of the data in scientific research.

Study duration

Duration of the study included four years from 2016 to 2019.

Description of medical intervention

The data from the hospital case histories were used including age, gender of a child, way of admittance (by

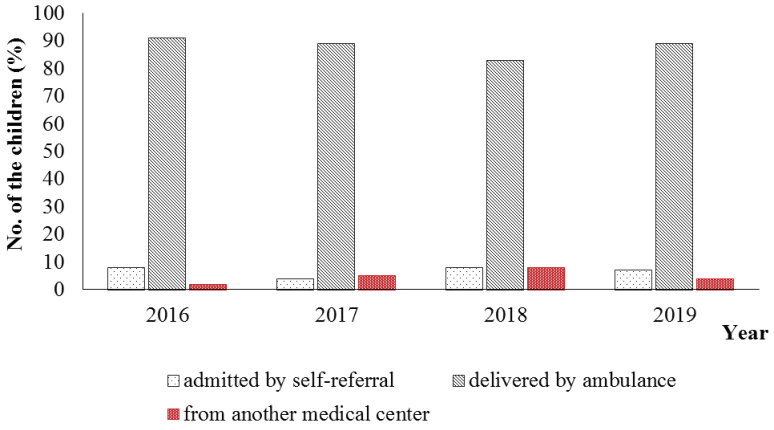

Figure 1. Annual diagram of acute poisoning cases. **Note:** The dynamics of the number of children admitted with acute poisoning over the years demonstrates a relatively constant trend of emergency care.

ambulance, delivered by parents, transferred from another medical center/hospital), type of poisoning (accidental or intentional), poisonous substance, intake route, how soon medical help was sought, kind of medical care provided, results of clinical and laboratory examinations and tests, drug therapy, and the outcome of poisoning.

Anamnesis, clinical and laboratory studies data, as well as effective treatment criteria, were entered into electronic spreadsheets and served as the basis for a database on children's poisoning (certificate of database registration No. 2020620717 dated 04/25/2020).

Main results of the study

Collection of data on the structure of exogenous poisoning in children of Voronezh region.

Result registration methods

A retrospective analysis of case histories of children with poisoning was used; the data of anamnesis and clinical and laboratory examination of patients were taken into account.

Statistical analysis

Statistical processing included assessment of descriptive statistics parameters, comparison of indicators in the groups, using non-parametric and parametric methods, and Pearson's correlation. The children subject to the study were divided into 3 age groups: infants (0–5 years old), younger school children (6–10 years old) and teenagers/adolescents (11–17 years old).

Data are presented as mean and median. Statistical data processing was carried out using Excel 2010 application program, version: 14.0.7268.5000 (license No. 02260-566-1219627-48596).

Results and discussion

A retrospective analysis was carried out using data from 183 hospital case histories for the period from 2016 to 2019. All the patients were hospitalized for examination and treatment at Voronezh Regional Children's Clinical Hospital No. 1.

Analysis of the children admitted to hospital was performed based on the way of hospitalization. In 2016: 5 children (7.8%) were admitted by self-referral, 1 child (1.6%) – by transfer from another medical center, and 58 children (90.6%) – delivered by ambulance. In 2017: 1 child (3.70%) – by self-referral, 2 children (5.41%) – by transfer from another medical center, and 24 patients (88.89%) – delivered by ambulance. In 2018: 3 children (8.33%) – admitted by self-referral, 3 children (8.33%) – by transfer from another medical center, and 30 patients (83.34%) – delivered by ambulance. In 2019: 4 children (7.14%) – by self-referral, 2 children (3.57%) – by transfer from another medical center, 50 patients (89.29%) – delivered by ambulance. The annual dynamics of the number of children with acute poisoning who applied for medical care shows a relatively stable tendency of emergency care (Fig. 1).

Analysis of the annual distribution of the children by age showed that in 2016 there were 64 children (34.97%) admitted to the hospital, in 2017 – 27 children (14.75%), in 2018 – 36 children (19.67%), and in 2019 – 56 children (30.6%). The annual distribution of the number of children with acute poisoning by age groups – infants (0–5 years old), younger schoolchildren (6–10 years old) and teenagers/adolescents (11–17 years old) – showed a relatively stable predominance of the early age (infants) for the period under study (Fig. 2).

Distribution by gender is as follows: in 2016 there were 34 girls (53.13%) and 30 boys (46.87%) who sought medical care; in 2017: 19 girls (70.37%) and 8 boys (29.63%); in 2018: 16 girls (44.4%) and 20 boys (55.6%), and in 2019: 30 girls (53.57%) and 26 boys (46.43%). The diagram (Fig. 3) presents the gender and age distribution of the number of children with acute poisoning by groups (infants, younger schoolchildren, teenagers/adolescents), which shows bimodal peaks at 1–2 years and 13–14 years. Infants aged 1 year prevailed in the structure of acute poisoning (19.67%). Small girls dominated by gender and age – 66 girls (56.9%) (Fig. 3).

The diagram (Fig. 4) shows frequency of various intake routes of all toxic substances among the child population.

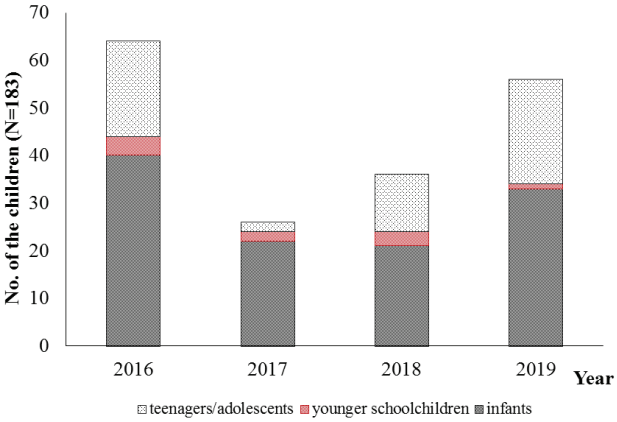

Figure 2. Distribution of the number of children per age groups for the period 2016–2019. **Note:** Infants, younger schoolchildren, and teenagers/adolescents refer to children aged 0–5 years, 6–10 years, and 11–17 years, respectively.

The youngest person among the patients with deliberate self-poisoning was 11 years old.

Infants, younger schoolchildren, and teenagers/adolescents refer to children aged 0–5 years, 6–10 years, and 11–17 years respectively.

Statistical analysis by age groups showed predominance of drug poisoning in young children (70.69%) and psychoactive substances among adolescents (61.40%). Hospitalization in the intensive care unit was higher among adolescents (50.88%) than among young children (13.8%).

Hospitalization, ward – hospitalized in a pediatric ward.

Hospitalization, ICU – hospitalized in the intensive care unit.

Statistical analysis of the data of the total number of the children under study without their division into

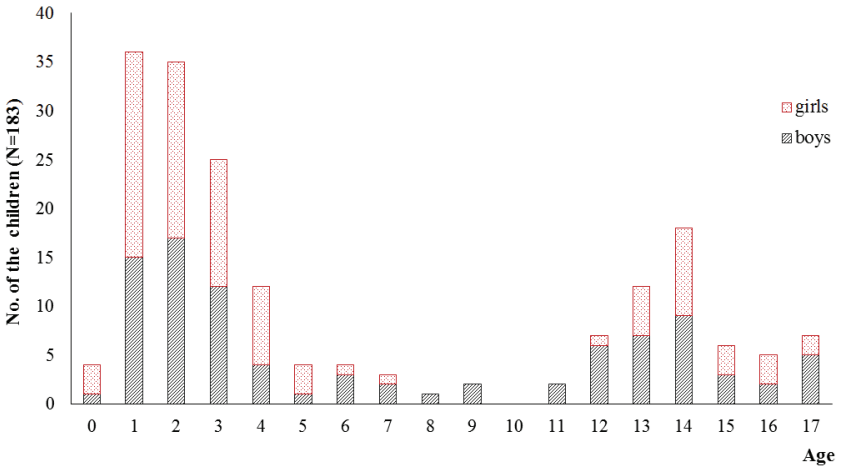

Figure 3. Distribution of the number of children with acute poisoning per age and gender. **Note:** Distribution shows bimodal peaks at 1–2 years and 13–14 years. Proportion of the girls was the highest among the infants – 66 girls (56.9%). Regarding the ratio of gender and age characteristics, Pearson's correlation coefficient (r) was 0.45 ($P < 0.05$).

The predominant intake route was enteral – 136 children (74.32%), via inhalation – 21 children (11.47%), intranasal – 12 children (6.56%), sublingual – 1 child (0.55%), intramuscular – 3 children (1.64%), by a snake bite – 5 children (2.73%), mixed – 3 children (1.64%), and of unknown etiology – 2 children (1.09%) (Fig. 4).

When distributed by age groups, the most common were children of small age (infants) – 116 children (63.5%), 10 younger schoolchildren (5.35%), and 57 teenagers/adolescents (31.15%) (Table 1). Proportion of the girls was the highest among the infants – 66 girls (56.9%). Regarding the ratio of gender and age characteristics, Pearson's correlation coefficient (r) was 0.45 ($P < 0.05$).

30 children (52.63%) in the group of teenagers/adolescents were aged between 13 and 14. Of all the poisoning cases reviewed, 169 (92.35%) were accidental; 14 (7.65%) – a result of deliberate use of drugs with suicidal intent, of which 12 were demonstrative poisonings and in 2 cases the patients had severe psychological disorders that led to consumption of poisonous substances. Intentional poisoning occurred during adolescence ($P < 0.05$). groups by age showed prevalence of drug poisoning in 103 children (56.3%), poisoning with psychotropic, narcotic, alcohol-containing drugs – in 35 patients (19.1%), poisoning with carbon monoxide and household gas,

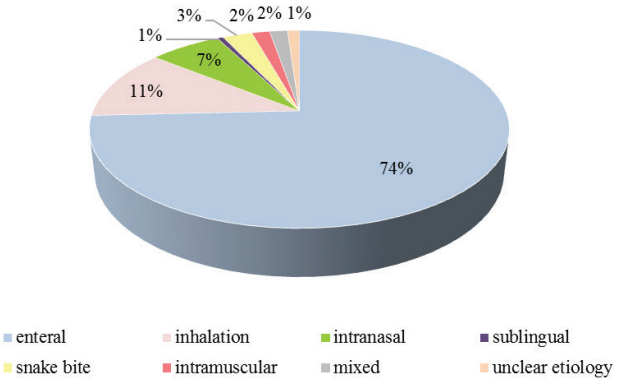

Figure 4. Frequency of various intake routes of poisonous substances. **Note:** The diagram shows frequency of various intake routes of all toxic substances among the child population. The predominant intake route was enteral – 74.32%.

Table 1. Frequency of occurrence of the research parameters in the study groups

Characteristic	Total (N = 183)	Infants* (N = 116)	Younger schoolchildren* (N = 10)	Teenagers/ adolescents* (N = 57)	P
Girls/boys					<0.05
Girls	99 (54.1)	66 (56.9)	2(20.0)	23 (40.35)	
Substances					<0.05
Drugs	103 (56.3)	82 (70.69)	5 (50.0)	16 (28.08)	
Psychotropic, narcotic, alcohol-containing drugs	35 (19.1)	0	0	35 (61.4)	
Carbon monoxide and household gas, combustion products	26 (14.21)	24 (20.69)	1 (10.0)	1 (1.75)	
Household chemicals, fertilizers, industrial poisons	12 (6.56)	8 (6.89)	3 (30.0)	1 (1.75)	
Mushrooms, poisonous plants	7 (3.83)	2 (1.73)	1 (10.0)	4 (7.02)	
Therapy					<0.05
Infusion therapy	114 (62.3)	75 (64.66)	5 (50.0)	34 (69.65)	
Gastric lavage	88 (48.09)	60 (51.72)	3 (30.0)	25 (43.86)	
Enterosorption therapy	71(38.8)	60 (51.72)	2 (20.0)	9 (15.79)	
Emergency medical care	47 (25.69)	30 (25.86)	5 (50.0)	12 (21.1)	
Department in the hospital					<0.05
Hospitalization, ward	137 (74.86)	100 (86.2)	8 (80.00)	29 (50.88)	
Hospitalization, ICU	46 (25.14)	16(13.8)	2(20.00)	28(49.12)	

Note: Values are expressed as the absolute number of poisoning cases (percent, %).

combustion products – in 26 patients (14.21%), poisoning with household chemicals, fertilizers, industrial poisons – in 12 children (6.56%), and poisoning with mushrooms and poisonous plants – in 7 children (3.83%) (Table 1).

Analysis by age groups reveals predominance of alpha-2 adrenergic agonists poisoning in infants – 23 children (12.57%), antihistamines and household chemicals, fertilizers, industrial poisons – 3 patients per each (30.00%) in younger children group and significant prevalence of psychotropic, narcotic, and alcohol-containing drugs in the group of teenagers/adolescents – 35 children (61.4%) (Table 2).

Table 2. Characteristics of poisonous substances by age groups

Characteristic	N (%)
Infants (N = 116)*	
Alpha-2 adrenergic agonists	23 (19.83)
Antihypertensive drugs	18 (14.52)
Anxiolytics	15 (12.93)
Others	60 (51.72)
Younger schoolchildren (N = 10)*	
Antihistamines	3 (30.0)
Household chemicals, fertilizers, industrial poisons	3 (30.0)
Bronchodilators	2 (20.0)
Others	2 (20.0)
Teenagers/adolescents (N = 57)*	
Psychotropic, narcotic, alcohol-containing drugs	35 (61.4)
Multi-druds	5 (8.78)
Antipsychotics	3 (5.26)
Anxiolytics	3 (5.26)
Others	11 (19.3)

Note: Infants, younger schoolchildren, and teenagers/adolescents refer to children aged 0–5 years, 6–10 years, and 11–17 years, respectively.

Poisoning by Alpha-2 adrenergic agonists prevailed among young children – 23 children, by antihistamines – 3 children among young children. Antipsychotic drug and drug combination poisoning dominated in adolescents.

In the structure of acute drug poisoning (103 children (56.3%)), 82 children (70.69%) belonged to the infants' group. Alpha-2 adrenergic agonists were the most common drug in this age group (23 children (19.83%)), whereas antihistamines – among the younger schoolchildren (3 children (30.0%)). Antipsychotics and anxiolytics (3 children per each (5.26%)) are the most common among teenagers/adolescents (Fig. 5).

Multi-drugs poisoning (5 children (8.78%)) occurs among the teenagers/adolescents. There are combinations of psychotropic drugs and NSAID group drugs, e.g. amitriptyline and papaverine, phenibut and ibuprofen, phenobarbital and paracetamol.

Fig. 6 shows the main symptoms in acute poisoning among the child population. Apathy, drowsiness, emotional lability, hallucinations, depression of consciousness, skin pallor, punctate hemorrhagic rash on the face and neck and gastrointestinal disorders were the key symptoms of anxiolytic poisoning. Impaired consciousness up to coma, skin pallor and coldness, hyperhidrosis, hypothermia, bradycardia, arterial hypotension and miosis with a preserved response to light were observed in intoxication in infants. Ataxia, dysarthria, muscular hypotension, depression of consciousness (somnolentia, sopor, coma) are characteristic of intoxication with benzodiazepines. The main symptoms of poisoning with barbiturates are bradycardia, arterial hypotension, hypersalivation and miosis (presence of light reflex depends on the depth of the coma). Apathy, drowsiness, visual and auditory hallucinations, depression of consciousness and confluent rash of hyperemia kind rising above the skin were observed as the clinical features of antihistamine poisoning.

Distribution of the emergency care activities during primary admission and the necessary syndromic drug therapy in the hospital by age groups shows a stable predominance of all types of care in infants (Fig. 7). Most of the children underwent gastric lavage by an emergency doctor – 46 children (25.14%) or by a hospital emergency doctor – 42 children (36.21%).

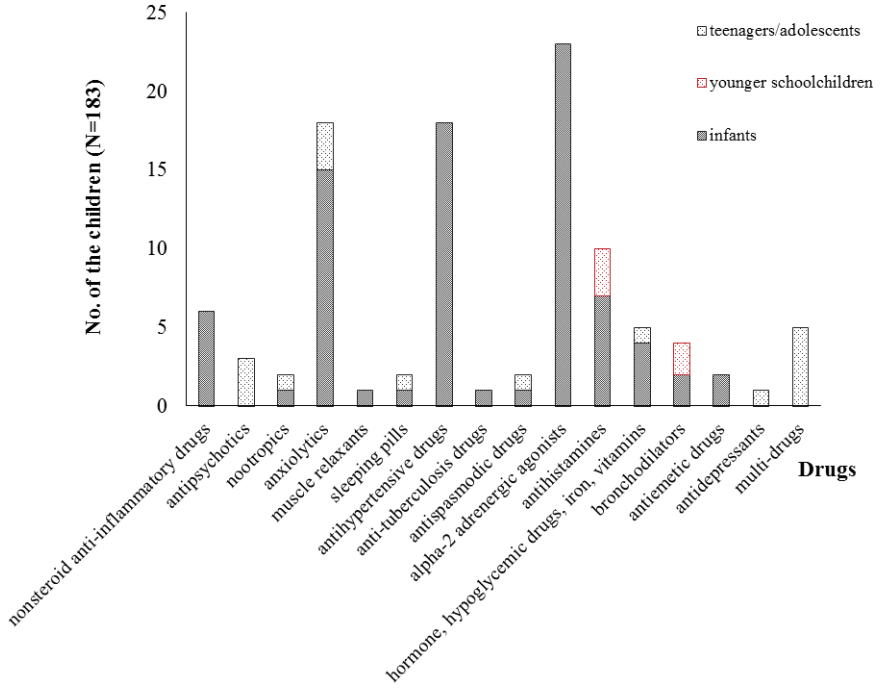

Figure 5. Distribution of drug poisoning by age groups in acute poisoning. **Note:** Infants, younger schoolchildren, and teenagers/adolescents refer to children aged 0–5 years, 6–10 years, and 11–17 years, respectively.

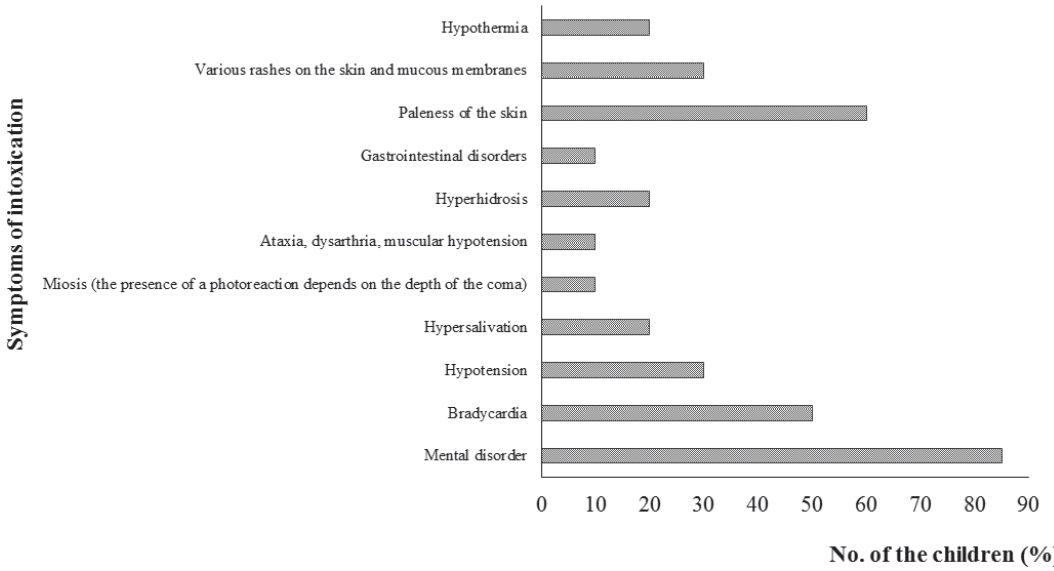

Figure 6. Clinical features in children with acute poisoning. **Note:** The main symptoms in acute poisoning among the child population: Mental disorder, Paleness of the skin, Bradycardia and hypotension.

In the general structure of medical care, most children received infusion therapy with glucose-salt solutions (Table 1). Opioid receptor agonists (Naloxone) were administered intravenously if required – 6 adolescents (3.28%). Parenteral administration of diazepam was used to relieve convulsive syndrome – 3 children (1.64%).

A moderate condition was observed in 122 patients (66.12%), a severe condition – in 60 children (32.79%), and an extremely severe condition – in 2 children (1.09%). 137 children received therapy in the pediatric department and 46 patients – in the intensive care unit. 28 teenagers/adolescents (49.12%) were admitted to the intensive care unit, which was significantly higher than in the other age groups (Table 1). Correlation between the period during which a child applied for medical care and their age is statistically significant (correlation coefficient $r = 0.38$, $P < 0.05$). This is confirmed by the fact that teenagers/adolescents applied for medical help in the first hours after poisoning compared to the other groups. The most common cause of admission to the intensive care unit ($n = 46$) was phenazepam (8 children (17.39%), naphazoline, multi-drugs and alcohol-containing drugs (5 children per each (10.87%), psychotropic-containing drugs (4 children (8.69%), carbon monoxide gas and narcotic-containing

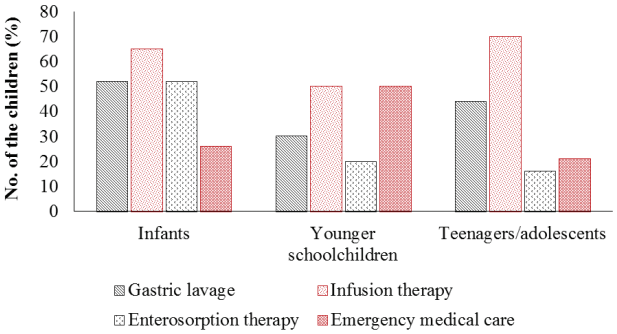

Figure 7. General structure of all types of therapy for children with acute poisoning. **Note:** Infants, younger schoolchildren, and teenagers/adolescents refer to children aged 0–5 years, 6–10 years, and 11–17 years, respectively. Infusion therapy prevailed among adolescents, whereas gastric lavage – among young children. Correlation between the period during which a child applied for medical care and their age is statistically significant (correlation coefficient $r = 0.38$, $P < 0.05$).

drugs (3 children per each (6.52%)) (Fig. 8). Improvement of the state and recovery following the treatment was recorded in all the patients.

All the children received syndromic therapy, effectiveness of which was assessed by presence or absence of systemic dysfunctions and need for long-term therapeutic support.

The study revealed that drug poisoning prevailed in the structure of acute poisoning in children in Voronezh region (56.3%). Acute poisoning with toxic substances was more common among infants (0–5 years old) – 63.34%, which is most likely associated with their active cognitive behavior and imitation of the adults' activities since all the cases of the use of toxic substances were accidental. The cases of poisoning with psychotropic, narcotic and alcohol-containing substances with a deliberate intention were prevailing among senior schoolchildren. Hospitalization in the intensive care unit was more frequent in this group (49.12%) than in the other groups (20% and 13.8% in younger schoolchildren and infants, respectively). This is confirmed by the fact that teenagers/adolescents applied for medical help in the first hours after poisoning compared to the other groups and is associated with a high dose or concentration of a toxic substance.

The biggest number of medical interventions was observed in infants, which is related to the late assessment of the child's state by their parents and a delayed health encounter (Kunelskaya et al. 2017; Zhamlikhanov and Fedorov 2019a).

Timely and high-quality medical care for children with poisoning is of crucial importance for prognosis and outcome of the patient's state. Pharmacoepidemiological studies are aimed at determination of the most rational modus operandi for medical personnel for effective and safe pharmacotherapy for children with drug poisoning (Ulseth et al. 2019).

Clinical manifestations and severity of acute poisoning depend on the poisoning substance (Garashchenko et al. 2016). It is very important to perform timely assessment of the patient's state and determine the type and characteristics of the poisonous substance (Petukhova et al. 2019). New drugs, psychotropic and narcotic drugs appear in the world, following changes in the structure of the drugs used by people, which lead to poisoning (Helander et al. 2015; Krabseth et al. 2016). Accordingly, clinical characteristics and medical care change as well (Mégarbane et al. 2020; Ordak et al. 2021).

Quality of emergency medical care for children at the prehospital stage is crucial for the prognosis and outcome of the patient's state (Wenzel et al. 2004). In acute poisoning cases, prehospital treatment includes infusion therapy with 0.9% sodium chloride solution at a dose of 10 ml/kg per hour and correction of existing violations of the vital functions (if necessary, emergency resuscitation) (Baranov et al. 2015). At the hospital stage, laboratory tests are performed additionally, such as clinical and biochemical blood tests, coagulogram, clinical urinalysis, toxicological analysis of urine and

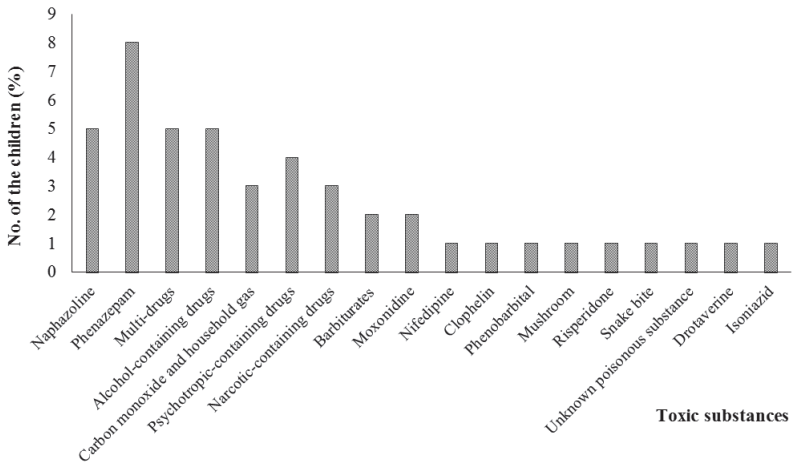

Figure 8. The structure of toxic substances that caused poisoning in children admitted to bringing children to the intensive care unit. **Note:** The most common cause of admission to the intensive care unit (n = 46) was phenazepam (8 children (17.39%), naphazoline, multi-drugs and alcohol-containing drugs (5 children per each (10.87%), psychotropic-containing drugs (4 children (8.69%), and carbon monoxide gas and narcotic-containing drugs (3 children per each (6.52%)).

blood; the treatment scheme is based on the same principles as at the prehospital stage (Zhamlikhanov and Fedorov 2019b).

Clinical guidelines do not contain criteria for assessing severity of the patient's state and differentiated choice of therapy scheme (Wong and Irwin 2013; Kochetkov and Fatyanova 2017). Unfortunately, in severe and extremely severe conditions, detoxification measures may be ineffective and insufficient. Usually in such cases, there is no clear procedure for a doctor to follow to assess severity of the patients state, to check clinical and laboratory parameters and to select a scheme for individual choice of the drugs.

Thus, taking into account high incidence of acute poisoning in children, lack of adaptation of traditional schemes for acute poisoning treatment to the clinical state of a patient, it is necessary to develop a method for differentiated choice of the therapy depending on the severity of the child's state.

Study of acute poisoning problem in children makes it possible to recommend an individual choice of treatment scheme depending on the patient's manifestations, the state of their central nervous system, cardiovascular system, autonomic vegetative nervous system, and the period when medical help was first applied after the moment of poisoning.

The study is retrospective, carried out on the basis of the data of inpatients' case histories and makes it possible to characterize the current problem of acute poisoning among the child population.

Conclusion

The problem of acute poisoning requires special attention among other pediatric issues. Most poisonings occurred in young children at home as a result of unintentional ingestion of a single substance. The most common drug in this age group was naphazoline; with patients more often admitted at the late stage of intoxication. The adolescents were patients with intentional poisoning; use of psychoactive substances was the main cause of poisoning in the early period of intoxication. Such information allows doctors in emergency department to determine individual treatment regimens for poisoning in children and to focus their efforts on the poisoning diagnosis.

Conflict of interests

The authors of the article confirmed the absence of a conflict of interests to be reported.

References

- Baranov AA, Bagnenko SF, Namazova-Baranova LS, Alexandrovich YuS, Pshenisnov KV, Alexeyeva EA, Selimzyanova LR (2015) Federal clinical recommendations on emergency medical care rendering to children with acute intoxication. Pediatric Pharmacology [Pediatricheskaya Farmakologiya] 12(6): 657–667. https://doi.org/10.15690/pf.v12i6.1489 [in Russian]
- Bellmann R, Joannidis M (2017) Intoxication with psychotropic drugs. Medizinische Klinik, Intensivmedizin und Notfallmedizin 112(6): 557–575. https://doi.org/10.1007/s00063-017-0323-8 [PubMed] [in German]
- Díaz M, Granson E, Taiman J, Alava J, Gabrielli T, Mendoza L (2018) Severe poisoning with naphazoline: update from a therapeutic error. Archivos Argentinos de Pediatría 116(4): 626–629. https://doi.org/10.5546/aap.2018.e626 [PubMed]
- Garashchenko TI, Boikova NE, Zelenkin EM (2016) Choice of vasoconstrictors for children with rhinosinusitis. Russian Bulletin of Perinatology and Pediatrics [Rossiyskii Vestnik Perinatologii i Pediatrii] 61(3): 124–131. https://doi.org/10.21508/1027-4065-2016-61-3-124-131 [in Russian]
- Goswami O, Mahanta P, Kalita D, Konwar R, Yadav DS (2021) A three-year study on acute poisoning cases brought for medico-legal autopsy in a north-eastern city of India. Open Access Emergency Medicine 13: 45–50. https://doi.org/10.2147/OAEM.S297083 [PubMed] [PMC]
- Gummin DD, Mowry JB, Spyker DA, Brooks DE, Fraser MO, Banner W (2017) 2016 annual report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 34th annual report. Clinical Toxicology 55(10): 1072–1252. https://doi.org/10.1080/15563650.2017.1388087 [PubMed]
- Helander A, Beck O, Bäckberg M (2015) Intoxications by the dissociative new psychoactive substances diphenidine and methoxphenidine. Clinical Toxicology 53(5): 446–453. https://doi.org/10.3109/15563650.2015.1033630 [PubMed]
- Kochetkov PA, Fatyanova EI (2017) Acute rhinusinusitis: modern approaches to diagnosis and treatment. Medical Council [Meditsinskii Sovet] 8: 130–136. https://doi.org/10.21518/2079-701X-2017-8-130-136 [in Russian]
- Kovalenko LA, Ipatova MG, Kovalchuk AS, Grishakina SM, Afukov II (2019) Acute drug poisoning during adolescence. Experimental and Clinical Gastroenterology (8): 67–71. https://doi.org/10.31146/1682-8658-ecg-168-8-67-71 [in Russian]
- Krabseth HM, Tuv SS, Strand MC, Karinen RA, Wiik E, Vevelstad MS, Westin AA, Øiestad EL, Vindenes V (2016) Novel psychoactive substances. Journal of the Norwegian Medical Association 136(8): 714–777. https://doi.org/10.4045/tidsskr.15.1278 [PubMed]
- Kunelskaya NL, Turovsky AB, Luchsheva YuV, Khamzalieva RB, Izotova GN (2017) Some aspects of treatment of acute rhinitis with local complex drugs. Medicine [Meditsina] 3: 37–43. [in Russian]
- Luzhnikov EA, Suhodolova GN (2013) Pediatric Clinical Toxicology. Phoenix, Rostov-on-Don, 253 pp. [in Russian]
- Mégarbane B, Oberlin M, Alvarez JC, Balen F, Beaune S, Bédry R, Chauvin A, Claudet I, Danel V, Debaty G, Delahaye A, Deye N, Gaulier JM, Grossenbacher F, Hantson P, Jacobs F, Jaffal K, Labadie M, Labat L, Langrand J, Lapostolle F, Le Conte P, Maignan M, Nisse P, Sauder P, Tournoud C, Vodovar D, Voicu S, Claret PG, Cerf C (2020) Management of pharmaceutical and recreational drug poisoning. Annals of Intensive Care 10(1): 157. https://doi.org/10.1186/s13613-020-00762-9 [PubMed] [PMC]

- Ordak M, Zmysłowska A, Bielski M, Rybak D, Tomaszewska M, Wyszomierska K, Kmiec A, Garlicka N, Zalewska M, Zalewski M, Nasierowski T, Muszynska E, Bujalska-Zadrozny M (2021) Pharmacotherapy of patients taking new psychoactive substances: A systematic review and analysis of case reports. Frontiers in Psychiatry 12: 669921. https://doi.org/10.3389/fpsyt.2021.669921 [PubMed] [PMC]
- Petukhova YuS, Karpushkina ES, Batishcheva GA, Zhdanova OA, Lubavskaya SS (2019) Characteristics of exogenous poisoning in children in Voronezh region. Youth Innovative Bulletin [Molodezhnyy Innovatsionnyy Vestnik] (8): 500–502. [in Russian]
- Starkey E, Sammons H (2016) Acute poisonings in a children's emergency department. Archives of Disease in Childhood 101: e1. https://doi.org/10.1136/archdischild-2015-310148.52
- Shukla L, Ghadigaonkar DS (2019) Poisoning with drugs of abuse: Identification and management. Indian Journal of Critical Care Medicine 23(4): S296–S304. https://doi.org/10.5005/jp-journals-10071-23309 [PubMed] [PMC]
- Ulseth ET, Freuchen A, Köpp UMS (2019) Acute poisoning among children and adolescents in southern Norway. Journal of the Norwegian Medical Association 139(13). https://doi.org/10.4045/tidsskr.17.1116 [PubMed]
- Wenzel S, Sagowski C, Laux G, Kehrl W, Metternich FU (2004) Course and therapy of intoxication with imidazoline derivate naphazoline. International Journal of Pediatric Otorhinolaryngology 68(7): 979–983. https://doi.org/10.1016/j.ijporl.2004.02.011 [PubMed]
- Wong GT, Irwin MG (2013) Poisoning with illicit substances: toxicology for the anaesthetist. Anaesthesia 1: 117–124. https://doi.org/10.1111/anae.12053 [PubMed]
- Zhamlikhanov NKh, Fedorov AG (2019a) Clinical features of acute toxicosis caused by nasal vasoconstrictor drugs in children and adolescents. Healthcare of Chuvashia [Zdravookhranenie Chuvashii] 1: 16–21. https://doi.org/10.25589/giduv.2019.66.61.003 [in Russian]
- Zhamlikhanov NKh, Fedorov AG (2019b) Poisoning with psychoactive substances as a form of deviant behavior of schoolchildren of the Chuvash Republic. Practical medicine [Prakticheskaya Meditsina] 17(5): 75–80. https://doi.org/10.32000/2072-1757-2019-5-75-80 [in Russian]

Author contributions

- **Ekaterina S. Karpushkina**, Ph.D. student of the Department of Clinical Pharmacology, e-mail: favi85@mail.ru, **ORCID ID** http://orcid.org/0000-0003-3807-7188. The author conceived the idea of research, analyzed the results, made the conclusions and translated the manuscript in English.

- **Olga A. Zhdanova**, Doctor habil. of Medical Sciences, Associate Professor, Department of Clinical Pharmacology, e-mail: olga.vr9@yandex.ru, **ORCID ID** http://orcid.org/0000-0002-3917-0395. The author defined the idea of research, analyzed the clinical material and the results, and made the conclusions.

- **Galina A. Batishcheva**, Doctor habil. of Medical Sciences, Full Professor, Head of the Department of Clinical Pharmacology, e-mail: bat13@mail.ru, **ORCID ID** http://orcid.org/0000-0003-4771-7466. The author consulted on the research idea, the analysis of the clinical material and conclusions.