Pediatrics and Neonatology (2019) 60, 59–67

Available online at www.sciencedirect.com

ScienceDirect

journal homepage: http://www.pediatr-neonatol.com

Original Article

Clinical spectrum of acute poisoning in children admitted to the pediatric emergency department

Jung Lee [a,b], Nai-Chia Fan [a,b], Tsung-Chieh Yao [b,d], Shao-Hsuan Hsia [b,c], En-Pei Lee [a,b,c], Jing-Long Huang [b,d,], Han-Ping Wu [a,b,*]**

[a] *Division of Pediatric General Medicine, Department of Pediatrics, Chang Gung Memorial Hospital at Linko, Kweishan, Taoyuan, Taiwan*
[b] *College of Medicine, Chang Gung University, Taoyuan, Taiwan*
[c] *Division of Pediatric Critical Care Medicine, Department of Pediatrics, Chang Gung Memorial Hospital at Linko, Kweishan, Taoyuan, Taiwan*
[d] *Division of Pediatric Allergy, Asthma, and Rheumatology, Department of Pediatrics, Chang Gung Memorial Hospital at Linko, Kweishan, Taoyuan, Taiwan*

Received May 11, 2017; received in revised form Oct 20, 2017; accepted Apr 9, 2018
Available online 19 April 2018

Key Words
children;
emergency department;
intentional;
poisoning;
toxicology

Abstract *Background:* Pediatric poisoning is a common emergency worldwide. Routine surveillance is required for public health authorities and physicians to update strategies for prevention and management of pediatric poisoning. This study investigated the epidemiology of poisoning among children admitted to an emergency department (ED).
Methods: This was a retrospective descriptive study. Data were collected from patients under 18 years old (y/o) presenting with poisoning at the largest ED in North Taiwan from 2011 to 2015.
Results: Five-year records of 590 patients—309 (52.3%) boys and 281 (47.7%) girls—were analyzed. The mean age was 5.07 y/o (Standard Deviation [SD] = 5.02 years), and 94.7% of events occurred at home. Incidence was highest from 6 p.m. to 12 a.m. (42.2%, n = 249). Most patients younger than 11 y/o were male, but this gender distribution was reversed in adolescents (11–17 y/o). Pharmaceutical ingestion (41.4%, n = 244) was the leading cause of poisoning; pesticide was the most common non-pharmaceutical poison ingested (9.5%, n = 55). Carbon monoxide (CO) intoxication (87.6%, n = 99) and snakebite (75%, n = 9) were

Abbreviations: ED, Emergency department; ICU, Intensive care unit; SD, Standard deviation.

* Corresponding author. Division of Pediatric General Medicine, Department of Pediatrics, Chang Gung Memorial Hospital at Linko, No. 5, Fu-Hsin Street, Kweishan, Taoyuan, Taiwan. Fax: +886 3 3288957.
** Corresponding author. Division of Pediatric Allery, Asthma, and Rheumatology, Department of Pediatrics, Chang Gung Memorial Hospital at Linko, No. 5, Fu-Hsin Street, Kweishan, Taoyuan, Taiwan. Fax: +886 3 3288957.
E-mail addresses: hjlong0182@gmail.com (J.-L. Huang), arthur1226@gmail.com (H.-P. Wu).

https://doi.org/10.1016/j.pedneo.2018.04.001

the common causes of inhalation (n = 113) and venom (n = 12) poisoning, respectively. The mean duration of the ED stay was 5.45 h (SD = 7.39 h), and 101 cases (17.2%), including 21 cases (3.6%) requiring intensive care, were admitted to the hospital. All patients survived.
Conclusion: Most poisonings occurred in young children, at home, by unintentional ingestion of a single substance, from 6 p.m. to 12 a.m. Female adolescents were the common intentional poisoning patients and pharmaceutical ingestion was the leading cause of poisoning. This kind of information enables ED physicians to improve preparations for pediatric poisoning cases and allows public health authorities to sharpen the focus of poisoning prevention efforts.

1. Introduction

Pediatric poisoning is a common emergency worldwide, occurring when substances are ingested, inhaled, injected, or absorbed through skin contact in quantities that are harmful to the body.[1–3] When evaluating patients, it is useful to have information on common poisoning substances, common aspects of patient history, and the progress and effects of the poison in the body.[4] Decontamination, enhanced elimination, antidotes, and supportive care are commonly used to manage poisoning cases.[5]

In most pediatric poisonings, the substances are non- or minimally toxic, but occasionally some are severely toxic, requiring immediate and specific medical intervention to prevent severe harm or death.[2] The emergency department (ED) physician must be familiar with the management of poisoning and be prepared for the common causes of pediatric poisoning according to the most recent available information.

Even in the same area, the etiology and demographics of pediatric poisoning may change over time; therefore, it is always a challenge for ED physicians.[1,4,6,7] Regular surveillance is required to recognize trends in specific agents and other variables related to childhood poisoning; this also helps create prevention strategies and helps ED physicians effectively identify and manage poisoning according to age and time.[6,8]

This study investigated and updated the characteristics of children admitted to an emergency center with poisoning. Specifically, the primary objectives were to describe the frequency of poisoning as a cause of ED admission, the demographic profile of affected children, and the specific agents involved in poisoning among children younger than 18 years old.

2. Methods

2.1. Patient population

This retrospective descriptive study utilizing chart review was conducted at Chang Gung Hospital in Taiwan from 2011 to 2015. The data were collected from hospital's electronic medical records. Children younger than 18 years old (y/o) admitted to the pediatric emergency department (ED) for poisoning were included. Children whose poisoning was due to foreign body ingestion (coins, plastics, or toys), food over-ingestion, or vaccination were not included in this study. All medical records were reviewed, and patients with incomplete records were excluded. The Institutional Review Board of the Chang Gung Memorial Hospital approved the study (IRB NO: 201600319B0).

2.2. Methods

Patient characteristics were obtained from electronic medical records, and all data were identified and abstracted by ED physicians. Information obtained for analysis included patient demographics, substance involved in poisoning, vital signs (body temperature (BT), heart rate (HR), respiratory rate (RR), blood pressure (BP)), clinical presentation, place of poison exposure, and route of exposure. HR, RR, and BP were assessed according to the table of vital signs in children by age from the Pediatric Advanced Life Support Provider Manual Book, 2015, American heart Association.[9] History of poisoning, intentionality of poison exposure, medical intervention and outcome of the poisoning, and duration of ED observation or hospitalization were also included. The duration of major symptoms, as evaluated by physicians, comprised the period from onset to subsidence of symptoms. Children who presented with very unstable vital signs (i.e., respiratory failure, severe hypovolemia, persistent unconsciousness) were admitted to the pediatric intensive care unit (PICU).

2.3. Statistical methods

Our specific data analysis depended on the types of information obtained and included descriptive statistics for most variables (i.e. demographics). 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 *t*-tests (for continuous variables) and 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.

3. Results

3.1. Demographics

We retrieved 5-year records for 605 patients younger than 18 years old admitted to the ED of Chang Gung Hospital in Taiwan between 2011 and 2015 due to poisoning. The poisoned children represented 0.27% (605/221,008) of pediatric ED visits during the study period. Due to missing documentation, 15 patients were excluded. The study population included 309 males (52.4%) and 281 females (47.6%) (Table 1). In all, 35 intensive (5.9%) and 555 non-intensive (94.1%) exposures were recorded. Home was a common site of poisoning (n = 559, 94.7%). Ninety-nine children (16.7%) were sent to the ED by ambulance, whereas 83.3% arrived by other transport. The mean age of the victims was 5.07 y/o (SD = 5.02 y/o), and the most common ages for poisoning were 1 and 2 y/o (43.2%, n = 254). Among children younger than 11 y/o, males (53.3%) were predominant, but this gender distribution was reversed in older children, with 53.1% of reported exposures in children over 11 y/o found in female patients. Children younger than 5 y/o were involved in 71.2% of unintentional exposures.

3.2. Time distribution and duration

Based on a total of 221,008 visits over 5 years, the proportion of ED visits due to pediatric poisoning ranged from 0.25% to 0.3% annually. The average weekday-visiting rate was 14.74%, which was higher than 13.15% at weekends. The most common time of day for visits was 6 p.m.–12 p.m. (42.2%, n = 249). Fewer visits occurred in summer (20%, n = 118), which was associated with decreased inhalation poisoning (carbon monoxide (CO)) (Fig. 1A). Of all cases presenting at the ED, 404 patients (68.4%) of our cases were brought to the ED within 4 h of poisoning, including 15.1% (n = 89) who arrived within 1 h of poisoning, 15.1% (n = 89) who arrived in the second hour and 38.3% (n = 226) who arrived in the subsequent 2 h. A total of 119 patients (20.2%) arrived at the ED later than 4 h of poisoning and there was no documentation of timing for 67 cases (11.4%).

3.3. Route of poisoning and agents involved

Causative substances and routes of poisoning are listed in Table 2. Ingestion was the most common route, observed in 463 cases (78.5%); this was followed by inhalation (19.2%, n = 113), venom (2%, n = 12), and contact (0.2%, n = 2). Pharmaceuticals (41.4%, n = 244) were the leading cause of poisoning by ingestion; pesticide was the most common cause of non-pharmaceutical ingestion poisoning (9.5%, n = 55).

The number of drugs ingested was recorded in 230 ingestion cases: 44 (19.1%) patients had ingested more than one drug (range: 2–9). Among them, the age group of 11–17 years old ($p = 0.01$), intentional ingestion ($p < 0.05$), and admission to hospital rate ($p < 0.05$) were associated with multi-drug ingestion (Table 3).

Among 186 patients poisoned by ingestion of one pharmaceutical, drugs act on neurological system were the

Table 1 Demographic data of children with poisoning.

	n	%
Gender		
Male	309	52.3
Female	281	47.6
Age (y/o)		
≤5 y/o	420	71.2
<1 y/o	17	
1 y/o	110	
2 y/o	144	
3 y/o	86	
4 y/o	43	
5 y/o	20	
6–11 y/o	74	12.5
12–17 y/o	96	16.3
Site of poisoning		
At home	559	94.7
Away from home	27	4.6
Poor documented	4	0.7
Transportation by Ambulance		
Yes	99	16.8
No	491	83.2
Route of poisoning		
Ingestion	463	78.5
Inhalation	113	19.2
Venom	12	2
Contact	2	0.2
Intentional		
Yes	35	5.9
No	555	94.1
Time elapse to ED (Hours)		
<1	89	15.1
≤2	89	15.1
≤3	65	11
≤4	161	27.3
>4	119	20.2
Unknown	67	11.4
Season		
Spring (March–May)	165	28.0
Summer (June–August)	118	20.0
Autumn (September–November)	153	25.9
Winter (December–February)	154	26.1
Time of report		
6 a.m. to 12 p.m.	91	15.4
12 a.m. to 6 p.m.	155	26.3
6 p.m. to 12 a.m.	249	42.2
12 a.m.–6 a.m.	95	16.1
Disposition		
Home	476	80.6
Ward	80	13.6
PICU	21	3.6
Escape	13	2.2
Total	590	100
	Mean ± SD	
Age (Years old)	5.07 ± 5.02	
ED stay (Hours)	5.45 ± 7.39	

ED: Emergency department; PICU: Pediatric Intensive care unit; SD: Standard deviation.

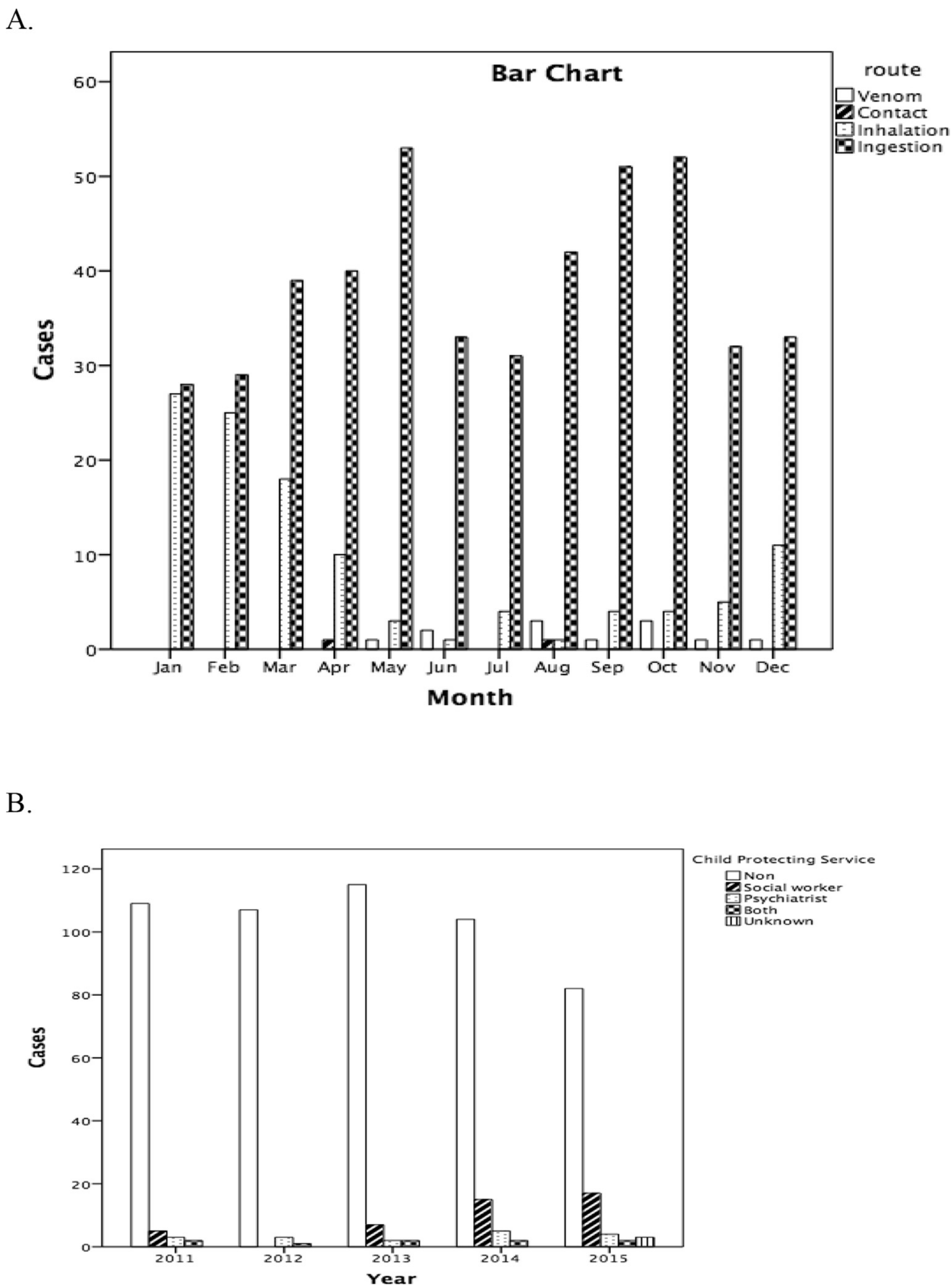

Figure 1 Monthly distribution of poisoning in children (A); the trend of Children's Protection Service from 2011 to 2015 (B).

dominant agents (29.6%, n = 55), including hypnotics (n = 40), anti-psychotics (n = 9), anti-depressants (n = 2), anti-convulsants (n = 2), anticholinergic (n = 1), and narcotics (n = 1). Of hypnotics, benzodiazepines (n = 25) were most common, followed by zolpidem (n = 10), unknown sleeping pills (n = 4), and chloral hydrate (n = 1).

Analgesics (16.1%, n = 30) were the next most commonly ingested drugs (NSAID [n = 15], acetaminophen [n = 8], combinations [n = 5], and local analgesics [n = 2]), followed by cardiovascular drugs (11.8%, n = 22) (anti-hypertensives [n = 20], anti-arrhythmics [n = 2]), antihistamines (8.1%, n = 15), cold/cough preparations (5.9%, n = 11), montelucasts (5.9%, n = 11), electrolytes/minerals (3.8%, n = 7), bronchodilators (2.7%, n = 5), gastrointestinal preparations (2.7%, n = 5), anti-diabetics (2.1%, n = 4), hormone/hormone antagonists (2.1%, n = 4), antibiotics (1.6%, n = 3), muscle relaxants (1.6%, n = 3), anticoagulants (1.1%, n = 2), ant-gouts (1.1%, n = 2), dietary supplements/herbals (1.1%, n = 2), street drugs (1.1%, n = 2), acetylcysteine (0.5%, n = 1), anti-dyslipidemias (0.5%, n = 1), and oxytocics (0.5%, n = 1).

Benzodiazepines in drugs act on the neurological system (13.4%, n = 25), anti-hypertensives (11.3%, n = 21) in cardiovascular medications, NSAIDs (8.1%, n = 15) in analgesics, and antihistamines (8.1%, n = 15) were more commonly ingested alone.

Table 2 Substance and route for poisoning.

Substances	Route	Frequency	Percent
Drugs	Ingestion	244	41.4
Single drug	*Ingestion*	*186 (76.2%)*	
Multiple drugs		*44 (18%)*	
Single drug and detergent		*1 (0.4%)*	
Unknown drug numbers		*13 (5.3%)*	
Gases	Inhalation	113	19.2
Pesticides	Ingestion (1 eye contact)	56	9.5
Cleaning substances	Ingestion	45	7.6
Desiccants	Ingestion	33	5.6
Personal care products	Ingestion	21	3.6
Topicals	Ingestion	15	2.5
Venoms	Bite or sting	12	2
Hydrocarbons	Ingestion	10	1.7
Alcohols	Ingestion	9	1.5
Office supplies	Ingestion	8	1.4
Metals	Ingestion	6	1
Deodorizers	Ingestion	5	0.8
Plants	Ingestion (1 skin contact)	4	0.7
Unknown substances	Ingestion	4	0.7
Healthy foods or vitamins	Ingestion	3	0.5
Chemicals	Ingestion	2	0.3
Total		590	100

Inhalation was the route of exposure in 113 (19.2%) cases. The most common cause was CO (87.6%, n = 99), followed by the vapor of bleach/cleaners (4.4%, n = 5), chlorides (3.5%, n = 4), and one case (0.9%) each for alkaline substances, mercury, pesticides, hydrocarbons, and "unknown". Hyperbaric oxygen therapy was the treatment for 37 (32.7%) of CO poisoning cases; 16 (16.1%) additionally required hospitalization, including 3 (3%) PICU stays.

Among 12 cases of venom poisoning, 9 (75%) were due to snakebite; the remaining three (25%) were stung or bitten by bees, insects, or unknown animals. Four (41.7%) patients were hospitalized, and one (8.3%) required a PICU stay.

3.4. Intentional poisoning

There were 35 cases of intentional exposure in this study. Patients' mean age was 15.63 y/o (SD = 1.3 y/o). All were 11–17 years old, and 20 (57.1%) were female. The causes of intentional poisoning were: pharmaceutical (n = 26, 74.3%), gas (n = 3, 8.6%), pesticide (n = 2, 5.7%), unknown

Table 3 Single vs. Multiple drugs ingestion (Total N = 230).

	Single (N = 186)	Multiple (N = 44)	Total (N = 230)	*P* value
	No. (%)	No. (%)	No. (%)	
Gender				
Male	99 (53.2)	16 (36.4)	115 (50)	
Female	87 (46.8)	28 (63.6)	115 (50)	0.06
Age group				
≤5 y/o	158 (84.9)	29 (65.9)	187 (81.3)	
6–11 y/o	8 (4.3)	3 (6.8)	11 (4.8)	
12–17 y/0	20 (10.8)	12 (27.3)	32 (13.9)	0.01
Intentional				
Yes	13 (7)	12 (27.3)	25 (10.9)	
No	173 (93)	32 (72.7)	205 (89.1)	<0.05
Disposition				
Home	160 (86)	25 (56.8)	185 (80.4)	
Ward	18 (9.6)	11 (25)	29 (12.6)	
PICU	4 (2.2)	8 (18.2)	12 (5.2)	
Escape	4 (2.2)	0 (0)	4 (1.8)	<0.05

Table 4 Initial presentation to ED.

		Home (n = 476)	Ward (n = 80)	PICU (n = 21)	Escape (n = 23)	Total (n = 590)	*P* value
Body Temperature (°C)							
$35 \leq BT \leq 38$		473	77	15	13	578	
$BT > 38$		3	2	5	0	10	
$BT < 35$		0	1	1	0	2	<0.05*
Respiration Rate[a]							
Normal		403	65	14	11	493	
Tachypnea		23	10	5	0	38	
Hypopnea		50	5	2	2	59	0.003*
Heart Rate[a]							
Normal		328	42	9	11	390	
Tachycardia		132	33	10	2	177	
Bradycardia		16	5	2	0	23	0.013*
Blood Pressure							
Normal		137	26	5	3	171	
Hypertension[b]		129	30	9	3	171	
Hypotension[a]		3	1	1	0	5	
Missing		207	23	6	7	243	0.119
Glasgow Coma Scale (GCS)							
GCS = 15		456	75	8	12	551	
GCS < 15		20	5	13	1	39	<0.05*
O2 Saturation (OSAT) (%)							
OSAT ≥94		455	79	20	13	567	
OSAT <94		19	1	1	0	21	
Missing		2	0	0	0	2	0.55
TTAS level*	1	14	2	10	0	26	
	2	151	45	8	10	214	
	3	264	26	3	2	295	
	4	42	7	0	0	49	
	5	5	0	0	1	6	<0.05*
Total						590	

*TTAS: Triage: Taiwan Triage and Acuity Scale.
[a] Pediatric Advanced Life Support (PALS) Provider Manual Book, 2015, American heart Association.
[b] Pediatric hypertension by age. Reference from: National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. Pediatrics 2004; 114; 555-576.

substances (n = 2, 5.7%), alcohol (n = 1, 2.9%), and topical preparation (n = 1, 2.9%).

3.5. Initial symptoms

Upon presentation at the ED, 285 (48.3%) patients were asymptomatic (Table 4). Among symptomatic patients, neurological symptoms (26.9%, n = 159) were most common, followed by gastrointestinal symptoms (12%, n = 71), multi-system symptoms (7.1%, n = 42), respiratory symptoms (1.9%, n = 11), pain (1.7%, n = 10), "other" (1.2%, n = 7), cardiovascular symptoms (0.5%, n = 3), and shock (0.3%, n = 2). Initial vital signs and coma scales were obtained for the Taiwan Triage and Acuity Scale (TTAS) triage level. Two (0.3%) cases had hypothermia ($BT < 35$ °C), and 10 (1.7%) had fever ($BT > 38$ °C). In all, 38 (6.4%) children had tachypnea and 59 (10%) had hypopnea, while 177 (9%) cases had tachycardia and 23 (3.9%) had bradycardia at presentation. BP was taken for 347 patients; 5 (1.4%) had hypotension and 171 (49.3%) had hypertension with a blood pressure level over the 95th percentile by gender for age and height.[9,10]

Hypoxia (oxygen level < 94% by pulse oximeter) was detected in 21 (3.6%) cases. Thirty-nine patients (6.6%) presented with a Glasgow Coma Scale (GCS) score < 15, and 86.3% (n = 509) of cases were given an initial TTAS level of 2 or 3. Severe TTAS triage level due to abnormal body temperature ($p < 0.05$), respiratory rate ($p < 0.03$), heart rate ($p < 0.013$), and lower GCS ($p < 0.05$) were associated with a higher admission rate in children with poisoning ($p < 0.05$).

3.6. Toxicology and psychosocial consultation

When facing poisoning in children, 25.9% (n = 153) of physicians documented a consultation. Toxicology centers (20.8%, n = 123) and the Internet (5.1%, n = 30) were resources for consultation. Seventy children were required to receive a psychosocial evaluation by child protective services, including 17 (7.5%) with a child psychiatrist, 44 (7.5%) with a social worker, and 9 (1.5%) with both. In this study, the proportion of cases requiring child protective services increased from 7.9% in 2011 to 36.1% in 2015 (Fig. 1 B).

3.7. Management, disposition, and outcome

In most cases, treatment was non-specific, including general decontamination and symptomatic treatment. Gastric lavage was performed in 41 (6.9%) children, and active charcoal was given to 32 (5.4%) patients who had ingested poison. The mean duration of ED stay was 5.45 h (SD = 7.39 h). Most patients were then discharged, but 101 (17.2%) of patients required a hospital stay, including 21 (3.6%) who were admitted to the PICU. The hospital admission rate increased with age, from 15.2% among patients 0–5 years old to 26.0% among patients 11–17 years old, and the PICU admission rate was higher among patients 11–17 years old. The mean duration of hospital stay was 1.02 days (SD = 3.2 days).

Hydrocarbons (70%), chemicals (50%), and venom (50%) were sources of poisoning that commonly resulted in hospital admission. Hydrocarbons (10%), venom (8.3%), and pharmaceuticals (5.7%) commonly resulted in PICU admission. All included children survived after treatment. Two children with alkaline ingestion developed esophageal stricture. Encephalopathy was observed in one patient with methadone intoxication and another with amphetamine intoxication. One patient with CO intoxication had seizures after discharge.

4. Discussion

The pediatric poisoning-related ED visit rate was 0.27%, which was consistent with rates from other studies (0.14–7.6%).[11–16] This suggests that pediatric poisoning accounts for a small but important percentage of ED visits.

Most cases of poisoning happened at home, and males had a higher overall risk for poisoning.[2–4,8,15,17–19] Children younger than 5 y/o, especially children of 1 or 2 y/o, accounted for more cases than other age groups.[1,4,13,17,20,21] Male patients predominated among younger victims, but the gender distribution was reversed in adolescents, and the majority of intentional poisonings involved female adolescents.[2,6,15]

Among the seasons, some studies have found peaks of pediatric poisoning in summer or winter.[7,8,14,22] Our study found a lower rate in summer, which was associated with overall increased CO intoxication in the winter. Similarly, the most common time for poisoning to occur has been reported to be 8 a.m.–6 p.m. or 6 p.m.–12 a.m.[7,17] We found that most poisonings occurred from 6 p.m. to 12 a.m., which is consistent with the late time that many children return home. Physicians must be more aware of pediatric poisoning, especially that related to CO intoxication and ED visits in the late evening in cold seasons.

Pharmaceutical ingestion was the leading cause of poisoning in children, which is similar to the results of previous reports in Taiwan and other high-income countries.[3,8,17,19] Neurological medications, especially benzodiazepines, kept in an unprotected environment at home, were the most common cause of pediatric poisoning.[4,8,15,17,19,20,23,24]

In Taiwan, poisoning caused by multiple drugs rose from 5.6% to 17.6% of cases during the study period, which was lower than a previous report of 38.9%.[8,17] The increased rate of multi-drug ingestion might be related to the easy accessibility of prescription drugs in the study area.[6,25]

Intentional pharmaceutical ingestion was the most common cause of poisoning among adolescents; in the literature, the proportion has been reported to be 0.4–10.3% internationally and 10.3–22.3% in Taiwan.[13,17,20,26,27]

We found that intentional ingestion among adolescents tended to be linked to multi-pharmaceutical ingestion and a high hospital admission rate. The predominance of intentional poisoning using multiple pharmaceuticals among adolescents should be taken seriously by public health authorities and ED physicians when designing policies regarding pharmaceutical availability and poisoning management.

Pesticides, the most common agent of non-pharmaceutical ingestion poisoning in our study, are also a major problem in Taiwan and other Asia–Pacific regions.[6,28] Despite government campaigns to minimize the use of pesticides, they are still widely used in Taiwan.[24,29] A higher rate of pesticide poisoning was observed in the pediatric group compared with the report of poisoning among the general population of Taiwan, which found an annual incidence of 2.7–3.2 per 100,000 individuals for acute pesticide poisoning.[24,30] The easy-access packaging and colorful appearance of home pesticides increase their danger to young children.[8] Public health authorities should impose stricter regulations on the packaging of pesticides to prevent ingestion.

Household supplies including cleaning substances, desiccants, personal care products, and topical agents were also common sources of poisoning at home. Among them, caustic agents are the most dangerous because ingestion of minimal caustic substances can cause severe esophageal burns.[2] Caregivers should be responsible when selecting, storing, and informing children about the dangers of household supplies.

Poisoning by gas inhalation was the second most common cause in the present study, and CO intoxication accounted for most of these cases. CO poisoning is one of the most common causes of morbidity and mortality throughout the world, and the restricted residential space available in this small and densely populated island increases the risk of CO intoxication in the cold season.[8] Venom-injected by bite or sting—was the third-most common poisoning route; the tropical weather of this area explains the high rate of snakebites.

Identifying intentional poisoning is crucial, as this could be an indication of mental health for behavioral problems or child abuse.[1] Physicians treating poisoned patients should always be aware of these possibilities, which require both careful management and psychiatric or behavioral support. Unfortunately, researchers have reported that proper prevention education was lacking for patients who visit EDs with intentional poisoning.[1,31] However, our records indicate that the rates of post-exposure counseling for those victims have increased annually.[1] The increased psychosocial support was associated with popular child protection increases in Taiwan and is a good example for the world.

The clinical severity of most cases was mild in this study, with 101 (17.2%) cases admitted to the hospital and only 21 (3.6%) admitted to the PICU. The clinical presentation of poisoning is diverse and nonspecific. In the present study, neurological and gastrointestinal symptoms were common, which was related to the frequency of poisonings from ingesting neurological system pharmaceuticals.[18]

More than half of the cases were asymptomatic, suggesting that the amount ingested was small or nonexistent, or that the substances were non- or minimally toxic. This explains why 476 (80.6%) of the children were rapidly discharged.[15]

There were no exposure-related fatalities, which is noteworthy considering that the average mortality rate of poisoning is 1% in developed countries, 3–5% in developing countries, and that it was previously 5.7% in Taiwan.[20,29] The good prognosis in our pediatric poisoning cases might be attributable to the fact that the majority of poisoning cases involved accidental ingestion of small amounts or minimally toxic substances.[7] Additionally, 68.4% of our cases visited the ED within 4 h after poisoning, and emergency care was conveniently located in the study area.

Unlike pediatric poisonings, the fatality rate of adult poisoning is much higher because most adult poisonings are intentional suicide attempts.[17,24] Education for caregivers, as well as child-resistant packing, have been recommended as effective methods to prevent pediatric poisoning; however, effective strategies to prevent suicide attempts are urgently required to decrease poisoning in adults.[6,24]

4.1. Limitations

The main limitation of the study is that it was a retrospective study and the data could be incomplete. It is possible that some of the medical data were not recorded in the files of patients in a busy ED.

5. Conclusion

Most poisonings occurred in young children, at home, via the unintentional ingestion of a single substance, from 6:00 p.m. to 12:00 a.m. Female adolescents were common intentional poisoning patients, whereas unintentional poisoning was common among young boys. Pharmaceutical ingestion was the leading cause of poisoning. Multi-drug ingestion tended to be intentional, performed by adolescents, and associated with high admission rates. This information enables ED physicians to improve preparations for pediatric poisoning cases and allows public health authorities to sharpen their focus on poisoning prevention efforts.

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

Acknowledgments

We thank for the statistician in Chang-Gung Memorial hospital to complete the statistical analysis. This research grant was supported by CORPG3F0381, Chang-Gung hospital.

References

1. Bacha T, Tilahun B. A cross-sectional study of children with acute poisoning: a three-year retrospective analysis. *World J Emerg Med* 2015;**6**:265–9.
2. Woo JH, Ryoo E. Poisoning in Korean children and adolescents. *Pediatr Gastroenterol Hepatol Nutr* 2013;**16**:233–9.
3. Bond GR, Woodward RW, Ho M. The growing impact of pediatric pharmaceutical poisoning. *J Pediatr* 2012;**160**:265–70.
4. Lin YR, Wu TK, Liu TA, Chou CC, Wu HP. Poison exposure and outcome of children admitted to a pediatric emergency department. *World J Pediatr* 2011;**7**:143–9.
5. Bachur Richard G, Shaw Kathy N, editors. *Fleisher & Ludwig's textbook of pediatric emergency medicine*. 7th ed. Philadelphia: Lippincott Williams and Wilkins; 2015.
6. Lee HL, Lin HJ, Yeh SY, Chi CH, Guo HR. Etiology and outcome of patients presenting for poisoning to the emergency department in Taiwan: a prospective study. *Hum Exp Toxicol* 2008;**27**:373–9.
7. Ram P, Kanchan T, Unnikrishnan B. Pattern of acute poisoning in children below 15 years-a study from Mangalore, South India. *J Forensic Leg Med* 2014;**25**:26–9.
8. Sahin S, Carman KB, Dinleyici EC. Acute poisoning in children; data of a pediatric emergency unit. *Iran J Pediatr* 2011;**21**:479–84.
9. American heart association. In: *Pediatric advanced life support (PALS) provider manual*. Philadelphia: Lippincott Williams and Wilkins; 2015.
10. National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents. The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents. *Pediatrics* 2004;**114**:555–76.
11. Mintegi S, Fernández A, Alustiza J, Canduela V, Mongil I, Caubet I, et al. Emergency visits for childhood poisoning: a 2-year prospective multicenter survey in Spain. *Pediatr Emerg Care* 2006;**22**:334–8.
12. Burillo-Putze G, Munne P, Dueñas A, Pinillos MA, Naveiro JM, Cobo J, et al. National multicentre study of acute intoxication in emergency departments of Spain. *Eur J Emerg Med* 2003;**10**:101–4.
13. Mutlu M, Cansu A, Karakas T, Kalyoncu M, Erduran E. Pattern of pediatric poisoning in the east Karadeniz region between 2002–2006: increased suicide poisoning. *Hum Exp Toxicol* 2010;**29**:131–6.
14. Agarwal G, Bithu KS, Agarwal R. An epidemiological study of acute poisoning in children in a tertiary care hospital of western Rajasthan, India. *Int J Contemp Pediatr* 2016;**3**:1249–51.
15. Lamireau T, Llanas B, Kennedy A, Fayon M, Penouil F, Favarell-Garrigues JC, et al. Epidemiology of poisoning in children: a 7-year survey in a paediatric emergency care unit. *Eur J Emerg Med* 2002;**9**:9–14.
16. Marchi AG, Messi G, Renier S. Epidemiology of children poisoning: comparison between telephone inquiries and emergency room visits. *Vet Hum Toxicol* 1992;**34**:402–4.
17. Yang CC, Wu JF, Ong HC, Kuo YP, Deng JF, Ger J. Children poisoning in Taiwan. *Indian J Pediatr* 1997;**64**:469–83.
18. Keka A, Ramosaj A, Toro H, Azemi M, Baloku A, Sylaj B, et al. Acute poisoning in children; changes over the years, data of pediatric clinic department of toxicology. *J Acute Dis* 2014;**3**:56–8.
19. Ahmed A, AlJamal AN, Mohamed Ibrahim MI, Salameh K, AlYafei K, Zaineh SA, et al. Poisoning emergency visits among children: a 3-year retrospective study in Qatar. *BMC Pediatr* 2015;**15**:104.
20. Ozdogan H, Davutoglu M, Bosnak M, Tutanc M, Haspolat K. Pediatric poisonings in southeast of Turkey: epidemiological and clinical aspects. *Hum Exp Toxicol* 2008;**27**:45–8.

21. Petridou E, Kouri N, Polychronopoulou A, Siafas K, Stoikidou M, Trichopoulos D. Risk factors for childhood poisoning: a case control study in Greece. *Inj Prev* 1996;**2**: 208—11.
22. Ravindras H, Lavlesh K, Kumar SA, Jirlip S. A study of pediatric poisoning cases at district hospital, Belgaum, Karnataka. *Medico Legal Update Int J* 2010;**10**:17—50.
23. Lin YR, Liu TH, Liu TA, Chang YJ, Chou CC, Wu HP. Pharmaceutical poisoning exposure and outcome analysis in children admitted to the pediatric emergency department. *Pediatr Neonatol* 2011;**52**:11—7.
24. Lin LJ, Lin TJ, Shih YL, Tsai JL, Tsai MS. The patients presented in emergency department with poisoning exposure, 1995-2002. *J Taiwan Emerg Med* 2003;**5**:181—9.
25. Chien WC, Lin JD, Lai CH, Chung CH, Hung YC. Trends in poisoning hospitalization and mortality in Taiwan, 1999-2008: a retrospective analysis. *BMC Public Health* 2011;**11**: 703.
26. Abdollahi M, Jalali N, Sabzevari O, Hoseini R, Ghanea T. A retrospective study of poisoning in Tehran. *J Toxicol Clin Toxicol* 1997;**35**:387—93.
27. Pelkonen M, Marttunen M. Child and adolescent suicide: epidemiology, risk factors, and approaches to prevention. *Paediatr Drugs* 2003;**5**:243—65.
28. Jesslin J, Adepu R, Churi S. Assessment of prevalence and mortality incidences due to poisoning in a South Indian tertiary care teaching hospital. *Indian J Pharm Sci* 2010;**72**:587—91.
29. Yang CC, Wu JF, Ong HC, Hung SC, Kuo YP, Sa CH, et al. Taiwan national poison center: epidemiologic data 1985-1993. *J Toxicol Clin Toxicol* 1996;**34**:651—63.
30. Sheu JJ, Wang JD, Wu YK. Determinants of lethality from suicidal pesticide poisoning in metropolitan Hsin-Chu. *Vet Hum Toxicol* 1998;**40**:332—6.
31. Demorest RA, Posner JC, Osterhoudt KC, Henretig FM. Poisoning prevention education during emergency department visits for childhood poisoning. *Pediatr Emerg Care* 2004;**20**:281—4.