Poison exposure and outcome of children admitted to a pediatric emergency department

Yan-Ren Lin, Tung-Kung Wu, Tzu-An Liu, Chu-Chung Chou, Han-Ping Wu

Changhua, Taiwan, China

Background: **This paper reports the characteristics, outcomes and clinical features of children with poisoning treated at an emergency department (ED).**

Methods: **This retrospective study at an emergency department consisted of 140 children with poison exposure who were aged under 18 years. Their characteristics were analyzed in order to understand the differences between accidental and non-accidental poisoning. The poisonous materials were divided into two major categories (pharmaceuticals and non-pharmaceuticals) and their associations with patient outcomes were analyzed. Furthermore, the association was analyzed between the incidence of poison exposure and the season in which the poison exposure occurred.**

Results: **The incidence of poison exposure was highest among adolescents and pre-school age children. Non-accidental poisoning was more common in older girls and accidental poisoning was more common in younger boys ($P<0.001$). Neurological system agents were the most common cause of poisoning in the pharmaceutical group and cleansing products were the most common cause of poisoning in the non-pharmaceutical group. Neurological and gastrointestinal symptoms were the most common clinical presentations for the pharmaceutical and non-pharmaceutical groups, respectively. Furthermore, poisoning due to cleansing products and analgesics were associated with the longest duration of hospitalization. March was the highest risk month for pediatric poisoning ($P=0.018$).**

Conclusions: **Cleansing products and analgesics were associated with the longest duration of hospitalization and intentional poison was more common in girls.**

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Key words: **children;**
cleansing products;
duration of hospitalization;
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Original article

Introduction

Management of pediatric poisoning is dependent on the type of toxin ingested and the clinical presentation of the patient. Clinically, the prognosis and outcome are often difficult to determine initially at the emergency department (ED), especially when the substance is poorly defined or medical history of the patient is unknown.

Epidemiological studies on pediatric poisoning have found that the most common risk factors for poison exposure are young age, female sex, the low education level of patients and family members, and low socioeconomic status.[1-5] There is also a bimodal age distribution of poisoning across children of various ages, with toddlers comprising the majority (mainly accidental poisonings with a male preponderance), and with a second peak during adolescence (with an increase in intentional poisonings, and a female preponderance).[5-12] Moreover, the most common categories of poisons vary from country to country. For example, cleansing products are the most common in France and kerosene is the most common in Nigeria and India.[3,9,11]

However, the association between the duration of hospitalization and category of poisons (pharmaceuticals or non-pharmaceuticals) in children has not been well addressed. In this study, we

Author Affiliations: Department of Emergency Medicine, Changhua Christian Hospital, Changhua, Taiwan, China (Lin YR, Chou CC); Department of Pediatrics, Buddhist Tzu Chi General Hospital, Taichung Branch, Taichung, Taiwan, China (Wu HP); Department of Biological Science and Technology and Institute of Biochemical Engineering, National Chiao Tung University, Hsinchu, Taiwan, China (Lin YR, Wu TK); Institute of Cellular and System Medicine, National Health Research Institutes, Zhunan, Miaoli County, Taiwan, China (Liu TA); Institute of Medicine, Chungshan Medical University, Taichung, Taiwan, China (Chou CC); Institute of Clinical Medicine, National Yang-Ming University, Taipei, Taiwan (Wu HP); Department of Medicine, Tzu Chi University, Hualien, Taiwan, China (Wu HP)

Corresponding Author: Dr. Han-Ping Wu, Department of Pediatrics, Buddhist Tzu Chi General Hospital, Taichung Branch, Taichung, No.66, Sec. 1, Fongsing Rd., Tanzih Township, Taichung County 42743, Taiwan, China (Tel: 886-4-36060666; Fax: 886-4-36021123; Email: arthur1226@gmail.com)

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analyzed patient characteristics, outcomes, and clinical presentations of pediatric poisoning in an ED and the differences in clinical features between pharmaceutical and non-pharmaceutical poisoning among children.

Methods

Patient population

We retrospectively studied 140 children with poison exposure, aged 18 years or younger, who had been treated at the ED of Changhua Christian Hospital, a 2000-bed medical center in central Taiwan, during the period of January 2001 to December 2006. Poison exposure was defined as the ingestion, either accidentally or intentionally, of pharmaceutical or non-pharmaceutical substances at a dose that elicited a toxic response. Children in whom poisoning was due to foreign body ingestion (coins, plastics, or toys), food over ingestion or envenomation were not included in this study. Children treated for poison exposure were required to remain in the pediatric ED for observation or were hospitalized until vital signs stabilized and the major symptoms subsided. The information on patients was obtained and analyzed after approval of the Institutional Review Board of Changhua Christian Hospital.

Methods

Patient characteristics were obtained from medical records and all data were identified and abstracted by ED physicians. The variables included onset date of exposure, age at onset, sex, clinical presentations, category of substances, place of poison exposure, reason for poison exposure (accidental or intentional), treatment, period from poison exposure to arrival at the ED, duration of observation at the ED, and duration of hospitalization. The reason for and the place of poison exposure were self-reported by family members, patients or witnesses. The duration of major symptoms, as evaluated by physicians, comprised the period from the onset of symptoms to subsidence of symptoms.

Patients were divided into four age groups: an infant group (1 month-1 year), a pre-school age group (2-6 years), a school age group (7-12 years), and an adolescent group (13-18 years). The clinical presentations were categorized into seven major groups of constitutional symptoms: (1) asymptomatic (without any uncomfortable symptom or chief complain and there was no specific finding after physical examinations at the ED); (2) gastrointestinal symptoms (nausea, vomiting, diarrhea, constipation, and abdominal pain); (3) neurological symptoms (dizziness, vertigo, convulsion, headache, and consciousness change); (4) respiratory tract symptoms (cough and dyspnea); (5) cardiovascular symptoms (brady/tachycardia, cardiac dysrhythmia, and hypo/hypertension); (6) other symptoms; and (7) multiple symptoms (two or more symptoms).

Substances were classified as pharmaceutical or non-pharmaceutical poisons. The pharmaceuticals were subdivided into six categories based on the pharmacological effects: (1) neurological system agents (anxiolytic/hypnotic agents, antidepressant agents, and antiepileptic drugs); (2) analgesics (acetaminophen and non-steroid anti-inflammatory drugs); (3) respiratory system agents (bronchodilators and dextromethorphan); (4) cardiovascular system agents (antihypertensive drugs and anticoagulants); (5) metabolic and nutrient agents (vitamins and iron); and (6) others. Non-pharmaceutical substances were subdivided into five categories according to use or physical characteristics: (1) cleansing products (bathroom detergents, glass detergents, and bleach); (2) industrial products (desiccating agents, banana oil, and mercury); (3) pesticides (pyrethrum, rat poison, and organophosphate); (4) gaseous agents (carbon monoxide, fuel gas and waste gas); and (5) cosmetics (hair glue and lotion). Across these categories of substances, patient characteristics and the duration of hospitalization were analyzed to identify any differences in associations between the categories of substances, patient characteristics, clinical features, and the duration of hospitalization. Children who presented with very unstable vital signs were admitted to the pediatric intensive care unit (PICU), including respiratory failure, severe hypovolemia and persistent unconsciousness.

The reasons for poison exposure were classified as intentional (suicidal behavior) and accidental (overdose). Associations were analyzed between the causes of poison exposure, age, sex, and category of substances. In addition, the number of poison exposure patients arriving at the ED was related to the month of onset, which could be used to explore the month with the highest risk of poison exposure.

Statistical analysis

The data were analyzed by one-way ANOVA, the Chi-square test, and Student's *t* test. The results of the descriptive statistics (age, sex, clinical presentations, categories of poisons, duration of symptoms, and duration of hospitalization) were defined as numbers, percentages, medians and means ± SD. One-way ANOVA was used to compare the mean age of children across the different age groups for the different categories of pharmaceutical and non-pharmaceutical substances. Differences in clinical features between

pharmaceutical and non-pharmaceutical poisons were analyzed by the Chi-square test and Student's *t* test. Differences in accidental and intentional poison exposure between age, sex and months were analyzed by the Chi-square test. A *P* value less than 0.05 was regarded as statistically significant. All statistical analyses were performed on a personal computer with the statistical package SPSS for Windows (version 15.0, SPSS).

Results

Patient characteristics

This study included 140 children with poison exposure who had been treated at the pediatric ED during the period of January 2001 to December 2006. These children were at the aged or 18 years and younger, with a mean age of 8.97±6.73 years. They were 71 boys (50.7%) and 69 girls (49.3%). The adolescent age group had the greatest representation (41.4%), followed by pre-school age children (35.7%), infants (15.0%), and school age children (7.9%). The most common location of poison exposure was home (85.0%) and the major reason for poison exposure was accidental (61.4%) (Table 1).

Clinical presentations

The most common symptoms were neurological symptoms (34.3%), followed by gastrointestinal symptoms (25%), and no symptoms (18.6%). The most common duration of major symptoms was ≤2 days (73.6 %), followed by 3-6 days and ≥7 days (6.4%). Poisoning was due to non-pharmaceutical substances in the majority of patients (52.1%). In all patients, 61.4% of the poison exposures were accidental and 38.6% were intentional. In the pediatric ED, most of the patients were managed by observation and intravessel fluid supplement only. The median period from poison exposure to arrival at hospital was 2.7 hours. All children except for those hospitalized were observed at the ED and the median duration of ED observation was 6.2 hours (*n*=102). In total, 38 (27.1%) children were hospitalized for severe clinical presentations. Among the 38 children, 8 were admitted to the PICU because of the presence of unstable vital signs. The median duration of hospitalization was 56.3 hours. One child with pesticides intoxication (paraquat) and two children with neurological system agent intoxication (lorazepam and oxazolam abuse) presented with acute respiratory failure in the pediatric ED and were subjected to ventilatory support. In addition, acute renal failure was noted in one child who suffered from pesticides intoxication (organophosphate). After appropriate care, all children were discharged alive (Table 1).

Table 1. Characteristics and clinical presentations of children with poison exposure after treatment

Variables	Poison exposure in children (*N*=140)	
	n	%
Sex		
Male	71	50.7
Female	69	49.3
Age (mean ± SD, y)	9.0±6.7	
Infant	21	15.0
Pre-school age	50	35.7
School age	11	7.9
Adolescents	58	41.4
Clinical presentations		
Asymptomatic	26	18.6
Gastrointestinal symptoms	35	25.0
Neurologic symptoms	48	34.3
Respiratory symptoms	6	4.3
Cardiovascular symptoms	8	5.7
Multiple symptoms	14	10.0
Others	3	2.1
Duration of major symptoms		
≤2 d	103	73.6
3-6 d	28	20.0
≥7 d	9	6.4
Pharmaceutical agents	67	47.9
Non-pharmaceutical agents	73	52.1
Location of poison exposure		
Home	119	85.0
Outside home	21	15.0
Causes of poison exposure		
Accidental	86	61.4
Intentional	54	38.6
Hospitalization	38	27.1
Median period from poison exposure to arrival at hospital (h) (5)*	2.7	
Median duration of ED observation (h) (*n*=102)	6.2	
Median duration of hospitalization (h) (*n*=38)	56.3	

*: Number of patients with missing information.

Categories of poisons and length of hospital stay

Non-pharmaceutical poisons

The proportion of non-pharmaceutical poisoning was 52.1% (41 boys, 56.2%; 32 girls, 43.8%; mean age, 7.78 ±6.68 years). The most common non-pharmaceutical agents were cleansing products (39.7%), followed by pesticides (28.8%), industrial products (16.4%), gaseous agents (11%), and cosmetics (4.1%). The mean age differed significantly between the five categories of non-pharmaceutical poisons. Gaseous agents (11.36±6.68 years) and pesticides (10.11±7.07 years) were the most common causes of poisoning in older children, and cosmetics (2.40±1.12 years) were the most common cause of poisoning in younger children (*P*=0.043). In addition, poison exposure was intentional in 17.8% of children and the median duration of hospitalization in this group was 12 hours. Furthermore, cleansing products were associated with the longest median duration of hospitalization and cosmetics with the shortest hospitalization (Table 2).

Table 2. The outcomes for children who suffered different categories of poisons exposure

Categories of poisons	Poison exposure in children (*N*=140)						
	n (%)	Male/Female *n* (%)	Intentional* *n* (%)	Age† (y/o) (95% CI)	Median duration of hospitalization‡ (h)	Hospital admission *n* (%)	PICU admission *n* (%)
Non-pharmaceuticals (*n*=73)							
Cleansing products	29 (39.7)	17 (23.3)/12 (16.4)	7 (9.6)	6.46±6.65 (3.92-8.98)	16.6	11 (52.4)	1 (16.7)
Industrial products	12 (16.4)	9 (12.3)/3 (4.1)	1 (1.4)	5.86±4.86 (2.77-8.94)	3.5	2 (9.6)	1 (16.7)
Pesticides	21 (28.8)	10 (13.7)/11 (15.1)	3 (4.1)	10.11±7.07 (6.90-13.33)	8.2	4 (19.0)	2 (33.3)
Gaseous agents	8 (11.0)	2 (2.8)/6 (8.2)	2 (2.7)	11.36±6.68 (5.78-16.95)	12.5	4 (19.0)	2 (33.3)
Cosmetics	3 (4.1)	3 (4.1)/0 (0)	0 (0)	2.40±1.12 (-0.4-5.2)	3.0	0	0
Total	73	41 (56.2)/32 (43.8)	13 (17.8)	7.78±6.68 (6.22-9.34)	12.0	21	6
Pharmaceuticals (*n*=67)							
Neurological system agents	35 (52.2)	17 (25.3)/18 (26.9)	19 (28.4)	10.60±6.87 (8.24-12.96)	12.1	9 (52.9)	3 (100)
Analgesics	12 (17.9)	3 (4.6)/9 (13.3)	11 (16.4)	11.60±6.84 (7.26-15.94)	18.5	5 (29.4)	0 (0)
Respiratory system agents	5 (7.5)	4 (6.0)/1 (1.5)	4 (6.0)	5.50±3.44 (1.23-9.78)	6.0	1 (5.9)	0 (0)
Cardiovascular system agents	4 (6.0)	3 (4.5)/1 (1.5)	1 (1.5)	6.95±6.33 (-3.11-17.02)	5.5	0 (0)	0 (0)
Metabolic and nutrient agents	4 (6.0)	2 (3.0)/2 (3.0)	0 (0)	3.40±1.45 (1.09-5.71)	13.1	0 (0)	0 (0)
Others	7 (10.4)	1 (1.4)/6 (9.0)	6 (8.9)	15.41±1.81 (13.75-17.1)	12.0	2 (11.8)	0 (0)
Total	67	30 (44.8)/37 (55.2)	41 (61.2)	10.26±.6.59 (8.65-11.86)	9.2	17	3

*: The cause of poison (accidental *vs.* intentional) differs significantly between the categories of poison in the pharmaceutical group (*P*=0.001); †: The mean age differs significantly between poison categories both in the non-pharmaceutical group (*P*=0.043) and the pharmaceutical group (*P*=0.019); ‡: The duration of hospitalization included the duration of observation in pediatric observation unit as well as hospital admission time.

Pharmaceutical poisons

The proportion of pharmaceutical poisoning was 47.9% (30 boys, 44.8%; 37 girls, 55.2%; mean age, 10.26± 6.59 years). Neurological system agents (52.2%) were the most common pharmaceutical poisons, followed by analgesics (17.9%), respiratory system agents (7.5%), cardiovascular system agents (6%), metabolic and nutrient agents (6%) and others (10.4%). Metabolic and nutrient agents were significantly associated with a younger age (3.40±1.45 years) (*P*=0.019). Intentional poison exposure was the most common cause for poisoning (61.2%). The causes for exposure differed significantly between the six categories of pharmaceutical poisons (*P*=0.001). Furthermore, neurological system agents and analgesics were the two most common pharmaceuticals associated with intentional poison exposure. Overall, analgesics were associated with the longest median duration of hospitalization and cardiovascular system agents were associated with the shortest median duration of hospitalization (Table 2).

Differences between pharmaceutical and non-pharmaceutical poisoning

The clinical presentations differed significantly between pharmaceutical poisoning and non-pharmaceutical poisoning (*P*<0.001). Gastrointestinal symptoms were the most common presentations (42.5%) in patients treated for non-pharmaceutical poisoning and neurological symptoms were the most common presentations (55.2%) in patients treated for pharmaceutical poisoning. The duration of major symptoms differed significantly between the two groups of patients (*P*=0.025). Major symptoms persisted for less than 2 days in both groups, but symptoms persisting for more than 7 days were more common in cases of non-pharmaceutical poisoning (10.9%) than in those of pharmaceutical poisoning (1.5%). There was also a significant difference in the mean age of children between the two groups (*P*=0.029). The mean age of the patients treated for pharmaceutical poisoning was greater than that of those treated for non-pharmaceutical poisoning (10.26±6.60 years *vs.* 7.78±6.68 years). There were no differences in sex (*P*=0.120), location of poison exposure (*P*=0.113), or hospitalization (*P*=0.108) between the patients treated for pharmaceutical poisoning and those treated for non-pharmaceutical poisoning (Table 3).

Accidental poisoning and intentional poisoning

In this study, the causes of poison exposure in children were classified as accidental and intentional. Clinical features were compared between patients with accidental exposure and those with intentional exposure. The comparison revealed that there were significant associations between type of poison, age group, and sex. Furthermore, the incidence of intentional poison exposure increased with age (infant group, 0%; pre-school age group, 12%; school age group, 45.5%; and adolescent group, 74.1%) (*P*<0.001). The majority of intentional poisonings were due to pharmaceutical poisons, whereas the majority of

Table 3. Significant differences between non-pharmaceutical and pharmaceutical related poison exposure

Variables	Non-pharmaceuticals (n=73)		Pharmaceuticals (n=67)		P value
	n	%	n	%	
Clinical presentations*					<0.001
Asymptomatic	15	20.5	11	16.4	
Gastrointestinal	31	42.5	4	6.0	
Neurological	11	15.1	37	55.2	
Respiratory	4	5.5	2	3.0	
Cardiovascular	2	2.7	6	9.0	
Multiple	8	11.0	6	9.0	
Others	2	2.7	1	1.4	
Duration of major symptoms*					0.025
≤2 d	54	74.0	49	73.1	
3-6 d	11	15.1	17	25.4	
≥7 d	8	10.9	1	1.5	
Age groups					0.207
Infant	14	19.2	7	10.4	
Pre-school age	29	39.7	21	31.3	
School age	5	6.8	6	9.0	
Adolescent	25	34.3	33	49.3	
Sex					0.120
Male	41	56.2	30	44.8	
Female	32	43.8	37	55.2	
Location of poison exposure					0.113
Home	59	88.1	60	89.6	
Outside home	14	11.9	7	10.4	
Hospitalization					0.108
Yes	21	28.8	17	25.4	
No	52	71.2	50	74.6	
Mean age*	7.78±6.68		10.26±6.60		0.029

*: Significant difference between non-pharmaceutical and pharmaceutical poison exposure.

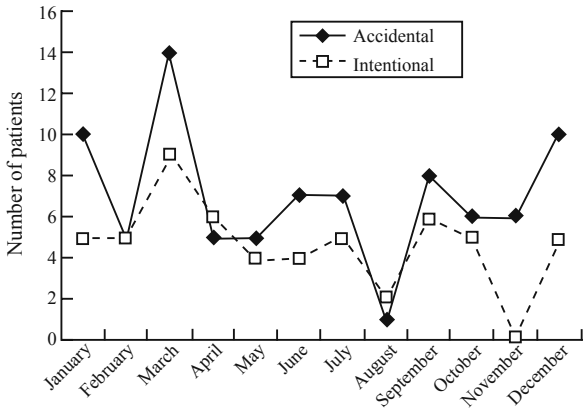

Fig. March was the month of highest risk for both accidental and intentional poison exposures from January 2000 to December 2006 (P=0.018).

accidental poisonings were due to non-pharmaceutical poisons (P<0.001). Male gender was significantly associated with accidental poisoning and female gender was significantly associated with intentional poisoning (P<0.001). Among older children, there was a significant association between female gender and poison exposure (P<0.001).

Distribution of pediatric ED patients by month

During the 6-year study period, there was no obvious year-on-year change in patient numbers (2001: 23 patients; 2002: 24; 2003: 25; 2004: 24; 2005: 19; 2006: 25); however, the incidence of poison exposure differed between different months. We found that the incidence of both accidental and intentional poison exposure was significantly higher in the month of March (P=0.018). The lowest incidence of poison exposure was in the month of August (Fig.).

Discussion

Substances involved in childhood poisoning vary and the treatment of poison exposure can be challenging for physicians when the substance is poorly identified or when the medical history of the patient is unknown. The outcome of poison exposure in children is dependent on whether the poison is pharmaceutical or non-pharmaceutical;[1-4,12-16] however, the clinical features and course, including the duration of major symptoms and the duration of hospitalization between pharmaceutical and non-pharmaceutical poisons in children have not been well addressed. In this study, we analyzed the patient characteristics, outcomes, and clinical features of pediatric poisoning in central Taiwan. Age was found to be a significant factor associated with poison exposure in the pediatric ED. The proportion was highest among pre-school age children (35.7%) and adolescents (41.4%) but the causes of poison exposure (intentional or accidental) differed significantly between the two age groups. The incidence of pediatric poison exposure among adolescents was much higher in this study than those reported in other studies (41.4% *vs.*12%-16%[6,9,10,16]). This finding might indicate the higher prevalence of intentional poison among adolescents and the psychosocial problems in adolescents in Taiwan.

In this study, we found that intentional poisoning was the most common cause of poison exposure in adolescents and that accidental poisoning was the most common cause of poison exposure in pre-school children. Overall, there was an inverse correlation between incidence of accidental poisoning and age, i.e., the incidence of accidental poisoning decreased as the age of children increased. In addition, there was also a significant correlation between the cause of poison exposure, age, and sex. The incidence of intentional poisoning was significantly higher in girls than in boys (girls: 68.5% *vs.* boys: 31.5%) and was

predominant in older girls. The cause of intentional poisoning in girls or in the higher age group varied in this study, but it was associated with attempted suicide. Studies[17-21] found that depressive symptoms and romantic disappointment are more predominant in girls than in boys and this might result in a higher rate of attempted suicide. Moreover, cigarette smoking or alcohol abuse, non-heterosexual attraction and having a friend or family member attempting suicide are also risk factors associated with attempted suicide in older children. According to our findings, suicide or drug overdose related poisoning should be considered as a cause of poison exposure in adolescent girls who present at a pediatric ED, especially when they are unconscious or no medical history is available. In the present study we identified five most common categories of non-pharmaceutical poisoning and six most common categories of pharmaceutical poisoning in Taiwan. We found that cleansing products and pesticides were the most common non-pharmaceutical poisons. Previous studies[6,9,10] showed that cleansing products were the leading causes of poisoning and that pesticides were the least common in children. This discrepancy might be explained by the location where the poisoning took place. The Changhua Christian Hospital is located in an agricultural region, where pesticides are available in many households. Moreover, organophosphate and paraquat are the most common pesticides causing intoxication in this region. Among the pharmaceutical poisons, neurological system agents and analgesics are the two most common substances, as reported by Hincal et al.[8] In our study, anxiolytic and hypnotic drugs (Lorazepam, Zolpidem, and similar drugs) and antidepressant drugs were the most common neurological system agents ingested, while acetaminophen was the most common analgesic or intoxication agent taken.

In our study the clinical presentations of poison exposure differed significantly between non-pharmaceutical and pharmaceutical poisons. Identification of the most common presentations among children may be useful in determining the type of poison involved, especially in very young children or in cases of intentional poisoning. Overall, 18.6% of children in this study were asymptomatic. Nonetheless, gastrointestinal symptoms were the most common presentations in the non-pharmaceutical group (42.5%) and neurological symptoms were the most common in the pharmaceutical group (55.2%). In addition, the mean age was younger in the non-pharmaceutical group than in the pharmaceutical group. Finally, the outcomes of poison exposure differed between the non-pharmaceutical and pharmaceutical groups.

The median duration of hospitalization was longer in the non-pharmaceutical group than in the pharmaceutical group. Furthermore, the longest or shortest duration of hospitalization was associated with cleansing products and cosmetics respectively in the non-pharmaceutical group, while analgesics and cardiovascular system agents were associated with the longest or shortest duration of hospitalization respectively in the pharmaceutical group. In this study, the duration of major symptoms was ≤2 days for most children (73.6%). Cleansing products were associated with the longest duration of hospitalization. Therefore, poisoning due to non-pharmaceutical substances may indicate a longer hospital stay.

To our knowledge, few studies[11] have analyzed the association between the incidence of poison exposure and seasonality of poison exposure. We found that the incidence of intentional and accidental poisoning was significantly higher in the month of March (P=0.018). This result may be associated with the fact that cleansing products can be easily obtained by young children in households during or after the Chinese New Year holidays, which could lead to an increase in the incidence of pediatric poison exposure (almost every family cleans their house during the Chinese New Year holidays in Taiwan). Also holiday stress due to family visits among adolescents is a possibility. Therefore, the month of March should be regarded as a high-risk month for pediatric poison exposure.

There were some limitations in this study. Five children were excluded from the study because on arrival at the hospital the patients were not sure of the timing of poison exposure (the missing information from Table 1). The retrospective nature of this study was another limitation. Hospital admission or non-admission and duration of hospitalization were the major outcomes in this study. However, some important clinical presentations like respiratory or renal failure, which might be quite useful to ED physicians, were not analyzed in this study because of the small sample size with these findings (only three children and one child suffered respiratory and renal failure, respectively) and also because some patients did not have a blood sample taken and therefore lacked laboratory data. Therefore, we hope that this area will be further investigated in the future by a prospective study.

In conclusion, the incidence of poison exposure was highest among adolescents and pre-school age children. Intentional poisoning was more common in older girls and accidental poisoning was more common in younger boys. Neurological system agents and cleansing products were responsible for the majority of cases of poison exposure. Neurological symptoms were the most common clinical presentations in children

in the pharmaceutical group and gastrointestinal symptoms were the most common manifestations in the non-pharmaceutical group. Most importantly, cleansing products and analgesics were associated with the longest duration of hospitalization and intentional poison was more common in girls.

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