Features and Prognostic Factors for Elderly With Acute Poisoning in the Emergency Department

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Background: Elderly persons with acute poisoning in the emergency department (ED) and prognostic factors of outcomes have not been well addressed in previous research. This study aimed to investigate the characteristics of elderly patients with acute poisoning visiting the ED, and to identify the possible predictive factors of mortality.

Methods: Patients aged ≥65 years with acute poisoning who visited the ED in Taipei Veterans General Hospital from January 1, 2006 through to September 30, 2008 were enrolled in the study. We collected demographic information on underlying diseases, initial presentations, causes and toxic substances, complications, dispositions, and outcomes. Analyses were conducted among different groups categorized according to age, suicide attempt, and outcome. Multiple logistic regression was applied to identify possible predictive clinical factors influencing mortality in the elderly with acute poisoning.

Results: A total of 250 patients were enrolled in the study, with a mean age of 77 years and male predominance. The most common cause of intoxication was unintentional poisoning. Medication accounted for 57.6% of poisonous substances, of which benzodiazepine was the most common drug, followed by warfarin. The overall mortality rate was 9.6%. The average length of stay in the ED increased significantly in the old (65–74 years), very old (75–84 years) and extremely old (≥85 years) groups. Suicide attempt patients experienced more complications including respiratory failure, aspiration pneumonia, hypotension and mortality. Three clinical predictive factors of mortality were identified: herbicide poisoning, hypotension and respiratory failure upon presentation.

Conclusion: Our results demonstrated that elderly patients with acute poisoning had a mortality rate of 9.6%. Suicide attempts resulted in more serious complications. The risk factors for mortality were herbicide intoxication, hypotension and respiratory failure. [*J Chin Med Assoc* 2010;73(2):78–87]

Key Words: emergency department, geriatrics, poisoning

Introduction

Poisoning is a major health problem worldwide, and it causes significant mortality and morbidity.[1,2] Acute poisoning is defined as exposure to a poison on 1 occasion or during a short period of time. According to *Dorland's Medical Dictionary*, poisons are substances that can cause disturbances to organisms, usually by chemical reaction or other activity on the molecular scale. Although patients aged over 60 years old comprise the minority in poisoning events, ranging from 2.3% to 5.3%,[3–6] the important consequences of acute poisoning in the elderly should not be neglected. The World Health Organization proclaimed that in 2006, 10% of the population were aged over 60 years worldwide, and the proportion was even up to 20% in high-income regions.[7] More than half of the intoxication events in the elderly over 65 years old were unintentional.[8,9] The characteristics of patients with acute poisoning vary from country to country.[1,2,6,10] A domestic report

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concerning causes and consequences of acute poisoning, especially in the elderly, is crucial for public awareness and for establishing preventive strategies. Although there have been several epidemiological studies of intoxication based on telephone inquiries, there are few reports exploring clinical courses in the elderly with acute poisoning.[8–10] The purpose of this study was to reveal clinical characteristics in elderly patients with acute poisoning in Taiwan and to identify the prognostic factors of mortality in the emergency department (ED).

Methods

The Taiwan National Poison Control Center (PCC) serves a population of 23 million inhabitants and has been in operation 24 hours a day since its opening in July 1985. Taipei Veterans General Hospital, with which the PCC is affiliated, is not only a tertiary teaching medical center but also a referral center for the treatment of any poisoning cases. The toxicology ward in Taipei Veterans General Hospital offers hospitalization services of intoxication management to approximately 450 patients annually.

This retrospective study was conducted based on a computerized information system and medical records, which the authors were authorized to access and to evaluate. The enrolled patients were selected from those who visited the ED, or were admitted to the toxicology ward with relevant International Classification of Disease codes between January 1, 2006 and September 30, 2008. These codes comprised 960–995, which refer to poisoning by drugs, medical and biological substances, as well as toxic effects of substances that are chiefly non-medicinal. They also provide reference to other unspecified adverse drug effects, and those of medicinal and biological substances due to correct administration. Patients poisoned by animal venom were excluded from the study because the event was accidental, and the nature was distinct from the other types of poisoning. Only patients aged ≥ 65 years were included in the study. The identification of toxic substances and the causes of poisoning events were confirmed by combining the following resources: the patients, witnesses, accompanying family members, presence of pills or bottles of poisons, qualitative or quantitative tests of blood or urine, and relevant symptoms or signs from the alleged poisons. The subsequent information of enrolled patients was obtained from the medical records and computerized information system, including age, sex, time of arrival and discharge from ED, initial blood pressure, pulse rate, body temperature, Glasgow Coma Scale score, causes of poisoning, symptoms and signs, disposition in ED, underlying medical and psychiatric diseases, toxic substances or medicines responsible for acute poisoning, length of stay in the intensive care unit (ICU) for those who were admitted to the ICU, length of stay in the hospital, total cost in the ED, complications such as hypotension, acute renal failure, respiratory failure, and outcomes. Outcomes were classified as survival or death. There was no strict criterion for discharge from the ED; however, patients were allowed to leave only if there were no symptoms or signs of intoxication, or predictable delayed effects.

Additionally, the living situation of the patients was recorded, which was defined as single, living alone or in a nursing home. The possible triggering of physical or emotional stress before the poisoning event was documented. Underlying medical or psychiatric diseases, dementia and insomnia were confirmed by specialists in the outpatient department. Heart diseases encompassed any cardiac abnormalities such as chronic or acute arrhythmia, valvular heart disease, coronary artery disease and hypertensive cardiomyopathy. Chronic kidney disease was identified when the glomerular filtration rate was ≤ 60 mL/min/1.73 m^2 for more than 3 months.[11] The total number of medical diseases, excluding psychiatric disease, dementia and insomnia, was calculated. To further understand the influence of age on poisoning consequences, we categorized age into 3 groups: old (65–74 years), very old (75–84 years) and extremely old (≥ 85 years).

Causes of acute poisoning were categorized into 4 groups: (1) suicide—deliberate exposure to substances, including drugs and chemical agents to harm oneself; (2) drug overdose or adverse drug reaction (ADR)—unintentional exposure to overdose of drugs, or unexpected effect of therapeutic range of prescribed medicine; (3) an accidental event not related to drugs, i.e. unintentional exposure to toxic agents not including medicine; and (4) substance addiction, i.e. addiction to alcohol or narcotic agents. Poisonous substances were classified into several groups based on their different properties and toxicities: benzodiazepine, medication other than benzodiazepine, insecticides, herbicides, chemical agents, and others. Insecticides and herbicides (2 different types of pesticide) were categorized in 2 groups because of their different pathogenicities and toxicities. Benzodiazepine was isolated from other medications because it accounted for the major cause of poisoning. Mixed poisoning was also clarified if the patient had been exposed to more than 1 substance. Toxic substances were identified based on the most severe clinical toxidrome of patients with multisubstance

intoxication. It was recorded which patients in the ED had initial hypotension, which was defined as a mean arterial blood pressure of ≤59 mmHg. Acute renal failure was defined as a 3-fold increment of serum creatinine or an acute increase of at least 0.5 mg/dL when the present serum creatinine (i.e. that in the first blood sample taken in the ED) is greater than 4.0 mg/dL.[12] Patients were diagnosed with respiratory failure if an endotracheal tube was placed with mechanical ventilator support, or respiratory acidosis developed but airway assistance was refused by patients or their family. Pneumonia, whether aspirated or ventilator-associated, was diagnosed on the basis of radiographic evidence of infiltration in a characteristic bronchopulmonary segment and/or sputum bacterial culture or stain.[13,14] For those patients who were admitted to the ICU, the Acute Physiology and Chronic Health Evaluation II score was calculated.[15]

SPSS version 15.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. To evaluate data between different groups, the χ^2 and Fisher's exact tests were used for categorical data, and the nonparametric Mann-Whitney U test was applied for continuous data. Differences were considered statistically significant if p was ≤0.05 (2-tailed). The confidence interval (CI) within 95% was established for factors with a p value ≤0.05. We further applied multiple logistic regression in bivariate analysis of clinical factors between survivors and nonsurvivors to investigate predictive factors of mortality analyses.

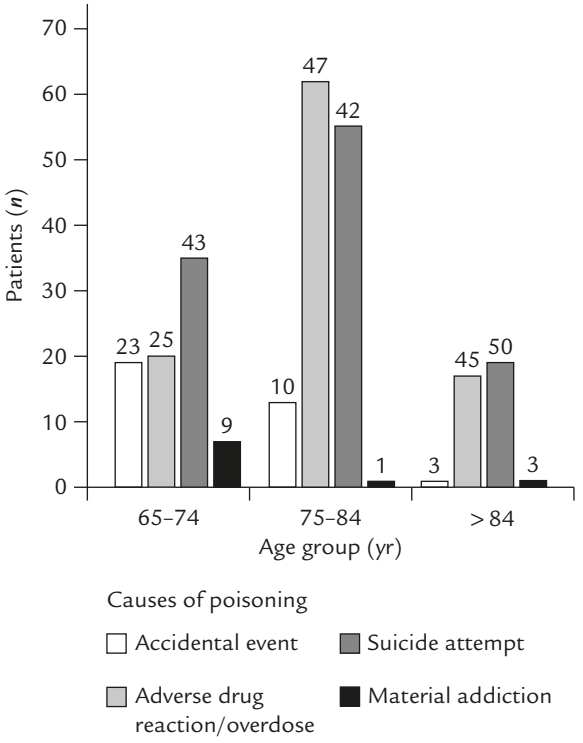

Figure 1. Causes of poisoning in different age groups. The percentage above each column denotes the proportion of the cause in each age group.

Results

Demographic data and clinical characteristics of all study patients

Of 250 patients enrolled among 330,218 patients visiting the ED and 1,252 patients admitted to the toxicology ward during the 33-month study period, there were 173 males (69.2%), with a male-to-female ratio of 2.2. The median age was 82.5 years (range, 65–100 years). Over half of the patients (52.2%) were categorized as very old, 32.4% as old and 15.2% as extremely old. Causes of poisoning in the 3 age groups are shown in Figure 1. The number of medical diseases (p=0.001) and length of stay in the ED (p=0.02) were significantly correlated with increased age. The mean length of stay in the ED was 5.6 hours, 8.5 hours and 10.2 hours in the old, very old and extremely old groups, respectively. Heart diseases (p<0.001), dementia (p=0.01), insomnia (p=0.01) and comorbidity with ≥3 medical diseases (p=0.02) were accompanied more frequently by an increase in age. However, suicide attempts, complications, length of stay in the ICU, total hospitalization days and mortality were not statistically different among the 3 age groups. Table 1 shows the demographic data, underlying diseases, causes of poisoning, categories of poisonous substances, clinical presentations, complications, disposition and mortality. Fifty-six percent of poisoning was unintentional. The details of medication and chemical agents involved in acute poisoning are shown in Table 2. Among 24 herbicide poisoning cases, paraquat accounted for 11 cases, glyphosate-surfactant herbicide accounted for 8 cases, and unspecified herbicides accounted for 5 cases. Among 31 insecticide poisoning cases, 13 cases were poisoned with organophosphate, 8 with pyrethrin, 2 with carbamate, and 8 with unspecified insecticides. Fifteen (6%) patients were poisoned by ≥2 substances, and 10 cases were multiple drug poisonings, 3 were drugs with alcohol and 2 were drugs with chemical substances. Warfarin, the second most frequently used medication, was related to acute poisoning events in 23 patients (9.2%). Eleven chemical substances were involved in poisoning, including 2 cases with cresol, 2 with toluene, 1 with citric acid, 1 with trichloroethylene, 1 with alkaloid solution, 1 with organic solvent,

Table 1. Clinical characteristics in 250 elderly patients with poisoning*

Age (yr)	77.2 ± 7.4
Male/female	173 (69.2)/77 (30.8)
Solitude†	44 (17.6)
Underlying disease	
Hypertension	125 (50.0)
Heart disease	76 (30.4)
CKD	59 (23.6)
Stroke/PD	47 (18.8)
MDD/bipolar disorder	47 (18.8)
OA or DJD of spine	45 (18.0)
DM	44 (17.6)
Insomnia	33 (13.2)
Cancer	30 (12.0)
Lung disease	27 (10.8)
Dementia	16 (6.4)
Cause of poisoning	
Suicide	109 (43.6)
Overdose/ADR	99 (39.6)
Accidental	33 (13.2)
Material addiction‡	9 (3.6)
Poisoning substance	
BZD	83 (33.2)
Drug other than BZD	61 (24.4)
Insecticide	31 (12.4)
Chemical agent§	28 (11.2)
Herbicide	24 (9.6)
Other‖	23 (9.2)
Presentation	
Altered mental status	123 (49.2)
GI tract discomfort	52 (20.8)
Short of breath	24 (9.6)
Skin manifestations	20 (8.0)
Dizziness	18 (7.2)
Cold sweats/chest discomfort	18 (7.2)
General weakness	16 (6.4)
Neurological symptoms	7 (2.8)
Out-of-hospital cardiac arrest	2 (0.8)
MBP < 60 mmHg	16 (16.4)
Acute renal failure	34 (13.6)
Pneumonia	48 (19.2)
Respiratory failure	57 (22.8)
Disposition after ED	
Discharge	85 (34.0)
Ward admission	98 (39.2)
ICU admission	65 (26.0)
Died in ED	2 (0.8)
Mortality	24 (9.6)

**Data presented as mean ± standard deviation or n (%); †single, living alone or in a nursing home; ‡alcoholism in 8 patients and heroin addiction in 1 patient; §includes chemical solutions, camphor, dry powder, carbon monoxide and rodenticide; ‖alcohol addiction in 13 patients, herb-related intoxication in 9 patients and heroin addiction in 1 patient. CKD = chronic kidney disease; PD = Parkinson's disease; MDD = major depressive disorder; OA = osteoarthritis; DJD = degenerative joint disease; DM = diabetes mellitus; ADR = adverse drug reaction; BZD = benzodiazepine; GI = gastrointestinal; MBP = mean arterial blood pressure; ED = emergency department; ICU = intensive care unit.*

Table 2. Classification of poisonous substances*

Total	269 (100)
Benzodiazepine	87 (32.3)
Insecticide	31 (11.5)
Herbicide	24 (8.9)
Warfarin	23 (8.6)
Alcohol	15 (5.6)
Chemical solution	11 (4.1)
Plant/herbs	9 (3.3)
Digoxin	9 (3.3)
Xanthium	8 (3.0)
Carbon monoxide	6 (2.2)
Antipsychotic agent	6 (2.2)
Rodenticide	6 (2.2)
Antihypertensive	4 (1.5)
NSAID	4 (1.5)
Opioid analgesic	4 (1.5)
Camphor	3 (1.1)
Persantin	3 (1.1)
Antidepressant	3 (1.1)
Cholinergic agent	2 (0.7)
Acetaminophen	2 (0.7)
Lithium	2 (0.7)
Dry powder	2 (0.7)
Other†	5 (1.8)

**Data presented as n (%); †1 case each of antihistamine, sigmart, metformin, brown mixture and anticholinergic agent. NSAID = nonsteroidal anti-inflammatory drug.*

1 with vinyl adhesive, 1 with beta-iodine solution and 1 with hydrochloric acid. Nearly 2 thirds of poisoned patients needed inpatient services; furthermore, 40% of them required intensive care. The average length of stay in the ED was 7.7 hours (range, 1–64 hours) for all patients, and was 11.1 hours for those who were discharged from the ED. The average length of hospitalization was 11.6 days (range, 0.1–221 days) for the 163 inpatients (65.2%). The average length of stay in the ICU was 5.4 days (range, 1–37 days) for 65 patients (26%). The overall mortality rate was 9.6%, including 2 patients who died soon after arriving in the ED.

Comparison between patients with suicidal and unintentional poisoning

Comparison of clinical characteristics between suicide attempt-related poisoning and unintentional poisoning are summarized in Table 3. Suicide attempt patients suffered from a more severe clinical course than those with other causes of poisoning, including a lower mean Glasgow Coma Scale score (10 *vs.* 13, $p < 0.001$). Although suicide attempt patients had a shorter mean length of stay in the ED (6.2 hours *vs.* 8.9 hours, $p = 0.007$), they produced a higher ED cost (NT$9,022 *vs.* NT$6,391, $p < 0.001$).

Table 3. Characteristics of 250 elderly patients with poisoning by those who attempted suicide and those who did not*

	Attempted suicide ($n=109$)	Did not attempt suicide ($n=141$)	p
Age (yr)	77.2±7.6	77.2±7.2	NS
Male/female	67/42	106/35	0.02
Male/female ratio	1.6	3	–
Solitude†	12 (11.0)	32 (22.7)	0.02
Underlying disease			
Hypertension	55 (50.5)	70 (49.6)	NS
Heart disease	29 (26.6)	47 (33.3)	NS
CKD	17 (15.6)	42 (29.8)	0.01
Stroke or PD	17 (15.6)	30 (21.3)	NS
OA or DJD of spine	27 (24.8)	18 (12.8)	0.01
MDD/bipolar disorder	35 (32.1)	11 (7.8)	<0.001
DM	19 (17.4)	25 (17.7)	NS
Insomnia	19 (17.4)	15 (10.6)	NS
Cancer	13 (11.9)	17 (12.1)	NS
Dementia	3 (2.8)	13 (9.2)	0.04
Emotional/physical stress	56 (51.4)	10 (7.1)	<0.001
≥3 comorbidities‡	39 (35.8)	43 (30.5)	NS
Poisoning substance			
BZD	38 (34.9)	45 (31.9)	–
Drug other than BZD	8 (7.3)	53 (37.6)	–
Insecticide	26 (23.9)	5 (3.5)	–
Herbicide	21 (19.3)	3 (2.1)	<0.001
Chemical agent§	16 (14.7)	12 (8.5)	–
Other‖	0	23 (16.3)	–
Acute renal failure	17 (15.6)	17 (12.1)	NS
Respiratory failure	45 (41.3)	12 (8.5)	<0.001
Aspiration pneumonia	31 (28.4)	17 (12.1)	0.001
MBP<60 mmHg	13 (11.9)	3 (2.1)	0.002
Disposition after ED			
Ward admission	93 (85.3)	71 (50.4)	<0.001
ICU admission	47 (43.1)	19 (13.5)	<0.001
Died in ED	2 (1.9)	0	NS
Mortality	19 (17.4)	5 (3.5)	0.001

**Data presented as mean±standard deviation or n or n (%); †single, living alone or in a nursing home; ‡≥3 of the underlying diseases listed above; §includes chemical solutions, camphor, dry powder, carbon monoxide and rodenticide; ‖alcohol addiction in 13 patients, herb-related intoxication in 9 patients and heroin addiction in 1 patient. CKD=chronic kidney disease; PD=Parkinson's disease; OA=osteoarthritis; DJD=degenerative joint disease; MDD=major depressive disorder; DM=diabetes mellitus; BZD=benzodiazepine; MBP=mean arterial blood pressure; ED=emergency department; ICU=intensive care unit; NS=not significant.*

Comparison of clinical characteristics between survivals and mortalities

The comparison of clinical characteristics between survivors and nonsurvivors is shown in Table 4. Among 24 nonsurvivors, 19 (79%) patients committed suicide ($p<0.001$). Herbicide was the main toxic substance in half of the mortality cases ($p<0.001$), followed by chemical agents in 4 (2 cresol, 1 detergent, 1 hydrochloric acid), benzodiazepine in 3, insecticide in 3 and medications other than benzodiazepine in 2. Among the 12 patients who died of herbicide intoxication, 8 of them had taken paraquat, 1 had taken glyphosate-surfactant herbicide and 3 had used unspecified substances. Three patients poisoned by benzodiazepine died of aspiration pneumonia. One patient who had warfarin and 1 who had taken a narcotic agent died of an underlying terminal stage of cancer. One insecticide patient and 1 herbicide poisoning patient presented with out-of-hospital cardiac arrest. They were successfully resuscitated with restoration of spontaneous circulation in the ED, but both died approximately 2.5 hours later. Fifteen (62.5%) of the 24 mortality

Table 4. Characteristics of 250 elderly patients with poisoning by those who survived and those who did not*

	Survivors ($n=226$)	Nonsurvivors ($n=24$)	p
Age (yr)	77.1 ± 7.5	78.3 ± 6.4	NS
Male	157 (69.5)	16 (66.7)	NS
Underlying disease			
Hypertension	114 (50.4)	11 (45.8)	NS
Heart disease	70 (31.0)	6 (25.0)	NS
CKD	51 (22.6)	8 (33.3)	NS
Stroke/PD	46 (20.4)	1 (4.0)	0.056
OA or DJD of spine	43 (18.9)	2 (8.7)	NS
MDD/bipolar disorder	38 (16.8)	8 (33.3)	0.056
DM	44 (19.5)	0	0.01
Cancer	26 (11.6)	4 (16.0)	NS
Reason for poisoning			
Suicide	90 (39.8)	19 (79.2)	< 0.001
Medication overdose/ADR	95 (42.0)	4 (16.7)	–
Accidental	32 (14.2)	1 (4.2)	–
Material addiction	9 (4.0)	0	–
Poisoning substance			
BZD	80 (35.4)	3 (12.5)	–
Drug other than BZD	59 (26.1)	2 (8.3)	–
Insecticide	28 (12.4)	3 (12.5)	–
Herbicide	12 (5.3)	12 (50.0)	< 0.001
Chemical agent†	24 (10.6)	4 (16.7)	–
Other‡	23 (10.2)	0	–
Acute renal failure	23 (10.2)	11 (45.8)	< 0.001
Pneumonia	39 (17.3)	9 (37.5)	0.03
Respiratory failure	39 (17.3)	18 (75.0)	< 0.001
MBP < 60 mmHg	8 (3.5)	8 (33.3)	< 0.001
Presenting symptoms			
AMS	106 (46.9)	17 (70.8)	0.026
Shortness of breath	14 (6.2)	10 (41.7)	< 0.001
Cold sweats	13 (5.8)	5 (20.8)	0.02
GCS score	12 ± 3.8	8 ± 4.8	0.001
ED stay (hr)	8.2 ± 10.1	2.8 ± 1.2	< 0.001
Hospitalization (d)§	11.1 ± 10.3	15.3 ± 46.7	NS
ICU stay (d)‖	5.5 ± 7.4	5.4 ± 8.1	NS
Fee at ED (NT$)	7,208 ± 3,462	10,642 ± 3,266	< 0.001

**Data presented as mean ± standard deviation or n (%); †includes chemical solutions, camphor, dry powder, carbon monoxide and rodenticide; ‡alcohol addiction in 13 patients, herb-related intoxication in 9 patients and heroin addiction in 1 patient; §for the patients who were admitted to the ward or ICU (n = 164); ‖for the patients who were admitted to the ICU (n = 65). CKD = chronic kidney disease; PD = Parkinson's disease; OA = osteoarthritis; DJD = degenerative joint disease; MDD = major depressive disorder; DM = diabetes mellitus; ADR = adverse drug reaction; BZD = benzodiazepine; MBP = mean arterial blood pressure; AMS = altered mental status; GCS = Glasgow Coma Scale; ED = emergency department; ICU = intensive care unit; NS = not significant.*

patients died within 1 day after admission. The average length of stay in the ED was 8.2 hours in survivors and 2.8 hours in nonsurvivors ($p<0.001$; 95% CI, 4.04–6.86); however, the latter cost more in the ED ($p<0.001$; 95% CI, 1,977–4,890). For those patients who were admitted to the ICU, the mean Acute Physiology and Chronic Health Evaluation score was 19.6 in survivors and 28.2 in nonsurvivors ($p=0.001$). Different factors between survivors and nonsurvivors, including acute renal failure, pneumonia, respiratory failure, hypotension, altered mental status, Glasgow Coma Scale score, cold sweating, suicide attempts and herbicide intoxication, were further analyzed by the multiple regression method. Three factors for mortality prediction were identified: herbicide intoxication [$p<0.001$; odds ratio (OR), 12.5], hypotension

($p=0.002$; OR, 9.1) and respiratory failure ($p<0.001$; OR, 7.5) at initial presentation in the ED.

Discussion

To the best of our knowledge, this is the first study addressing the pattern of acute poisoning in the elderly population in the ED in Taiwan and examining the prognostic factors of mortality. Males outnumber females in poisoning events as shown by many different studies.[4,5,9,16] Taiwan PCC reported that the intoxication prevalence was slightly higher in males (54.2% *vs.* 44.7%) between 1985 and 1993.[17] In this study, the ratio of males to females was 2.2. However, in the same study period, the ratio of males to females in patients who visited the ED who were >65 years old was 2.5. This sex disparity is caused by the property of the target hospital, which is a referral center for veterans. Thus, there was no sex difference in poisoning events in this study. Causes of poisoning are affected by age,[6,17] and we focused on the elderly population in the current study. With regard to the cause of poisoning, suicide attempts were the most frequent reason in the entire age population,[3,5,6,16,17] ranging from 53% to 76%, especially among the teenage and adult populations. However, unintentional poisoning was the most common cause in the elderly.[8–10] In accordance with these findings, unintentional poisoning, including medicine overdose or ADR, accidental events and material addiction, accounted for 56.4% of our study population. We also found that the factor of age among patients >65 years old was positively related to an increasing length of stay in the ED, but it did not have an impact on the length of stay in the ICU or ward, or even mortality. In contrast, Mühlberg et al reported that the mean length of stay in the ICU increased with age among very old patients (age >70 years), old patients (age 60–69 years) and young patients (<60 years) ($p<0.001$).[10] However, other factors that contributed to the severity of illness, such as the type of poisoning substance and clinical condition, were not explored in that previous study. Thus, it is unclear whether or not age affects the length of stay in the ICU.

The application of poisonous substances is frequently influenced by the society structure of the country, the district where the hospital is located and the age of the population. For example, the most common poisonous substance is household products in India (44%),[16] pesticides in Sri Lanka (34%)[4] and Thailand (41%),[6] and medicines (56%)[5] in a big city in Iran. Drugs are the most common poisonous substance in the elderly population: 50% in Tehran[9] and 70% in Ireland.[8] Our study was conducted in a referral center located in the capital city of Taiwan. Medicine was responsible for the majority of poisoning (57.6%), followed by pesticides (22%) and chemical substances (11.2%). However, the proportion of poisonous substances in the present study was somewhat different in comparison with the poisonous substances reported from Taiwan PCC,[17] in which pesticides (29.3%) were the most common substance, followed by medicine (28.8%) in the entire population. On the other hand, benzodiazepine was the most common medicine causing poisoning in our study and the Taiwan PCC report, as well as in other studies carried out since 1970.[5,9,16,18–20] The different ranking of poisonous substances in Taiwan may be because of the methodology (telephone inquiry in the Taiwan PCC study) and a different era (2006–2008 in the present study *vs.* 1985–1993 in the PCC report). Since Taiwan has been transformed from an agricultural country into a developed country in the past 10 years, pesticide exposure has declined significantly. Meanwhile, the current well-developed medical and pharmaceutical system makes drugs easily accessible. In our study, among the 83 patients poisoned by benzodiazepine, 47% of them had underlying disease of either major depression/bipolar or insomnia. Warfarin, a standard treatment of atrial fibrillation and deep vein thrombosis, accounted for 16% of the medicine-related poisoning. It is notable that major depressive disorder, insomnia, atrial fibrillation and deep vein thrombosis are very common diseases in the elderly, but these people may experience intoxication easily from the side effects of their treatment, or from the steady supply of the drug for self-harm.

Suicide is an important global public health issue. The Global Burden of Disease study reported that suicide caused 593,000 deaths in developing countries in 1990, and accounted for 75% of deaths worldwide.[21,22] In addition, the World Health Organization estimated that there were 873,000 suicide cases worldwide in 2002.[23] According to an annual statistical report from the Department of Health, Executive Yuan, Taiwan, suicide was the 9th main (2.8%) cause of mortality in 2007. Without a doubt, suicide-related intoxication is an important issue requiring more public attention, especially in the elderly population, since many factors such as comorbidities, depression, loss of spouse and simple advanced age, may contribute to self-poisoning. Common precipitating factors inducing deliberate self-harm in people >60 years old include physical illness (46.1%), social isolation (33.5%), relationship problems with family (29.4%)

or partner (25.9%), and bereavement or loss (16.7%).[24] In this study, we found that the patients who attempted to commit suicide had suffered more from bone pain (such as osteoarthritis or degenerative joint disease of the spine), major depression/bipolar disorder, and acute emotional stress (such as quarrelling with family), compared to those without suicide attempts. Multiple logistic regression analysis showed that bone, pain, depressive disorders and emotional stress remained independent factors in the elderly who attempted suicide. Although benzodiazepine is most frequently applied for suicide attempts in urban areas,[25] 30% of all suicide attempts worldwide are caused by pesticide ingestion, especially in Africa, India, China and Malaysia.[26] The most alarming finding of suicide-related poisoning was its higher mortality outcomes in comparison with other reasons (17% *vs.* 3.5%, $p = 0.001$). This finding is consistent with the reports of Taiwan PCC, which found 9.4% mortality in suicide-related poisoning and 2.3% in non-suicide cases.[17] On the other hand, among our patients with unintentional poisoning, 70% experiencing drug overdose or ADRs frequently had chronic kidney disease, dementia and a solitary lifestyle ($p < 0.05$). Aging-related impaired renal and cognitive function, as well as specific characteristics of pharmacodynamics and pharmacokinetics, indicated that the elderly were more vulnerable to the adverse effects of drugs. The finding of a positive relationship of solitary status and unintentional poisoning, other than suicide attempts, might be explained by the condition of patients having no one to fight with and no one to take care of.

The mortality rate of poisoning varies significantly, and is determined by many factors such as poisonous substances and patient age. Mortality rates of poisoning in the general population are reported as 0.8–3.9% in Turkey,[3,27–29] 0.24% in Germany,[10] 1.4% in Hong Kong,[30] 1.6% and 0.08% in Spain,[31,32] 2.9% in Greece[33] and 8% in Sri Lanka.[4] The mortality rate of intoxication in the elderly has been seldom studied, and was reported as 11.7% in Iran in patients who were >60 years old.[9] According to domestic data, Yang et al reported that poisoned patients >70 years old had a mortality rate of 16%, which is approximately 3 times that of the general population (5.7%).[17] In this study, the mortality rate in patients >65 years old was 9.6%, which is higher than the reports mentioned above focusing on the general population. Identifying the targets at high risk of mortality is crucial for initial management and for disposition of poisoned patients in the ED. Several variables have been reported as risk factors of poor prognosis in different poisoning situations. For example, dosage of the poison, age, respiratory rate, pH, PaO_2, hemoglobin, white blood cell count, blood urea nitrogen, amylase, and the number of dysfunctional organs are associated with mortality from paraquat poisoning;[34] metabolic acidosis, abnormal chest X-ray, tachycardia, and elevated creatinine levels indicate a high mortality for glyphosate-surfactant herbicide poisoning;[35] pH < 7, coma on admission and more than a 24-hour delay from ingestion to admission are associated with a poor outcome from methanol intoxication.[36] In a Turkish study analyzing adult poisoning in the ED, Seydaoglu et al reported that toxicity of ingested substances (organic phosphorus, alcohol and methanol poisoning), severity of the poisoning, and delay of medical support (>2 hours) may be the major predictors of mortality.[3] In the present study focusing on the elderly population, 3 factors were identified as predictors of mortality after multivariate logistic regression analysis: herbicide poisoning, hypotension and respiratory failure. Surprisingly, age and suicide attempt-related poisoning did not show a statistically significant predictive value after multivariate analysis. The chances of developing pneumonia after poisoning from herbicides, insecticides and benzodiazepine were 25%, 48% and 25%, respectively. However, the mortality rate of poisoning from herbicides, insecticides and benzodiazepine was 50%, 9.6% and 3.6% respectively. Despite a low fatality rate, the high incidence of pneumonia after benzodiazepine poisoning in the elderly with underlying comorbidities may cause respiratory failure, severe ventilation-associated pneumonia, prolonged length of stay in the ICU and ward, and increased cost. The hospitalization days of the 3 fatal cases poisoned by benzodiazepine were 13, 31, and 221 days, respectively.

By clarifying the characteristics of acute poisoning in the elderly, a physician may decrease the chance of drug overdose or ADR by simplifying the prescription and by avoiding prescribing long-term hypnotics, especially in patients who have chronic kidney disease or mood disorders. It is important to be aware of the physical condition of the elderly and to try to avoid arguing with them. In addition, authorities should establish regulations about purchasing pesticides or other toxic chemical materials. Finally, the most important responsibility of ED physicians is to recognize the 3 poor prognostic factors of herbicide intoxication, respiratory failure and shock, as well as to take prompt and proper action to avoid poor outcomes.

The major limitation of this study was underestimating poisoning events in the study hospital. Many other ADRs, such as hypoglycemia from oral antidiabetic drugs, gastrointestinal upset from pain killers, urticaria from allergic drugs, bradycardia from negative

inotropic agents, etc., were not included in the study. Patients with minor side effects or overdosing of medicine may visit the outpatient department rather than the ED, and thus they were not screened through our enrolment process. Their medical condition may not have been severe enough for them to be admitted, or they were admitted to wards other than the Toxicology section. In addition, 1 single-center experience cannot accurately represent the true situation in Taiwan. Further prospective, meticulous, comprehensive and multicenter-based studies designed to determine adverse drug effects or poisoning events in all age populations are necessary.

In conclusion, unintentional poisoning was the most common cause of acute poisoning in the elderly. Drugs were the most frequent substance for poisoning, followed by pesticides, herbicides and other chemical materials. Benzodiazepine was responsible for 1 third of all poisonous substances. Suicide attempt-related poisoning resulted in more serious complications including pneumonia, respiratory failure, hypotension, and mortality. The overall mortality rate was 9.6%. Three prognostic factors of mortality were identified: herbicide intoxication, respiratory failure and hypotension in the ED. Strategies should be undertaken to prevent poisoning in the elderly, especially in those with a high risk for suicide (i.e. those with bone pain, depressive disorders and under emotional stress).

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