SN Comprehensive Clinical Medicine (2021) 3:1722–1726
https://doi.org/10.1007/s42399-021-00922-3

MEDICINE

Geographic Difference in Elderly with Acute Poisoning

Chih-Wen Tsai[1] · Bo-Ruei Chiou[1] · Chih-Chun Hsu[1] · Yu-Jang Su[1,2,3,4]

Accepted: 19 April 2021 / Published online: 28 April 2021

Abstract

In the elderly, a significant decline in the liver and renal function was observed with increasing aging. This study aims to identify the characteristics of elderly with acute poisoning and analyzed the difference between Asia and non-Asia. We gathered works of literature from the Google Scholar database and PubMed with limits in human, English, MEDLINE, age above 65 years old, and title or abstract of "acute poisoning in the elderly" from the year 1983 to 2019. During the 36 years, 11 articles from Google Scholar (including 9 articles in PubMed) with 34,593 patients were included to study. Data of age, gender, etiology, poisoned substance, outcome, length of stay (LOS), and mortality rate were collected, and we divide them into two groups: Asia and non-Asia, to compare the diversities and discussion were made. The mean ± SD (standard deviation) in age is 72.3 ± 4.5 years old. Of these patients, 57.8% were male. Accidental poisoning was more common in elderlies. Of the types of poisoning, drugs were the most common substance (40.4%). Among all the cases in this study, 60.2% were admitted to the hospital after poisoning. Of them, 26.2% were admitted to an intensive care unit (ICU). The mortality rate of the study participants was 13.2%. Most of the poisoned elderly patients are unintentional, and drug (BZDs) is the most common agent poisoned. Asia group of poisoned elderly patients are older, male predominant, more intentional, and having a higher rate of mortality than the non-Asia group.

Keywords Asia · Non-Asia · Elderly · Poisoning

Introduction

Acute poisoning is an important health issue in all population nowadays. The World Health Organization (WHO) proclaimed in 2015, the world's population over 60 years had reached up to 12% worldwide and estimated to be nearly double until 2050. Until 2019, the life expectancy at birth of both sexes came up to 72 years old on average [1]. It is believed the health issue in the elderly becomes more and more important.

In the elderly, a significant decline in the liver and renal function was observed with increasing aging. Drug clearance of some drugs by the liver can be reduced by up to 30% and renal excretion is decreased almost by half in about two-thirds of elderly subjects accompanied by comorbid factors such as hypertension, diabetes, and coronary heart disease [2].

However, the characteristics in elderly poisoning are not well understood yet due to papers discussed toxicology were seldom focused on the elderly. This study aims to identify the characteristics of elderly with acute poisoning and analyzed the difference between Asia and non-Asia.

Materials and Methods

We gathered works of literature from the Google Scholar database and PubMed with limits in human, English, MEDLINE, age above 65 years old, and title or abstract of "acute poisoning in the elderly" from the year 1983 to 2019. During the 36 years, a total of 9 articles were selected from PubMed and 11 articles (China: 2; Hong Kong: 1; Taiwan: 1; Korea: 1; Tehran:1; the USA: 3; Egypt: 1; and Spain: 1) from Google Scholar (including 9 articles in PubMed). Of them, 34,593 patients were included to study.

This article is part of the Topical Collection on *Medicine*

✉ Yu-Jang Su
yjsu.5885@mmh.org.tw

[1] Emergency Department, MacKay Memorial Hospital, Taipei, Taiwan

[2] Poison Center, MacKay Memorial Hospital, Taipei, Taiwan

[3] Department of Medicine, MacKay Medical College, New Taipei City, Taiwan

[4] MacKay Junior College of Medicine, Nursing and Management, No. 92, Sec 2, North Chung Shan Rd, Taipei 10449, Taiwan

Data of age, gender, etiology, poisoned substance, outcome, length of stay (LOS), and mortality rate were collected, and we divide them into two groups: Asia and non-Asia, to compare the diversities and discussion were made. Data were collected and analyzed using the Student *t* test and chi-square test using IBM SPSS 20. *p* values < 0.05 (2-tailed) indicated statistical significance.

Results

Baseline demographic and clinical data of all patients are shown in Table 1. The mean ± SD (standard deviation) in age is of 72.3 ± 4.5 years old. Of these patients, 57.8% were male and 42.2% were female. Accidental poisoning was more common in elderlies, which accounted for 59.9% of all the cases. Of the types of poisoning, drugs were the most common substance (40.4%), followed by herbicide and pesticide (20.7%), corrosive and detergent (15.4%), chemical (8%), toxic gases (7.9%), and insect sting (7.6%).

The key causative substance in drugs was BZD (benzodiazepine) overdose (22.5%), followed by illicit drug (opioid) use (20.7%). Among all the cases in this study, 60.2% were admitted to hospital after poisoning. Of them, 26.2% were admitted to intensive care unit (ICU). The average length of stay (LOS) was 13.2 days, and the mortality rate of the study participants was 13.2%.

We also compared Asia and non-Asia group as geographic analysis in Table 2. In gender, male intentional overdose cases were more commonly seen in Asia group (59.7% versus 43.5%, $p = 0.001 < .05$) while non-Asia group was female predominant. In etiology of poisoning, Asia group was more commonly poisoned intentionally (62.4% versus 38.4%, $p = 0.001 < .05$), but non-Asia group outnumbered in accidental poisoning (61.6%). For substance, Asia group also had higher proportion in drug poisoning (48.4% versus 31.9%, $p = 0.014 < .05$) and higher mortality rate (16.6% versus 9.0%, $p = 0.028 < .05$) than non-Asia group.

Table 1 General data of acute poisoning in the elderly

Mean age (years old)		72.3 ± 4.5
Gender	Male	57.8%
	Female	42.2%
Etiology	Intentional	40.1%
	Accidental	59.9%
Substance	Drug	40.4%
	Benzodiazepine	22.5%
	Opioid	20.7%
	Herbicide + pesticide	20.7%
	Corrosive	15.4%
	Chemical	8.0%
	Gases	7.9%
	Insect sting	7.6%
Admission rate		60.2%
	Ward	39.2%
	ICU (intensive care unit)	26.2%
Length of stay (days)		13.2 days
Mortality rate		13.2%

Discussion

Age

In consensus, comparing to younger population, elderly has more comorbidities and decline physiological function. Klein-Schwartz and Oderda pointed out the factors during the physiological changes, such as renal insufficiency, slower hepatic biochemical metabolism, or decreased lean body mass, that inconsequence affect drug distribution and pharmacodynamics [3]. Therefore, the drug dosage should be adjusted carefully if the patients have known renal or liver dysfunction. If possible, drug levels should also be monitored since the serum creatinine level or liver enzyme levels alone may not reflect the real metabolism function. Besides, the elderly has more comorbidities under medication control resulting in polypharmacy, which is already known raising risks in adverse drug effects (ADR), hospital admission, and even death [4, 5]. For these reasons, intentionally poisoned elderly is vulnerable and fragile to recover from intoxication. The incidence of intentional elderly poisoning is significantly higher in Asians than in non-Asians (62.4% versus 38.4%), possibly because of the relatively low availability of firearms, extremely heavy workload, and social pressures in East Asian regions such as China, Japan, and South Korea [6].

Besides physiological factors, psychological change with aging could also lead to unintentional poisoning. Several studies had mentioned age-related dementia increasing the possibility of drug poisoning [7, 8]. Degenerated mental function is an also risk factor of drug-related poisoning that we should avoid in clinical practicing. Medication reconciliation at outpatient department (OPD) may also be efficient as prevention.

The mean age of Asia group in poisoning is slightly older than the non-Asia group by 3 years (73.4 years versus 70.1 years, $p = 0.000$). According to the World Population Project of the United Nations, WHO, within the developed countries, Asian countries are more significant in population aging than other areas. Until 2017, there were about 549 million persons aged 60 years or older in Asia area, which accounted for more than half of the old age population in the whole world [9]. Thus, elderly poisoning is indeed an urgent issue to be concern about.

Table 2 Comparison of Asia group and non-Asia group in clinical parameters of poisoning in the elderly. *Statistical significance is set at $p < 0.05$

	Asia	Non-Asia	All	p value, two-tailed
Mean age	73.4 ± 4.2	70.1 ± 5.8	72.3 ± 4.5	0.000*
Male %	59.7	43.5	57.8	0.001*
Female %	40.3	56.5	42.2	
Intentional %	62.4	38.4	40.1	0.001*
Accidental %	37.6	61.6	59.9	
Admission %	62.9	52.3	60.2	0.199
Drug %	48.4	31.9	40.4	0.014*
Benzodiazepine %	24.5	12.9	22.5	0.031*
(Herbicide + pesticide) %	15.2	21.2	20.7	0.010*
Corrosive %	29.3	8.1	15.4	0.006*
Sting %	2.2	8.4	7.6	0.000*
Mortality %	16.6	9.0	13.2	0.028*

Gender

Overall, like our statistics, poisoning events in males that slightly outnumber females were shown by several studies [10, 11]. However, when separating the population by nations, females outnumber males in the non-Asia group (56.5% versus 43.5%, $p = 0.001$). It may cause by different population structures that females are predominant in 65 years or above [3, 12]. Therefore, the results might not demonstrate the real female elderly in poisoned risk preponderance. Unlike non-Asian elderly poisoning (male: 43.5%, female: 56.5%), the incidence of Asian elderly poisoning is higher in men than in women (male: 59.7%, female: 40.3%). Our data on the gender indicated that Asian men have a higher rate of elderly poisoning than non-Asian men, with a statistically significant difference (59.7% versus 43.5%, $p = 0.001$).

Etiology

In our study, the main etiology of elderly poisoning is by accident in the whole picture (accidental versus intentional, 59.9% versus 40.1%, $p = 0.001$). Mostly these cases were caused by unintentional drug overdose, ADR, or accidental herbicide toxicity due to the daily agricultural use. Poisoned elderly owing to intentional overdose accounted for a higher rate in Asia than non-Asia (62.4% versus 38.4%, $p = 0.001 < 0.05$).

When it comes to intentional toxicity, many factors such as comorbidities, depression, losing the ability of activity of daily living, or decreased social participation may lead to the consequence of self-poisoning in the elderly [10, 13].

Poisoned Substance

Looking at the substances that cause elderly poisoning, we can find that the most common poisoned substance is the drug, which accounted for 40.4%, followed by benzodiazepine (22.5%), and herbicide and pesticide 20.7%. This is compatible with the report from Ireland in 2014. Tranquilizers are the most seen substance in intentional overdose [14, 15]. Regarding drug poisoning, we can find that Asians have a significantly higher rate than non-Asian (48.4% versus 31.9%, $p = 0.014 < .05$). Benzodiazepine poisoning accounts for the highest proportion of drug poisoning, followed by opioids (22.5% versus 20.7%).

Elderly usually get much more medication than they needed themselves from over the counter or hospital for comorbidities or chronic systemic diseases. The most common surplus medications prescribed are sedatives (benzodiazepine) and hypnotics.

Fujie et al. described that phenomena of inappropriate medications are 7.11 times and easily to be polypharmacy are 1.51 times in circumstances after visits of several physicians [16].

Rates of opioid misuse and overdose have reached new highs in recent years in the USA, fueled by an abundance of prescription opioids and new spikes in heroin and synthetic opioid use [17]. While numerous reports indicate that the co-abuse of opioids and BZDs are ubiquitous around the world, the reasons for the co-abuse of these medications possibly remain that opioid abusers are using BZDs therapeutically to self-medicate anxiety, mania, or insomnia [18].

We analyzed the cause of the second common elderly poisoning: herbicide and pesticide and found that the prevalence rate in Asians is significantly lower than in non-Asian people (15.2% versus 21.2%, $p = 0.010$). Most of the developed non-Asian capitalist countries have modernized agriculture. New progress in agricultural production technology after World War II is the following: the mechanization of individual operations has developed into the mechanization of the entire production process, forming a comprehensive series of mechanization and automation; the application levels of fertilizers and pesticides have been further improved and become more

efficient. Therefore, the chance of accidental pesticide poisoning is higher than that of Asians. Insect sting poisoning in non-Asia group is more common than in Asia group, possibly resulted from non-Asia people joined more outdoor activities than Asia group people by culture and much leisure time.

Outcome

As for the hospitalization rate due to poisoning, Asian elderly are higher than non-Asian elderly, but there is no statistical difference (62.9% versus 52.3%, $p = 0.199$). A Sweden study described poisoned patients with deeper coma (Glasgow Coma Scale (GCS) score 3–6) have an approximately 7-fold higher mortality rate than the overall hospital mortality from acute poisoning [19]. Poisoned elderly in Asia group has higher mortality rate than in non-Asia group possibly resulted from more cases in BZDs and drug poisoning. More than half (60.2%) of poisoned elderly need to be hospitalized, and the mean hospital stay was 13.2 days. Overall mortality rate of poisoned elderly patients was 13.2%. Low birth rate and aging population structured society gradually raise the concern of elderly patients in daily practice. Poisoned elderly patients are fragile and vulnerable to recover. Most of them are unintentional, and drug (BZDs) is the most common agent poisoned. Asia group of poisoned elderly patients are older, male predominant, more intentional, and having higher rate of mortality than non-Asia group.

Prescription is an art. Besides avoidance of opportunity of acute poisoning, a study from the Netherlands described over-prescription of short-acting beta agonists in the treatment of asthma associated with asthma exacerbations [20]. Being aware of prevention in opioid over-prescription from contributing to opioid misuse in post-surgical patients is also important [21]. Physicians need appropriate drug review and improvement in the quality of drug prescription especially in older patients who faced cancer or chronic progressive diseases [22].

Author Contribution Tsai CW, Chiou BR, Hsu CC: data gathering
Tsai CW, Chiou BR: draft writing
Su YJ: gathered data, statistical analyses, study designed, revised, and corresponding. Discussed with Tsai CW, Chiou BR, Hsu CC

Data availability Data gathered from the PubMed search.

Code availability Not applicable.

Declarations

Ethics Approval Not applicable.

Consent to Participate Not applicable.

Consent for Publication All authors have contributed significantly and that all authors agree with the content of the manuscript.

Conflict of Interest The authors declare no competing interests.

References

1. World health statistics 2019 monitoring health for the SDGs, sustainable development goals. Geneva License CC BY-NC-SA 3.0 IGO
2. Klotz U. Pharmacokinetics and drug metabolism in the elderly. Drug Metab Rev. 2009;41(2):67–76. https://doi.org/10.1080/03602530902722679.
3. Klein-Schwartz W, Oderda GM. Poisoning in the elderly. Epidemiological, clinical and management considerations. Drugs Aging. 1991;1(1):67–89. https://doi.org/10.2165/00002512-199101010-00008.
4. Masnoon N, Shakib S, Kalisch-Ellett L, Caughey GE. What is polypharmacy? A systematic review of definitions. BMC Geriatr. 2017;17(1):230. Published 2017 Oct 10. https://doi.org/10.1186/s12877-017-0621-2.
5. Molokhia M, Majeed A. Current and future perspectives on the management of polypharmacy. BMC Fam Pract. 2017;18(1):70. Published 2017 Jun 6. https://doi.org/10.1186/s12875-017-0642-0.
6. Ho CS, Ong YL, Tan GH, Yeo SN, Ho RC. Profile differences between overdose and non-overdose suicide attempts in a multi-ethnic Asian society. BMC Psychiatry. 2016;16(1):379. Published 2016 Nov 8. https://doi.org/10.1186/s12888-016-1105-1.
7. Chen R, Chien WC, Kao CC, et al. Analysis of the risk and risk factors for injury in people with and without dementia: a 14-year, retrospective, matched cohort study. Alzheimers Res Ther. 2018;10(1):111. Published 2018 Oct 30. https://doi.org/10.1186/s13195-018-0437-0.
8. Meuleners LB, Hobday MB. A population-based study examining injury in older adults with and without dementia. J Am Geriatr Soc. 2017;65(3):520–5. https://doi.org/10.1111/jgs.14523.
9. United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Ageing Highlights (ST/ESA/SER.A/397).
10. Hu YH, Chou HL, Lu WH, et al. Features and prognostic factors for elderly with acute poisoning in the emergency department. J Chin Med Assoc. 2010;73(2):78–87. https://doi.org/10.1016/S1726-4901(10)70006-X.
11. El-Hawary Amira E, El-Mehallawi Inas H, El-Kelany Rabab S, Enas I EL-M. Pattern of acute poisoning in a sample of elderly Egyptians. Nat Sci. 2019;17(8):79–85.
12. Dean BS, Krenzelok EP. Poisoning in the elderly. An increasing problem for health care providers. J Toxicol Clin Toxicol. 1987;25(5):411–8. https://doi.org/10.3109/15563658708992643.
13. Nakamura T, Tsuji T, Nagamine Y, et al. Suicide rates, social capital, and depressive symptoms among older adults in Japan: an ecological study. Int J Environ Res Public Health. 2019;16(24):4942. Published 2019 Dec 6. https://doi.org/10.3390/ijerph16244942.
14. Griffin E, Corcoran P, Cassidy L, O'Carroll A, Perry IJ, Bonner B. Characteristics of hospital-treated intentional drug overdose in Ireland and Northern Ireland. BMJ Open. 2014;4(7):e005557. Published 2014 Jul 29. https://doi.org/10.1136/bmjopen-2014-005557.
15. Miranda Arto P, Ferrer Dufol A, Ruiz Ruiz FJ, Menao Guillén S. Civeira Murillo Intoxicaciones agudas en pacientes mayores de 65 años [Acute poisoning in patients over 65 years of age]. An Sist

Sanit Navar. 2014;37(1):99–108. https://doi.org/10.4321/s1137-66272014000100011.
16. Fujie K, Kamei R, Araki R, Hashimoto K. Prescription of potentially inappropriate medications in elderly outpatients: a survey using 2015 Japanese Guidelines [published online ahead of print Jan 21]. Int J Clin Pharm 2020 https://doi.org/10.1007/s11096-020-00967-9
17. Upp LA, Waljee JF. The opioid epidemic. Clin Plast Surg. 2020;47(2):181–90. https://doi.org/10.1016/j.cps.2019.12.005.
18. Jones JD, Mogali S, Comer SD. Polydrug abuse: a review of opioid and benzodiazepine combination use. Drug Alcohol Depend. 2012;125(1-2):8–18. https://doi.org/10.1016/j.drugalcdep.2012.07.004.
19. Forsberg S, Höjer J, Ludwigs U. Hospital mortality among poisoned patients presenting unconscious. Clin Toxicol (Phila). 2012;50(4):254–7. https://doi.org/10.3109/15563650.2012.670245.
20. Looijmans-van den Akker I, Werkhoven A, Verheij T. Overprescription of short-acting beta agonists in the treatment of asthma. Fam Pract. 2021 March 19:cmab013. https://doi.org/10.1093/fampra/cmab013.
21. Petersen MJ, Adams KW, Siparsky NF. Avoiding opioid misuse after surgery in the era of the opioid epidemic: defining the new normal. Am Surg. 2020 Nov;86(11):1565–72. https://doi.org/10.1177/0003134820939933.
22. Bosetti C, Santucci C, Pasina L, Fortino I, Merlino L, Corli O, et al. Use of preventive drugs during the last year of life in older adults with cancer or chronic progressive diseases. Pharmacoepidemiol Drug Saf. 2021. https://doi.org/10.1002/pds.5223.