

Research Paper: Demographic and Clinical Characteristics of Patients Who Died of Methanol Toxicity During COVID 19 Outbreak in Loghman-e-Hakim Hospital, Tehran



Shahin Shadnia¹, Lida Shojaei Arani^{1,2}, Kiumars Bahmani³, Maryam Akhgari⁴, Hoorvash Faraji Dana^{1*}, Mohammadreza Ghadirzadeh⁴, Mohammadreza Hajiesmaeil⁵, Omidvar Rezaie Mirghaed⁶

1. Department of Clinical Toxicology, Loghman-e-Hakim Hospital, Poison Center, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

2. Department of Emergency, Alborz University of Medical Science, Karaj, Iran.

3. Department of Pharmacology and Toxicology, School of Pharmacy, Shahid Beheshti University of Medical Science, Tehran, Iran.

4. Legal Medicine Research Center, Legal Medicine Organization, Tehran, Iran.

5. Critical Care Quality Improvement Research Center, Loghman Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

6. Department of Neurosurgery, Loghman-e-Hakim Hospital, Shahid Beheshti University of Medical Sciences, Tehran, Iran.



Citation Shadnia S, Shojaei Arani L, Bahmani K, Akhgari M, Faraji Dana H, Ghadirzadeh M, et al. Demographic and Clinical Characteristics of Patients Who Died of Methanol Toxicity During COVID 19 outbreak in Loghman-e-Hakim Hospital, Tehran. International Journal of Medical Toxicology and Forensic Medicine. 2022; 12(1):36171. <https://doi.org/10.32598/ijmtfm.v12i1.36171>

<https://doi.org/10.32598/ijmtfm.v12i1.36171>



Article info:

Received: 18 Sep 2021

First Revision: 29 Sep 2021

Accepted: 24 Nov 2021

Published: 15 Jan 2022

Keywords:

Methanol toxicity, COVID-19, Metabolic acidosis, Formic acid, Outbreak

ABSTRACT

Background: Outbreaks of methanol poisoning were observed during the COVID-19 pandemic. Acute methanol poisoning is a global crisis. Methanol can cause acute and fatal toxicity through metabolic acidosis. In the present study, we evaluated demographic, clinical, and paraclinical characteristics of patients who died in the recent outbreak of methanol poisoning in Tehran from March to April 2020.

Methods: This cross-sectional study was accomplished at the Loghman-Hakim Hospital in Tehran on 80 patients who died of methanol toxicity. Demographic, clinical, and laboratory data were collected retrospectively from the patient's files and analyzed with appropriate statistical tests.

Results: Men were significantly more involved than women (%85 vs. %15). There were no significant differences between other characteristics of male and female patients, including the time between consumption to arrive hospital, dialysis sessions, pulse rate, respiratory rate, loss of consciousness, seizure, acute kidney injury, brain CT, and Intracerebral Hemorrhage (ICH). Blood sugar, serum potassium, and liver function tests were higher than average in most of the patients.

Conclusion: Our study showed that this outbreak of methanol poisoning was due to the use of alcoholic drinks that contain methanol. Men were primarily affected that could be because of the cultural and social status of our country. The greater seizure probability in females could be because of enhancing the NMDA receptor by estrogen. Abnormalities in Alanine aminotransferase (ALT), Aspartate Aminotransferase (AST), and Prothrombin Time (PT) were seen in most patients, indicating liver damage. Misbeliefs about the protective effects of alcohol consumption against COVID-19 may lead many to consume poorly made alcohols that contain methanol and outbreaks of methanol intoxication.

* Corresponding Author:

Hoorvash Faraji Dana, PhD.

Address: Department of Clinical Toxicology, Loghman-e-Hakim Hospital, Poison Center, School of Medicine, Shahid Beheshti University of Medical Sciences, Tehran, Iran.

Tel: +98 (26) 34284760

E-mail: f.drhoorvash@yahoo.com

1. Introduction

Acute methanol poisoning is a global crisis. In the past, many of these outbreaks have been reported worldwide [1-3]. Methanol is toxic alcohol, which is widely used as a solvent [4]. Ingestion of methanol can cause acute and fatal toxicity; after ingestion, methanol is metabolized by hepatic alcohol dehydrogenase enzyme to formaldehyde then formaldehyde metabolizes to formic acid by aldehyde dehydrogenase [5]. Metabolic acidosis with an elevated anion gap develops due to the accumulation of formic acid. Consequently, the ability of the toxic metabolites to damage the body organs and cells increases, because formic acid inhibits the mitochondrial electron transport chain and this inhibition markedly increases the production of reactive oxidative molecules and the likelihood of oxidative injury [6, 7]. Formic acid causes retinal injury with optic disc hyperemia, edema, and eventually permanent blindness, as well as ischemic or hemorrhagic injury to the basal ganglia [8].

At the time of the coronavirus outbreak, misconceptions about alcohol consumption emerged; one of them was a myth about drinking alcohol to prevent COVID-19 [9]. The presence of methanol in alcoholic beverages is the reason for this outbreak [10, 11]. This study was done to present and analyze the demographic, clinical, and paraclinical characteristics of patients who died in this outbreak.

2. Materials and Methods

Study design

This was a cross-sectional study approved by the Shahid Beheshti University of Medical Sciences Ethics Committee with the approval code of I.R.SBMU.RE-TECH.REC.1399.054 and accomplished at the Loghman-Hakim Hospital in Tehran. It was performed on all of the patients who died of methanol toxicity from March to April 2020 in Iran.

Inclusion criteria were as follow: patients without pre-existing health conditions who died due to methanol toxicity were enrolled in the study (Figure 1).

Exclusion criteria were as follow: patients with pre-existing health conditions and dissatisfaction of the patient's family to use the patients' data in the study.

Variables

Demographic, clinical, and laboratory data, including age, sex, the time between consumption and arrival at

the hospital, dialysis session, pulse rate, respiratory rate, Loss of Consciousness (LOC), seizure, Acute Kidney Injury (AKI), Intracerebral Hemorrhage (ICH), Oxygen Saturation (O₂ sat) blood pH, Partial Pressure of Carbon Dioxide (PCO₂), bicarbonate (HCO₃), base deficit, White Blood Cells (WBC), Blood Sugar (BS), sodium (NA), potassium (K), Blood Urea Nitrogen (BUN), creatinine (Cr), hemoglobin (Hb), Platelet Count (PLT), Prothrombin Time (PT), partial thromboplastin time (PTT), International Normalized Ratio (INR), Aspartate Transaminase (AST) and Alanine Transaminase (ALT) were collected retrospectively from the patient's files in the hospital record section.

Statistical methods

Statistical analysis was done using IBM Statistical Product and Service Solutions SPSS v. 22, based on instructions of the SAMPL guidelines. Continuous variables are presented as Mean±SD, and categorical variables are shown as frequency and percentage. Descriptive statistics were used to analyze demographic characteristics. Categorical data were compared using the Chi-square test. The student's t-test was used to compare data with normal distribution between two groups. A P<0.05 was considered to indicate statistical significance. The authors prepared and formatted the manuscript according to the guidelines of the EQUATOR Network for Observational Studies (STROBE).

3. Results

Eighty patients who died due to methanol poisoning and had no pre-existing comorbidity were selected and enrolled in the study (Figure 1). All of the patients were admitted to ICU and underwent standard treatment. Men constituted 85% (68/80) of patients. The number of patients who died before dialysis was 32% and 8% for men and women, respectively. The Mean and Standard Deviation of the age for male patients was 42.17±13.2 years, and of female patients was 35.5±8.3 years, and there was not a significant difference between male and female patients' ages. There were also a few but not significant differences between other characteristics of male and female patients, including time between consumption and arrival at the hospital, dialysis sessions, pulse rate, respiratory rate, LOC, seizure, AKI, brain CT, and ICH (Table 1).

The mean values of important laboratory parameters in patients are listed in Table 2. Most of the patients presented with profound metabolic acidosis. BS, liver functional tests, WBC, and serum potassium were higher than average in most of the patients, and there was not a

Table 1. Clinical and demographic characteristics of the patients

Variables	Mean±SD/%		P
	Male	Female	
Age	42.17±13.2	35.5±8.3	0.83
Sex	85% (68/80)	15% (12/80)	<0.000001
Time between consumption and arrival at the hospital	26.83±15.4	21±11.4	0.96
Number of patients Died before dialysis	32	8	0.09
Dialysis Sessions	1.18±1.1	1.8±1	0.83
Pulse Rate	82.77±20	77.75±0.4	0.99
Respiratory Rate	19.28±6.2	17.75±9.8	0.99
LOC	92	83	0.99
Seizure	09	25	0.96
AKI	38	41	0.99
Brain CT Performed Patients	33.8	50	0.99
ICH	52	33	0.99

International Journal of
Medical Toxicology & Forensic Medicine

The results show the higher rates of male gender in methanol poisoning cases; LOC: Loss of Consciousness; AKI: Acute Kidney Injury; ICH: Intracerebral Hemorrhage.

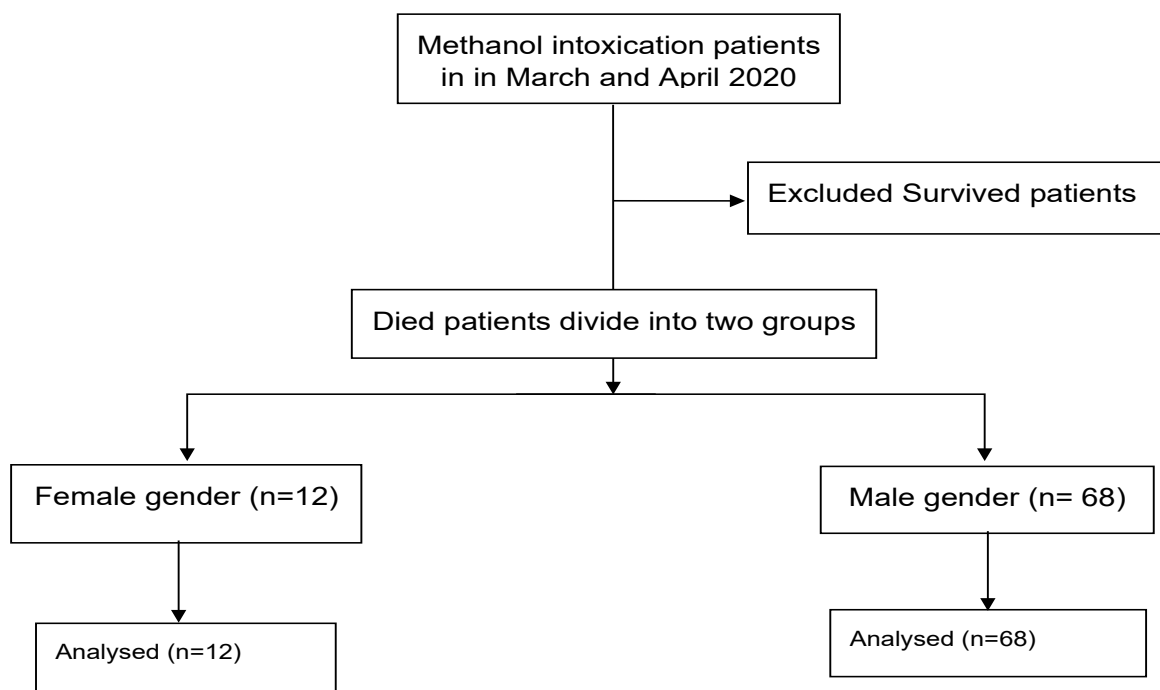


Figure 1. Flow diagram of the study

International Journal of
Medical Toxicology & Forensic Medicine

Table 2. Laboratory and biochemical characteristics of the patients

Variable	Unit	No. (%)		P
		Male	Female	
O2 Sat	Percent	91.09(9.5)	91.37(9.2)	0.99
Blood pH		6.83(0.1)	6.71(0.1)	0.76
PCO2	mmHg	39.46(24.9)	40.96(27.4)	0.99
HCO3	mEq/L	6.66(3.5)	5.37(1.9)	0.96
Base deficit	mEq/L	23.48(24.2)	28.93(6.3)	0.99
WBC	× 10 ⁹ /L	15.27(6.8)	20.06(10.1)	0.71
BS	mg/dL	192.56(98.2)	330.33(274.9)	0.10
NA	mEq/L	139.94(5)	139.12(3.20)	0.99
K	mEq/L	4.81(0.9)	5.36(1.2)	0.84
BUN	mg/dL	23.87(11.5)	20.71(8.1)	0.99
Cr	mg/dL	1.67(0.4)	1.38(0.3)	0.76
Hb	mg/dL	16.28(3.350)	14.57(0.7)	0.99
PLT	× 10 ³ /μl	295.69(70.08)	410.50(135)	0.51
PT	Seconds	14.29(1.52)	14.70(2.9)	0.99
PTT	Seconds	42.68(11.47)	56.67(46.4)	0.99
INR		1.33(0.283)	1.40±(0.5)	0.99
AST	units/L	118.25(159.9)	97.00±(81.3)	0.99
ALT	units/L	97.61(81.87)	80.13±(31.5)	0.99
Blood Methanol Level (Mean±SD)	mg/dL	19.96±9.7	17.77±8	0.82

International Journal of
Medical Toxicology & Forensic Medicine

O2sat: Oxygen saturation; PCO2: Partial Pressure of Carbon Dioxide; HCO3: Bicarbonate; WBC: White Blood Cells; BS: Blood Sugar; NA: Sodium; K: Potassium; BUN: Blood Urea Nitrogen; Cr: Creatinine; Hb: Hemoglobin; PLT: Platelet Count; P.T: Prothrombin time; PTT: Partial Thromboplastin Time; INR: International Normalized Ratio; AST: Aspartate Transaminase; and ALT: Alanine Transaminase.

significant difference between male and female patients. There were differences between males and females in BS and PLT and females showed a greater level but it was not statistically significant (Table 2).

4. Discussion

Based on the most recent review on alcohol consumption in Iran [12], 68% of the Iranian population consume alcohol, with most of them being males. Nearly one out of every eight Iranians have consumed alcohol; these numbers suggest the vastness of alcohol consumption;

however, after the Islamic revolution in Iran and illegalization of alcoholic beverages, consumers acquire alcohol at expensive rates, with most of them being made in less than standard conditions, and lower the quality of the beverage the lower the price.

Our study showed that the outbreak of methanol poisoning was due to the use of alcoholic drinks that contain methanol, which is consistent with other reports that mentioned it often happens when methanol is mistakenly substituted for ethanol or methanol is concentrated during the distillation process in alcoholic beverages [13-

15]. Based on our findings, primarily men were affected (85%) like previous reports of methanol poisoning in Iran [16-18] because of our country's cultural and social status. Although the time between alcohol consumption and arrival at the hospital was not statically significant, males tended to delay presenting to the hospital than females. As the results indicated, 32% of males visited the hospital so late that they could not have dialysis (Table 1). This can be another contributor to the higher mortality rates in males. According to the literature, males are more reluctant to visit physicians and more likely to ignore the symptoms of illness [19].

There seems to be a greater seizure probability in females (25% in females vs. 09% in males), it could be because of enhancing the NMDA receptor by estrogen [20]; however, it was not statically significant and a larger number of patients is needed for further evaluation. The number of our patients limited us, and although our hospital is the main referral hospital for toxicity in the country, more hospitals in other areas of the country should be evaluated to provide a more representative population. Among the patients subjected to brain CT scans (33.2% of males and 50% of females), the incidence of ICH was higher in males, but like many other characteristics, there was not a significant difference between the two groups.

Although there were no differences between men and women in the laboratory and biochemical characteristics, most of the patients presented with high levels of blood sugar, which is a prognostic factor of lethality in methanol poisoning [21].

Abnormality in ALT, AST, and PT was seen in most patients that indicate liver damage because methanol can damage hepatocytes [21]; males and females were equal in the test results that indicate no differences in hepatic damage between males and females. In this study and some other studies, it has been shown that the mortality due to methanol poisoning increased during the COVID-19 period compared to the pre-COVID-19 period [22].

5. Conclusion

After the COVID-19 outbreak and panic along with rumors and misbeliefs about the protective effects of alcohol consumption against COVID-19 infection, high demand for alcoholic beverages took place and led many to consume these cheap and poorly made alcohols; therefore, proper training and other necessary measures in this field should be done to prevent further outbreaks of methanol poisoning.

This study was conducted over a period of two months when there was an outbreak of methanol poisoning in Tehran, and the number of patients included was limited. Serum methanol levels were measured in these patients, however, it was too late in many cases.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles are considered in this article. The participants were informed of the purpose of the research and its implementation stages. They were also assured about the confidentiality of their information. They were free to leave the study whenever they wished, and if desired, the research results would be available to them. Written consent has been obtained from the subjects. Principles of the Helsinki Convention were also observed.

Funding

This research did not receive any grant from funding agencies in the public, commercial, or non-profit sectors.

Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflicts of interests.

References

- [1] Ravichandran R, Dudani RA, Almeida AF, Chawla KP, Acharya VN. Methyl alcohol poisoning. (Experience of an outbreak in Bombay). *Journal of Postgraduate Medicine*. 1984; 30(2):69-74. [PMID]
- [2] Divekar MV, Mamnani KV, Tendolkar UR, Bilimoria FR. Acute methanol poisoning: Report on a recent outbreak in Maharashtra. *JAPI: Journal of the Association of Physicians of India*. 1974; 22:477-83.
- [3] Kumar M, Kaeley N, Nagasubramanyam V, Bhardwaj BB, Kumar S, Kabi A, et al. Single center experience of managing methanol poisoning in the hilly state of Uttarakhand: A cross sectional study. *International Journal of Critical Illness and Injury Science*. 2019; 9(4):172-6. [DOI:10.4103/IJCIIS.IJCIIS_49_19] [PMID] [PMCID]
- [4] Barceloux DG, Bond GR, Krenzelok EP, Cooper H, Vale JA. American Academy of Clinical Toxicology Ad Hoc committee on the treatment guidelines for methanol poisoning. American academy of clinical toxicology practice guidelines on the treatment of methanol poisoning. *Journal of Toxicology: Clinical*

- Toxicology. 2002; 40(4):415-46. [DOI:10.1081/clt-120006745] [PMID]
- [5] Doreen B, Eyu P, Okethwangu D, Biribawa C, Kizito S, Nakanwagi M, et al. Fatal methanol poisoning caused by drinking adulterated locally distilled alcohol: Wakiso district, Uganda, June 2017. *Journal of Environmental and Public Health*. 2020; 2020:5816162. [DOI:10.1155/2020/5816162] [PMID] [PMCID]
- [6] Kerns W, Tomaszewski C, McMartin K, Ford M, Brent J. META study group. Methylpyrazole for toxic alcohols. Formate kinetics in methanol poisoning. *Journal of Toxicology: Clinical Toxicology*. 2002; 40(2):137-43. [DOI:10.1081/clt-120004401] [PMID]
- [7] McMartin K, Jacobsen D, Hovda KE. Antidotes for poisoning by alcohols that form toxic metabolites. *British Journal of Clinical Pharmacology*. 2016; 81(3):505-15. [DOI:10.1111/bcp.12824] [PMID] [PMCID]
- [8] Sivilotti ML, Burns MJ, Aaron CK, McMartin KE, Brent J. Reversal of severe methanol-induced visual impairment: No evidence of retinal toxicity due to fomepizole. *Journal of Toxicology: Clinical Toxicology*. 2001; 39(6):627-31. [DOI:10.1081/clt-100108496] [PMID]
- [9] Chick J. Alcohol and COVID-19. *Alcohol and Alcoholism (Oxford, Oxfordshire)*. 2020; 55(4):341-2. [DOI:10.1093/alcac/agaa039]
- [10] Arasteh P, Pakfetrat M, Roozbeh J. [A surge in methanol poisoning amid COVID-19 pandemic: Why Is this occurring? (Persian)]. *The American Journal of the Medical Sciences*. 2020; 360(2):201. [DOI:10.1016/j.amjms.2020.05.019] [PMID] [PMCID]
- [11] Banagozar Mohammadi A, Delirrad M. [Problems with methanol poisoning outbreaks in Iran (Persian)]. *Alcohol and Alcoholism*. 2019; 54(3):338. [DOI:10.1093/alcac/agz028] [PMID]
- [12] Chegeni M, Kamel Khodabandeh A, Karamouzian M, Shokoohi M, Abedi L, Khalili M, et al. [Alcohol consumption in Iran: A systematic review and meta-analysis of the literature (Persian)]. *Drug and Alcohol Review*. 2020; 39(5):525-38. [DOI:10.1111/dar.13093] [PMID]
- [13] Hovda KE, Hunderi OH, Tafjord AB, Dunlop O, Rudberg N, Jacobsen D. Methanol outbreak in Norway 2002-2004: Epidemiology, clinical features and prognostic signs. *Journal of Internal Medicine*. 2005; 258(2):181-90. [DOI:10.1111/j.1365-2796.2005.01521.x] [PMID]
- [14] Paasma R, Hovda KE, Tikkerberi A, Jacobsen D. Methanol mass poisoning in Estonia: Outbreak in 154 patients. *Clinical Toxicology (Philadelphia)*. 2007; 45(2):152-7. [DOI:10.1080/15563650600956329] [PMID]
- [15] Zakharov S, Pelcova D, Urban P, Navratil T, Diblik P, Kuthan P, et al. Czech mass methanol outbreak 2012: Epidemiology, challenges and clinical features. *Clinical Toxicology (Philadelphia)*. 2014; 52(10):1013-24. [DOI:10.3109/15563650.2014.974106] [PMID]
- [16] Mostafazadeh B, Eghbali H. [An epidemiologic study on methyl alcohol poisoning in Tehran, Iran (Persian)]. *Asia Pacific Journal of Medical Toxicology*. 2014; 3(Supplement1):8-8. [DOI:10.22038/apjmt.2014.2879]
- [17] Morteza Bagi HR, Tagizadieh M, Moharamzadeh P, Pouraghai M, Kahvareh Barhagi A, Shahsavari Nia K. [Epidemiology of alcohol poisoning and its outcome in the north-west of Iran (Persian)]. *Emergency*. 2015; 3(1):27-32. [PMID] [PMCID]
- [18] Shokoohi M, Nasiri N, Sharifi H, Baral S, Stranges S. [A syndemic of COVID-19 and methanol poisoning in Iran: Time for Iran to consider alcohol use as a public health challenge? (Persian)]. *Alcohol*. 2020; 87:25-27. [DOI:10.1016/j.alcohol.2020.05.006] [PMID] [PMCID]
- [19] Singleton A. "It's because of the invincibility thing": Young men, masculinity, and testicular cancer. *International Journal of Men's Health*. 2008; 7(1). <https://web.s.ebscohost.com/abstract?direct=true&profile=ehost&scope=site&authtype=crawler&jnl=15326306&AN=%3d31381756>
- [20] O'Connor SE, Zupanc ML. Women and epilepsy. *The Journal of Pediatric Pharmacology and Therapeutics*. 2009; 14(4):212-20. [DOI:10.5863/1551-6776-14.4.212] [PMID] [PMCID]
- [21] Sanaei-Zadeh H, Esfeh SK, Zamani N, Jamshidi F, Shadnia S. [Hyperglycemia is a strong prognostic factor of lethality in methanol poisoning (Persian)]. *Journal of Medical Toxicology*. 2011; 7(3):189-94. [DOI:10.1007/s13181-011-0142-x] [PMID] [PMCID]
- [22] Mousavi-Roknabadi RS, Arzhangzadeh M, Safaei-Firouzabadi H, Mousavi-Roknabadi RS, Sharifi M, Fathi N, et al. Methanol poisoning during COVID-19 pandemic; A systematic scoping review. *The American Journal of Emergency Medicine*. 2022; 52:69-84. [DOI:10.1016/j.ajem.2021.11.026]