International Journal of
Medical Toxicology & Forensic Medicine

October 2024, Volume 14, Number 4

Research Paper

Predictive Factors of Mortality in Methanol Poisoning Outbreaks: A Cross-sectional Study During the COVID-19 Pandemic

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Citation Bolvardi E, Rezvani Fard F, Habibzadeh SR, Vahabzadeh M, Panahi M, Mohammadi M, et al. Predictive Factors of Mortality in Methanol Poisoning Outbreaks: A Cross-sectional Study During the COVID-19 Pandemic. International Journal of Medical Toxicology and Forensic Medicine. 2024; 14(4):E45361.https://doi.org/10.32598/ijmtfm.v14i4.45361

https://doi.org/10.32598/ijmtfm.v14i4.45361

Article info:
Received: 18 May 2024
First Revision: 22 May 2024
Accepted: 30 Aug 2024
Published: 12 Oct 2024

Keywords:
Poisoning, Methanol, COVID-19, Iran

ABSTRACT

Background: Methanol poisoning has increased in some countries after the recent coronavirus pandemic. This study aimed to investigate the clinical and paraclinical findings of patients with methanol poisoning during the COVID-19 pandemic.

Methods: This cross-sectional study was conducted on patients diagnosed with methanol poisoning in Imam Reza and Hasheminezhad hospitals who were hospitalized from the beginning of March 2019 to the end of April 2020. Clinical and paraclinical data were extracted from patients' files and subsequently categorized into three groups: deceased patients, living patients without complications, and living patients with complications.

Results: Out of 107 patients included in the study, 20(18.69%) died, 50(46.7%) were discharged without complications, and 37(34.6%) with complications. The most frequent clinical symptoms in the patients were blurred vision (62.6%), lethargy (62.6%), nausea (43%), vomiting (41.1%), abdominal pain (15.9%), dizziness (11.2%), and dyspnea (6.5%). According to the multivariate logistic regression analysis, reduced pH (OR=0.007, P=0.009) and blurred vision symptoms (OR=5.096, P=0.007) significantly predicted complications. Based on univariate logistic regression, hypoxemia (OR=35.90, P=0.002), coma (OR=22.34, P<0.001), high creatinine (OR=62.39, P<0.001), and low pH (OR=0.001, P<0.001) had the greatest impact in predicting mortality.

Conclusion: This study shows the clinical and paraclinical characteristics of methanol poisoning during the COVID-19 pandemic, identifying critical predictors of complications and mortality, including low pH, blurred vision, hypoxemia, coma, and high creatinine levels.

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Introduction

Methanol is a colorless liquid with a distinct smell; its poisoning eventually leads to death by causing acidosis and damage to the vital organs of the body [1]. Most cases of methanol poisoning have been caused by the unintentional oral consumption of this alcohol [2]. So far, there have been reports of epidemics caused by the consumption of this alcohol, which was mainly in people who were exposed to this poisoning after consuming ethanol [1]. An outbreak of methanol poisoning has been reported in Iran and other countries in previous years. For example, 694 cases of methanol poisoning were recorded, among which 8 deaths occurred in Rafsanjan City, Iran, in 2013 [3]. Methanol poisoning epidemics have been reported in several countries. In the Czech Republic, 121 cases and 20 deaths were recorded in 2012. In Malaysia, 31 cases were reported in September 2018, resulting in a mortality rate of approximately 61%. Additionally, Norway experienced 51 cases of methanol poisoning between 2002 and 2004, with 9 fatalities [4-6].

On March 2020, the World Health Organization (WHO) declared the coronavirus infection (COVID-19), which started as a pandemic in Wuhan, China. Iran, along with China, had a significant increase in the infection rate with COVID-19 [7, 8]. In Iran, the COVID-19 pandemic increased the use of alcohol-based disinfectants, which sparked a misconception that drinking alcohol could prevent the disease, resulting in cases of methanol poisoning as people turned to unlicensed, high-methanol alcohol [9]. The most cases of hospitalization due to methanol poisoning in Iran have been reported in the three provinces of Tehran, Khuzestan, and Fars [3]. In March 2018, 647 cases of methanol poisoning were reported in Khuzestan Province, Iran, of which 59 deaths were reported (mortality rate 9.12%). At the same time, in Fars Province, 383 cases of methanol poisoning were reported, of which 61 deaths were recorded (15.93% mortality) [9]. Although the symptoms and signs of methanol poisoning have been investigated in previous studies [10-17], methanol poisoning has remained a significant concern that requires special attention. In the City of Mashhad, Iran, hospitals have seen an increase in patients with symptoms caused by methanol poisoning. To better understand this issue, this study aimed to investigate the frequency of clinical and paraclinical findings of patients with methanol poisoning in Imam Reza and Hasheminejad hospitals.

Materials and Methods

In this cross-sectional study, all hospitalized patients diagnosed with methanol poisoning who were hospitalized in Imam Reza and Hasheminezhad hospitals in Mashhad from the beginning of March 2019 to the end of April 2020 were investigated.

The patients' information in this study was kept confidential, and no one except the researcher had access to it. After the approval of the research assistant of Mashhad University of Medical Sciences and receiving the code of ethics, the patients' information was collected through their files. The inclusion criteria were patients diagnosed with methanol poisoning based on history and clinical and paraclinical findings (serum methanol level greater than 3 mg/dL at admission). The exclusion criteria were patients with a history or paraclinical findings of multiple drug poisoning, patients with simultaneous head trauma, and patients discharged with personal consent (due to the uncertainty of the outcome at discharge and lack of consent to continue treatment).

Then, the necessary information was extracted based on a pre-designed checklist, which included the following parts:

a) Demographic information, including age, gender, time of use until the onset of symptoms, time of use until the time of going to the hospital, underlying disease, history of smoking, history of alcohol use, history of opioid, stimulant, and hallucinogen use;

b) Symptoms and clinical examinations, including vital signs, abdominal pain, nausea, vomiting, blurred vision, flashes, storm and snow scenes, hand motion, complete blindness, lethargy, coma, headache, dizziness, agitation, convulsions and dyspnea, pupil condition, pupil response to light;

c) Laboratory findings, including white blood cells, hemoglobin, platelets, blood methanol level, blood urea, blood creatinine, blood sodium, blood potassium, blood sugar, and level of venous blood gases;

d) Procedures performed during hospitalization, including the need for intubation, need for cardiopulmonary resuscitation, hospitalization in the intensive care unit, emergency hemodialysis, treatment with ethanol, treatment with folic acid, treatment with sodium bicarbonate, hemodialysis, methylprednisolone; and

e) Outcome (without complications, complications, and death) and hospitalization period.

After collecting information, the patients were divided into alive and deceased patients, and the group of living patients was further divided into two groups: Living patients without complications and living patients with complications.

The patients in this study were treated with ethanol, folic acid, sodium bicarbonate, and hemodialysis. A summary of the treatment is described as follows:

a) In patients with severe methanol poisoning (severe acidosis (pH<7.2), presence of eye symptoms or signs, decreased level of consciousness), the patient was immediately treated with an antidote (10% intravenous ethanol with a dose of 8 mL/kg), intravenous folic acid administration, and emergency hemodialysis until the level of methanol in the blood reached 0. The serum pH became normal and continued. The suggested time for each dialysis session was at least 4 hours.

b) Treatment of mild to moderate methanol poisoning included the administration of antidote. If the patient is asymptomatic, antidote administration can be delayed for 2 hours until the serum methanol level is available. Folic acid was prescribed for all patients who received an antidote. Dialysis was performed in case of metabolic acidosis (pH<7.3) and serum methanol level of more than 50 mg/dL, even without severe clinical symptoms or lack of acidosis.

Data analysis was done using SPSS software, version 26. Quantitative variables were compared between living and deceased patients using the independent t-test, and non-normally distributed variables were compared using the Mann-Whitney test. Qualitative variables were compared using the chi-square test and, if necessary, the Fisher exact test. Logistic regression was also used to predict the influential factors that cause complications and mortality. Odds ratios were reported along with 95% confidence intervals. All tests had a significance level of P<0.05.

Results

A total of 149 patients diagnosed with methanol poisoning were admitted to Imam Reza and Hashemine-zhad hospitals. According to the inclusion and exclusion criteria, 107 patients (71.8%) were included in the study. The reason for the exclusion of 42 was that 29(69%) had taken other substances such as opioids, stimulants, hallucinogens, benzodiazepines, and anticonvulsants in addition to methanol poisoning, and 13(31%) left the hospital with their consent.

Of 107 patients included in the study, 92(86%) were male, and the average age of the patients was 29.52±9.73 years. Twenty patients (18.69%) died, 50(46.7%) were discharged from the hospital without complications, and 37(34.6%) with complications. In total, 87 patients (81.31%) survived. Among the 37 patients who experienced complications, the most common ones were visual impairment, which occurred in 33(89%), while 4(11%) developed neurological sequelae due to intracranial hemorrhage.

The mean time taken until the onset of symptoms in this study was 27.47±17.81 h, and the average time taken until going to the hospital was 36.08±19.67 h. Twenty-five patients (23.4%) had a history of smoking, 43(40.2%) had a history of alcohol consumption, and 13(12.1%) had a history of illegal substance use. The average age of the survived group without complications was significantly lower than the survived group with complications (P=0.02). The history of alcohol consumption in the surviving group with complications was significantly higher than in the living group without complications (P=0.04). In other cases, no statistically significant difference was found (Table 1).

The most common symptoms of the disease, in general, were blurred vision and lethargy in 67 patients (62.6%). However, in patients alive without complications, 26 patients had blurred vision (52%), and 19 had nausea (38%). Also, in survived patients with complications, 31 patients had blurred vision (83.8%), and 20 had nausea (54.1%). Of deceased patients, 10 had blurred vision (50%), 7(35%) nausea, and 7(35%) vomiting.

In the statistical analysis between the studied groups, in terms of blurring of vision and complete blindness, a significant difference was observed between the survived group without complications and those with complications, based on the chi-square and Fisher exact tests with P=0.002 and P=0.04, respectively. In other cases, the groups had no statistically significant difference (Table 2).

As Table 3 shows, between the three groups in terms of coma (P<0.001), hypotension (P=0.03), and tachypnea (P=0.007), there was a statistically significant difference in dyspnea (P<0.001). Also, between the three groups regarding leukocytosis (P<0.001), hypernatremia (P=0.003), hyperkalemia (P=0.001) and hyperglycemia (P<0.001) had a statistically significant difference (Table 2).

Table 1. Comparing demographic findings and underlying diseases of methanol poisoning patients

Variables		Mean±SD/No. (%)					P	
		All Patients	Alive Patients	Patients Without Complications	Patients With Complications	Deceased Patients	Alive vs Deceased	With Complications vs Without Complications
Age (y)		29.53±9.7	29.34±9.2’	28.48±9.71	31.68±7.98	30.3±1.2	0.69***	0.02***
Sex	Male	92(85.98)	74(85.06)	42(84)	32(86.49)	18(90)	0.43**	0.74*
	Female	15(14.02)	13(14.94)	8(16)	5(13.51)	2(10)		
Underlying disease	Yes	1(0.93)	0(0)	0(0)	0(0)	1(5)	-	-
	No	106(99.07)	87(100)	50(100)	37(100)	19(95)		
History of smoking	Yes	25(23.36)	21(24.14)	10(20)	11(29.73)	4(20)	0.47**	0.29*
	No	52(48.6)	66(75.86)	40(80)	26(70.27)	16(80)		
History of alcohol consumption	Yes	43(40.19)	34(39.08)	15(30)	19(51.35)	9(45)	0.62*	0.04*
	No	64(59.81)	53(60.92)	35(70)	18(48.65)	11(55)		
History of illegal substance use	Yes	13(12.15)	10(11.49)	5(10)	5(13.51)	3(15)	0.45**	0.42*
	No	92(85.98)	74(85.06)	42(84)	32(86.49)	18(90)		
Time of use until onset of symptoms, hours		27.47±18.71	27.4±18.54	26.08±17.08	29±16.82	28±12.39	0.67****	0.61***
Time of use until hospital arrival, hours		36.8±19.67	36.96±20.45	34.51±21.69	40.57±18.38	31.5±15.04	0.54****	0.26****

*Chi-square test, **Fisher exact test, ***Independent t-test, ****Mann-Whitney test.

International Journal of Medical Toxicology & Forensic Medicine

The average length of hospitalization of all patients was 3.33±2.3 days. Folic acid and ethanol were the most common treatments (Table 4). Of 69 patients with clinical symptoms, 33(47.82%) were discharged with visual impairment.

Univariate logistic regression has investigated factors predicting mortality in methanol poisoning patients. It was found that pH decrease, creatinine increase, hypoxemia, and coma had the strongest odds ratio in predicting mortality (Table 3).

Predictive factors of complications in methanol poisoning patients have been investigated by univariate logistic regression, which showed that pH reduction, blurring of vision, and history of alcohol use had the strongest odds ratio in predicting complications. Multivariate logistic regression indicated that the decrease in pH (95% CI, 0.000%, 0.278%; OR=0.007) and blurred vision (OR=5.096, 95% CI, 16.655%, 16.659%) significantly predicted what happened.

Discussion

Methanol poisoning is a severe and potentially life-threatening condition that typically occurs when methanol is ingested accidentally. In Iran, methanol poisoning has gained attention by experts shortly after the COVID-19 outbreak. Following the spread of misinformation on social media claiming that drinking or gargling with alcohol could prevent or treat COVID-19, numerous cases of toxic alcohol poisoning were reported to Iranian clinical toxicology centers. These cases presented with a range of symptoms, from mild gastrointestinal symptoms such as nausea and vomiting to severe and potentially fatal complications, including organ failure, blindness, and death [17, 18].

WHO advises using 70% ethyl alcohol to disinfect reusable equipment and 0.5% sodium hypochlorite to disinfect surfaces at homes and healthcare facilities, along with measures like social distancing and mask-wearing, to combat the spread of COVID-19. In response, the Iranian population rushed to use alcohol for hand and

Table 2. Comparing the frequency of clinical symptoms of methanol poisoning

	Variables	Mean±SD/No. (%)					P*	P**
		All Patients (n=107)	Alive Patients (n=87)	Patients Without Complications (n=50)	Patients With Complications (n=37)	Deceased Patients (n=20)		
Symptom	Nausea	46(42.99)	39(44.83)	19(38)	20(54.05)	7(35)	0.42	0.13
	Vomiting	44(41.12)	37(42.53)	17(34)	20(54.05)	7(35)	0.53	0.06
	Abdominal pain	17(15.89)	14(16.09)	6(12)	8(21.62)	3(15)	0.9	0.22
	Blurry vision	67(62.62)	57(65.52)	26(52)	31(83.78)	10(50)	0.19	0.002
	Flashes	0(0)	0(0)	0(0)	0(0)	0(0)		
	View of storm and snow	2(1.87)	2(2.3)	0(0)	2(5.41)	0(0)	0.66	0.17
	Hand motion	7(6.54)	7(8.05)	2(4)	5(13.51)	0(0)	0.22	0.11
	Complete blindness	6(5.61)	6(6.9)	1(2)	5(13.51)	0(0)	0.27	0.04
	Lethargy	67(62.62)	28(32.18)	17(34)	11(29.73)	5(25)	0.53	0.67
	Convulsions	3(2.8)	0(0)	0(0)	0(0)	3(15)	0.06	-
	Headache	7(6.54)	6(6.9)	4(8)	2(5.41)	1(5)	0.61	0.49
	Vertigo	12(11.21)	10(11.49)	7(14)	3(8.11)	2(10)	0.6	0.3
	Agitation	3(2.8)	2(2.3)	1(2)	1(2.7)	1(5)	0.46	0.67
	Dyspnea	7(6.54)	5(5.75)	4(8)	1(2.7)	2(10)	0.38	0.28
Physical examination	Coma	14(13.08)	3(3.45)	0(0)	3(8.11)	11(55)	<0.001	<0.001
	Hypotension	2(1.87)	0(0)	0(0)	0(0)	2(10)	0.03	-
	Tachycardia	18(16.82)	14(16.09)	6(12)	8(21.62)	4(20)	0.4	0.25
	Tachypnea	13(12.15)	7(8.05)	4(8)	3(8.11)	6(30)	0.007	0.64
	Hypoxemia	6(5.61)	1(1.15)	1(2)	0(0)	5(25)	<0.001	0.57
Laboratory data	Leukocytosis	52(48.6)	35(40.23)	19(38)	16(43.24)	17(85)	<0.001	0.3
	Anemia	3(2.8)	2(2.3)	1(2)	1(2.7)	1(5)	0.47	0.67
	Polycythemia	61(57.01)	51(58.62)	26(52)	25(67.57)	10(50)	0.28	0.09
	Thrombocytopenia	8(7.48)	6 (6.9)	2(4)	4(10.81)	2(10)	0.44	0.19
	Thrombocytosis	3(2.8)	1(1.15)	0(0)	1(2.7)	2(10)	0.08	0.41
	Hyponatremia	7(6.54)	5(5.75)	4(8)	1(2.7)	2(10)	0.43	0.36
	Hypernatremia	7(6.54)	2(2.3)	2(4)	0(0)	5(25)	0.003	0.39
	Hypokalemia	14(13.08)	11(12.64)	7(14)	4(10.81)	3(15)	0.55	0.63
	Hyperkalemia	20(18.69)	10(11.49)	6(12)	4(10.81)	10(50)	<0.001	0.5

	Variables	Mean±SD/No. (%)					P*	P**
		All Patients (n=107)	Alive Patients (n=87)	Patients Without Complications (n=50)	Patients With Complications (n=37)	Deceased Patients (n=20)		
Laboratory data	Hyperglycemia (mmol/L)	12(11.21)	3(3.45)	0(0)	3(8.11)	9(45)	<0.001	0.06
	Blood methanol level (mmol/L))	54.09±42.26	0.5±42.82	46.64±39.79	54.53±46.78	71.09±35.4	0.036	0.39
	Blood urea (mmol/L)	31.53±15.47	25.51±13.56	29.16±14.14	30.01±12.87	39.73±19.95	0.01	0.78
	Blood creatinine (µmol/L)	1.2±0.63	1.01±0.26	0.98±0.23	1.06±0.29	1.98±1.02	<0.001	0.09
	pH	7.13±0.22	7.19±0.19	7.24±0.11	7.12±0.17	6.88±0.29	<0.001	<0.001
	HCO_3 (mmol/L)	12.99±8.05	13.71±7.14	15.82±6.89	10.7±6.45	9.09±12.61	<0.001	<0.001
	PCO_2 (kPa)	33.69±14.36	32.26±13.54	35.22±14.68	28.15±10.64	38.76±16.83	0.06	0.06
	Base excess (mmol/L)	-13.14±10.74	-11.45±9.73	-8.17±7.99	-15.75±10.73	-24.78±8.95	<0.001	0.002
Treatments	Emergency hemodialysis	19(17.76)	12(13.79)	3(6)	9(24.32)	7(35)	<0.001	<0.001
	Intravenous ethanol	96(89.72)	80(91.95)	46(92)	34(91.89)	16(80)	0.47	0.9
	Intravenous folic acid	98(91.59)	82(94.25)	46(92)	36(97.3)	16(80)	0.43	0.84
	Intravenous sodium bicarbonate	70(65.42)	55(63.22)	29(58)	26(70.27)	15(75)	0.31	0.46
	Hemodialysis	85(79.44)	69(79.31)	33(66)	36(97.3)	16(80)	0.9	0.03
	Intravenous methylprednisolone	43(40.19)	37(42.53)	21(42)	16(43.24)	6(30)	0.67	0.9
	Hospitalization in ICU	11(10.28)	4(4.6)	0(0)	4(10.81)	7(35)	0.002	-
	Need for intubation	25(23.36)	5(5.75)	0(0)	5(13.51)	20(100)	<0.001	-
	Need for cardiopulmonary resuscitation	20(18.69)	0(0)	0(0)	0 (0)	20(100)	<0.001	-

International Journal of Medical Toxicology & Forensic Medicine

*For alive vs deceased patients' comparison, **For patients with complications vs without complications.

surface disinfection, leading to a shortage in pharmacies. However, misinformation on social media led many people to mistakenly believe that drinking alcohol could prevent or cure COVID-19, prompting them to consume it. This situation is particularly problematic in Iran, where the production, consumption, and distribution of alcoholic beverages have been prohibited by law since 1979 and are only permitted for medical and industrial purposes. As a result, many Iranians obtain alcohol through illegal means, such as homemade production or smuggling from neighboring countries [18, 19].

From March 2018 to May 2019, more than 5876 cases of methanol poisoning were reported in the country, according to the official announcement of the Ministry of Health and Medical Education. Of these, 534 cases of definite death due to methanol poisoning were reported. Iran's Forensic Medicine Organization has reported 800 deaths from all methanol poisonings in this period, including in-hospital and out-of-hospital cases (mortality rate 14%) [3]. The mentioned statistics have increased more than 8 times compared to the same period in the previous year [9]. This figure is about 5 times higher than the largest methanol poisoning epidemic in 2013 in Libya, where 1066 cases of poisoning were reported [3].

Table 3. Factors predicting the mortality of methanol poisoning patients by univariate logistic regression

Variables	OR (95% CI) for Death	P
Coma	34.22 (8.02-145.88)	<0.001
Tachypnea	6.25 (1.74-22.39)	0.005
Hypoxemia	35.9 (3.83-336.55)	0.002
Leukocytosis	11.41 (2.47-52.66)	0.002
Hyperglycemia	21.75 (12.47-97.59)	<0.001
Hypernatremia	12.83 (2.27-72.43)	0.004
Hyperkalemia	7.44 (2.04-22.79)	<0.001
Blood methanol level	0.01 (1.01-1.02)	0.004
Urea	1.37 (1.07-1.68)	0.015
Creatinine	62.39 (15.03-447.28)	<0.001
pH	0.01 (0-0.16)	<0.001
HCO_3	0.928 (0.1-856.006)	0.69
PCO_2	1.29 (9.97-1.63)	0.076
Base excess	8.35 (7.65-9.1)	<0.001

International Journal of
Medical Toxicology & Forensic Medicine

Table 4. Factors predicting the state of complications in methanol poisoning patients by univariate logistic regression

Variables	Univariate Logistic Regression	
	OR (95% CI)	P
Age	1.61 (1.03-2.23)	0.039
History of alcohol consumption	6.63 (1.18-14.62)	0.046
Vomiting	4.84 (9.55-9.62)	0.063
Blurred vision	11.69 (7.94-17.31)	0.003
Complete blindness	7.65 (8.55-73.99)	0.69
Creatinine	10.22 (6.21-22.29)	0.15
pH	0.02 (0-1.12)	0.002
HCO_3	8.86 (8.21-9.57)	0.002
PCO_2	9.55 (9.18-9.93)	0.021
BE	9.23 (8.74-9.75)	0.004

International Journal of
Medical Toxicology & Forensic Medicine

Methanol is quickly absorbed into the bloodstream after consumption. Although it is not toxic, it is converted into toxic metabolites, formaldehyde, and formic acid, by enzymes in the body. These metabolites can cause cell dysfunction, organ failure, and damage to the retina and brain, leading to blindness and brain lesions. The accumulation of these toxins also leads to metabolic acidosis and an increased anion gap, which are characteristic symptoms of methanol poisoning [20].

In our study, out of 107 patients, 18.69% died, 46.7% were discharged without complications, and 34.6% were discharged with complications, including visual impairment and neurological complications. Similar studies have reported comparable outcomes, including a 2014 study in the Czech Republic (20.8% mortality, 59.4% alive without complications, and 19.8% alive with complications) [6], a 2018 study in Egypt (17% mortality, 41.2% alive without complications, and 23.5% alive with complications) [21], a 2007 study in Estonia (23% mortality, 60% alive without complications, and 18% alive with complications) [10], and a 2005 study in Norway (18% mortality, 73% alive without complications, and 10% alive with complications) [22].

Our study found that the average age of methanol poisoning patients was 29.52±9.73 years, which is lower compared to similar studies in the Czech Republic (53 years), Egypt (43.47 years), and Norway (53 years) [6, 21, 22]. Older patients in our study had more complications, but age was not a significant predictor of complications in univariate or multivariate logistic regression. A history of alcohol consumption was reported in 40.2% of patients, which is lower compared to a study in Egypt (92.2%) [21]. Patients with a history of alcohol consumption had more complications, and this factor was a predictive factor in univariate logistic regression (OR=2.463, P=0.046). Visual disturbances were common at admission (67%), and blurred vision was a significant predictor of developing complications at discharge in both univariate (OR=4.769, P=0.003) and multivariate (OR=5.096, P=0.007) logistic regression. Similar studies have reported visual disturbances in 29% to 64% of patients [22, 24-28].

Gastrointestinal disorders, such as nausea (43%), vomiting (41.1%), and abdominal pain (15.9%), were common in methanol poisoning patients. Similar studies reported gastrointestinal symptoms in 18% to 67% of patients [6, 22, 24, 26, 28]. Seizures occurred in 2.8% of patients, which was associated with high mortality [29]. Leukocytosis was observed in 52% of patients and was a significant predictor of mortality in univariate logistic regression (OR=11.41, P=0.002) [30]. Hyperglycemia was also a significant predictor of mortality (OR=21.75, P<0.001) and may be associated with acute pancreatitis [31-33]. Hyperkalemia was higher in deceased patients and was a significant predictor of mortality in univariate logistic regression (OR=7.44, P<0.001) [34]. High blood methanol levels were also associated with mortality, although the effect was small (OR=1.01, P=0.04).

In our study, low pH, high creatinine, and coma were strongly associated with mortality and were significant predictors of mortality in univariate logistic regression. Similarly, other studies found that pH, creatinine, and coma were predictors of mortality in methanol poisoning patients [10, 22, 23, 35-38]. Metabolic acidosis, serum methanol concentration, and hyperventilation ability were also related to patient outcomes [10, 22]. Other studies identified additional predictors of mortality, including respiratory arrest [22], seizures [35], anion gap [37], and Glasgow coma scale score [39]. Multivariate regression models found that parameters such as severity of metabolic acidosis, coma during admission, serum ethanol, and serum creatinine were predictors of mortality [38, 40].

Patients with methanol poisoning often present with respiratory symptoms such as tachypnea, dyspnea, and hypoxemia, which can be mistaken for COVID-19, highlighting the importance of considering methanol poisoning as a differential diagnosis in patients with these symptoms [41]. The study provides an overview of the clinical and paraclinical symptoms of methanol poisoning in Iranian patients, emphasizing the need for improved management, prevention, and education to reduce morbidity and mortality from this preventable condition.

Conclusion

This study investigated the clinical and paraclinical findings of patients with methanol poisoning during the COVID-19 pandemic. The results showed that methanol poisoning is a severe condition with a mortality rate of 18.69%. Reduced pH and blurred vision were significant predictors of complications, while hypoxemia, coma, high creatinine, and low pH were the strongest predictors of mortality.

One of the study's limitations is its retrospective nature, and the information of some patients, such as serum chlorine level, was not recorded to check the anion gap of the patients and the cause of their death. Conducting this study in Imam Reza and Hasheminezhad (multicentral) hospitals, which are the center of poisonous

diseases in the region and many patients from different areas are referred to this hospital (high sample size), is one of the strengths of the study. Another strength is the cooperation of emergency medicine and clinical toxicology specialists in conducting this study.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the research assistant of Mashhad University of Medical Sciences (Code: IR.MUMS.REC.1399.133).

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 conflict of interest.

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