Turkish Journal of Neurology

Turk J Neurol 2024;30(1):31-36
Doi: 10.55697/tnd.2024.47

ORIGINAL ARTICLE

Methyl alcohol intoxication in Izmir: A retrospective analysis

İzmir'de metil alkol zehirlenmesi: Retrospektif analiz

Hasan Armağan Uysal[1], Halil Güllüoğlu[1], Müge Kuzu Kumcu[2,3], Fatma Nazlı Durmaz Çelik[4]

[1]Department of Neurology, Izmir Ekonomi University Medical Point Hospital, Izmir, Türkiye
[2]Department of Neurology, Lokman Hekim University Lokman Hekim University School of Medicine, Ankara, Türkiye
[3]Department of Neuroscience, Ankara University Faculty of Medicine, Ankara, Türkiye
[4]Department of Neurology, Osmangazi University Faculty of Medicine, Eskişehir, Türkiye

ABSTRACT

Objectives: This study aimed to investigate methyl alcohol poisoning cases in Izmir.

Patients and methods: The retrospective study included 15 patients (14 males, 1 female; mean age: 56.1±9.3 years; range, 40 to 71 years) diagnosed with methyl alcohol poisoning due to counterfeit alcoholic beverage consumption between October 1, 2020, and October 30, 2020. Patients were grouped according to survival. The demographic and clinical data, including the Acute Physiology and Chronic Health Evaluation II scoring and Glasgow Coma Scale scores, were compared.

Results: Of the patients, eight (53.3%) died, and seven survived. There was no significant difference between deceased and surviving patients regarding optical nerve involvement, mechanical ventilation need, and dyspnea (p=0.057, p=0.467, and p=0.467, respectively). On the other hand, a significant difference was observed between deceased and surviving patients regarding radiological imaging, visual impairment, gastrointestinal symptoms, and vasopressor agent need (p=0.044, p<0.001, p=0.011, and p=0.026, respectively). Mortality was significantly correlated with vasopressor agent needs, Acute Physiology and Chronic Health Evaluation II score, and Glasgow Coma Scale score (p=0.009; r=0.645, p=0.009; r=–0.652, p=0.008; and r=0.562, p=0.029; respectively).

Conclusion: Methyl alcohol poisoning is a common and even accelerating problem in Türkiye and results in high mortality and morbidity. Clinical, social, and economic strategies should be developed by national authorities to combat the issue.

Keywords: Alcohol consumption, methanol, poisoning.

ÖZ

Amaç: Bu çalışmada, İzmir'deki metil alkol zehirlenme vakalarının incelemesi amaçlandı.

Hastalar ve yöntemler: Bu retrospektif çalışmaya 1 Ekim 2020-30 Ekim 2020 tarihleri arasında sahte alkollü içecek tüketimi nedeniyle metil alkol zehirlenmesi tanısı konan 15 hasta (14 erkek, 1 kadın; ort. yaş: 56,1±9,3 yıl; dağılım, 40-71 yıl) dahil edildi. Hastalar sağkalıma göre gruplandırıldı. Akut Fizyoloji ve Kronik Sağlık Değerlendirme II skorlaması ve Glasgow Koma Skalası skorları dahil olmak üzere demografik ve klinik veriler karşılaştırıldı.

Bulgular: Hastalardan sekizi (%53,3) öldü ve yedisi hayatta kaldı. Hayatını kaybeden ve hayatta kalan hastalar arasında optik sinir tutulumu, mekanik ventilasyon ihtiyacı ve dispne açısından anlamlı bir fark yoktu (sırasıyla p=0,057, p=0,467 ve p=0,467). Bununla birlikte, hayatını kaybeden ve hayatta kalan hastalar arasında radyolojik görüntüleme, görme bozukluğu, gastrointestinal semptomlar ve vazopressör ajan ihtiyacı açısından anlamlı bir fark gözlendi (sırasıyla p=0,044, p<0,001, p=0,011 ve p=0,026). Mortalite; vazopressör ajan ihtiyacı, Akut Fizyoloji ve Kronik Sağlık Değerlendirme II skoru ve Glasgow Koma Skalası skoru ile anlamlı bir şekilde ilişkiliydi (sırasıyla p=0,009; r=0,645, p=0,009; r=–0,652, p=0,008; ve r=0,562, p=0,029).

Sonuç: Metil alkol zehirlenmesi, Türkiye'de yaygın ve hatta artan bir sorun olup yüksek mortalite ve morbiditeye neden olmaktadır. Ulusal otoriteler tarafından bu sorunun önüne geçmek için klinik, sosyal ve ekonomik stratejiler geliştirilmelidir.

Anahtar sözcükler: Alkol tüketimi, metanol, zehirlenme.

Correspondence: Hasan Armağan Uysal, MD. İzmir Ekonomi Üniversitesi Medical Point Hastanesi, Nöroloji Bölümü, 35575 Karşıyaka, İzmir, Türkiye
E-mail: druysalarmagan@yahoo.com
Received: July 23, 2023 **Accepted:** November 11, 2023 **Published online:** March 26, 2024
Cite this article as: Uysal HA, Güllüoğlu H, Kuzu Kumcu M, Durmaz Çelik FN. Methyl alcohol intoxication in Izmir: A retrospective analysis. Turk J Neurol 2024;30(1):31-36. doi: 10.55697/tnd.2024.47.

Methyl alcohol, also known as methanol, is a kind of aliphatic alcohol, mostly used as an organic solvent in cosmetic formulations and in many other industrial products, such as plastics, fuels, polyesters, and other chemicals.[1] It is categorized in the toxic alcohols group, which also includes ethylene glycol and isopropyl alcohol.[2] Nearly all cases of acute methyl alcohol intoxication arise from ingestion, and there are some rare cases resulting from inhalation or dermal absorption.[3] Accidental ingestions, particularly among children and the elderly, and intentional consumption through adulterated alcoholic beverages are common.[4,5] Given its cost-effectiveness and accessibility relative to ethanol, methyl alcohol is illicitly substituted, leading to widespread intoxication in developing countries.[6-8] Several methyl alcohol poisoning outbreaks have been reported in these countries, such as in Iran,[9] India,[10-12] and Türkiye.[13] The toxicity of methyl alcohol results from its metabolites, namely formaldehyde and its oxidized form of formic acid. Formic acid is highly toxic to the nervous system and induces severe metabolic acidosis, which can cause toxicity and permanent complications in various organs and even death.[14,15] Methyl alcohol is rapidly absorbed through various routes (dermal, inhalation, and oral routes), easily permeating cell membranes and distributing throughout tissues.[11] Clinical symptoms of methyl alcohol poisoning can be classified as headache, nausea, vomiting, drowsiness, abdominal pain, renal insufficiency, visual impairment, respiratory failure, and central nervous system depression leading to coma.[7,12,14] Treatment approaches include inhibiting toxic metabolite formation through antidote administration (intravenous/oral ethanol or fomepizole), alkalization to mitigate metabolic acidosis, removal of toxic metabolites via selective hemodialysis, intravenous folinic acid administration, and standard supportive care.[3,15]

This study aimed to underscore the severity and prevalence of such poisoning cases by investigating methyl alcohol poisoning cases in Izmir. Such research endeavors can assist in the development of strategies to prevent similar poisoning incidents in the future. This study represents a significant contribution to the field of methanol poisoning, supporting efforts to reduce the incidence of such cases and develop effective treatment approaches.

PATIENTS AND METHODS

This retrospective study was conducted with 15 patients (14 males, 1 female; mean age: 56.1±9.3 years; range, 40 to 71 years) who were diagnosed with methyl alcohol poisoning due to counterfeit alcoholic beverage consumption in the Intensive Care Unit (ICU) of the Izmir Ekonomi University Medical Point Hospital, between October 1, 2020, and October 30, 2020. Patients were grouped according to survival, and the demographic and clinical data were compared between the groups.

The diagnosis of methyl alcohol poisoning was performed according to the typical clinical presentation, clinical history, blood tests, and imaging. Acidosis analysis via arterial blood gases and serum bicarbonate level measurements were performed in all patients. All patients had blood acidosis and were treated with bicarbonate and hemodialysis. Acute Physiology and Chronic Health Evaluation (APACHE) II and Glasgow Coma Scale (GCS) were evaluated in all patients to classify the severity of the poisoning. The APACHE II interpretation is based on a score between 0 and 71, where a higher score is associated with higher risk of death.[16] Glasgow Coma Scale measures the consciousness level of the patients according to the eye-opening, motor, and verbal responses with a score between 3 and 15, where a higher score implies higher conscious response.[17] Magnetic resonance imaging of the brain was recorded in all of the patients.

Statistical analysis

Statistical analysis was performed using the PASW version 18.0 software (SPSS Inc., Chicago, IL, USA). The descriptive data were expressed as numbers and percentiles for categorical variables and as mean, standard deviation, median, and minimum-maximum (range) for numerical variables. The normal distributions of variables were tested by visual (histograms and probability graphics) and analytical (Kolmogorov-Smirnov/Shapiro-Wilk) test methods. For categorical variables, in two group comparisons, the Pearson chi-square test was used when applicable (expected value >5); otherwise, Fisher exact test was used. For numerical variables, the Mann-Whitney U test was used in two group comparisons when data were nonnormally distributed. Spearman correlation test was used for the analysis of the relation between patient data and mortality. A p-value <0.05 was considered statistically significant.

RESULTS

The distribution of the demographic and clinical data in the study groups is summarized in Table 1. Of

TABLE 1
Demographic and clinical data of surviving and deceased patients

	Patients who died (n=8)				Patients who survived (n=7)				
	n	%	Median	Min-Max	n	%	Median	Min-Max	*p*
Age (year)			52.5	41-61			66.0	40-71	0.072**
Sex									N/A
Male	8	100.0			6	85.7			
Female	0	0.0			1	14.3			
Magnetic resonance imaging									0.044*
Basal ganglia necrosis	0	0.0			3	42.9			
Diffuse axonal injury	8	100.0			3	42.9			
No	0	0.0			1	14.3			
Optical nerve involvement	5	62.5			1	14.3			0.057***
Hemorrhage	1	12.5			0	0.0			N/A
Visual impairment									N/A
No	0	0.0			7	100.0			
Not tested	8	100.0			0	0.0			
Gastrointestinal symptoms									N/A
Yes	1	12.5			2	28.6			
No	1	12.5			5	71.4			
Unknown	6	75.0			0	0.0			
Mechanical ventilation need	8	100.0			6	85.7			0.467***
Vasopressor agent need	8	100.0			3	42.9			0.026***
Organ transplant	1	12.5			0	0.0			N/A
Brain death	4	50.0			0	0.0			N/A
Dyspnea									0.467***
No	0	0.0			1	14.3			
Intubated	8	100.0			6	85.7			
Intensive care (day)			16.5	3-77			5.0	3-20	0.232**
Hemodialysis duration (day)			2.5	1-12			2.0	1-4	0.536**
APACHE II score			33.0	22-43			27.0	15-31	0.014**
Glasgow Coma Scale			3.0	3-6			9.0	3-14	0.040**

APACHE: Acute Physiology and Chronic Health Evaluation; * Pearson chi-square test; ** Mann-Whitney U test; *** Fisher exact test. APACHE Acute Physiology and Chronic Health Evaluation; N/A: Not applicable.

the patients, eight (53.3%) died, and seven survived. The only female participant in the study was in the survival group.

The 50-year-old male patient (APACHE II score of 33 and a GCS of 6) had optical nerve involvement, required a mechanical ventilator and vasopressor during the therapy, and had organ transplantation. Despite these interventions, the patient could not survive and died after 14 days of ICU stay.

Table 2 shows the correlation of mortality with demographic and clinical data of the patients. Accordingly, mortality was found to be significantly correlated with vasopressor agent need, APACHE II score, and GCS score (p=0.009; r=0.645, p=0.009; r=–0.652, p=0.008; and r=0.562, p=0.029; respectively).

DISCUSSION

In this retrospective study on methyl alcohol poisoning, mortality was significantly associated with radiological imaging, vasopressor agent need, APACHE II scoring, and GCS. In the current study, there was a positive correlation between mortality and APACHE II scoring and a negative correlation between mortality and GCS. It was an expected result since higher APACHE II scores and lower GCS scores are indicators of the lower well-being state of the patient. Similarly, in another study on methyl alcohol poisoning cases in Türkiye, a negative correlation between survival and APACHE II scoring and a positive correlation between survival and GCS were found.[15] In line with these findings, it was reported that mortality was associated with coma

TABLE 2
The correlation between patient data and mortality

	r	*p*
Age	0.498	0.059
Magnetic resonance imaging	−0.319	0.246
Optical nerve involvement	0.491	0.063
Hemorrhage	0.250	0.369
Vasopressor agent need	0.645	0.009
Mechanical ventilation need	0.286	0.302
APACHE II score	0.652	0.008
Glasgow Coma Scale	−0.562	0.029
Intensive care stay (day)	−0.345	0.209
Hemodialysis duration (day)	−0.177	0.529

APACHE: Acute Physiology and Chronic Health Evaluation; Spearman's correlation test coefficient. APACHE Acute Physiology and Chronic Health Evaluation.

and seizure on admission.[12] A significant negative correlation between mortality and gastrointestinal symptoms appears to result from the cases with unknown gastrointestinal conditions in the majority of deceased patients (6 of 8 patients in the current study). There was a significant positive correlation between mortality and vasopressor agent need, a finding consistent with those reported in a similar study.[15]

The sociological aspect comes into play as the surge in demand for illicit alcohol following the spike in alcohol prices is predominantly observed among males. Male individuals tend to exhibit a greater inclination towards alcohol consumption in society, thereby leading to a heightened interest in illicit alcohol within the male population. This could potentially explain why the study included only one female patient.

Radiological findings of the brain in methyl alcohol poisoning have been previously reported, and bilateral necrosis of the basal ganglia was presented as the most common radiological characteristic of methyl alcohol poisoning.[9] Consistently, regarding radiological scans of the current study, basal ganglia necrosis was present in half of the survived patients, and diffuse axonal injury was found in all deceased patients and in the other half of the survived patients. Other studies have reported findings such as bilateral putaminal hemorrhagic necrosis and neuron degeneration with hemorrhage in the parietal cortex.[14,18] In this study, hemorrhage was observed in only one deceased patient. In methyl alcohol poisoning, there is no general agreement between the scope of radiological abnormalities and their medical effect.[9]

The one specific symptom of methyl alcohol poisoning is visual disturbance and optical damage, which generally occur due to the inhibition of retinal hexokinase by the methyl alcohol metabolite formaldehyde. Optical variations, including blurring of the disc edges, hyperemia of the discs, retinal edema, and optic nerve atrophy, are characteristic abnormalities of this poisoning.[11,19] In the current study, in patients who survived, no visual impairment was observed, and optical involvement was found in only one case. Due to impaired consciousness, visual impairment patients from the group resulting in mortality were unable to be evaluated, and therefore, no comparison could be made. Although there was no significant difference between the patient groups, more than half of the patients who died had optical involvement. It appears that the effective and timely treatment in the surviving patients could delay the methyl alcohol metabolism in the liver. Consequently, the unmetabolized methyl alcohol was discharged from the kidneys and lungs, which limited the degree of ocular damage due to the metabolite formaldehyde.[3,20]

In the current study, there was one special case with liver and kidney transplantation. As far as it is concerned, this is the first study reporting organ transplantation in a patient with methyl alcohol poisoning.

Although the duration of ICU stay was relatively lower in the mortality group, no statistically

significant difference was found. We believe that this lack of significance may be attributed to the small sample size in the current study.

In parallel with previous studies,[13,14] the patients in our study were mostly middle-aged male individuals, which can be explained by the habitual alcohol consumption of this sex and age group. It was found that more than half of these patients died. The importance of early diagnosis and timely, appropriate, and aggressive treatment to be able to save patients' lives was confirmed here, as emphasized in many previous studies.[4,10,12,18,19] For successful clinical management, relevant supportive care, infusion of sodium bicarbonate, antidote, methyl alcohol inhibitors, and dialysis are crucial.[7,21] In addition, emergency department physicians should be specifically trained on methyl alcohol poisoning to achieve increased awareness and rapid action-taking capability.[13] Methyl alcohol poisoning should be suspected in all individuals with unexplained metabolic acidosis with an elevated anion gap and vision or neurological abnormalities[12] From the research perspective, even though there were functional therapy protocols, new strategies should be developed with a multidisciplinary approach for the effective treatment of this poisoning.[8,15] On the other hand, social and economic management is also prominent. Significant precautions should be identified to restrict the production and consumption of illegally produced alcoholic beverages,[5] and legal authorities should consider rearranging high taxes and general training of the society on the topic.[13] Future research should be designed to reveal and address both clinical and sociological aspects of methyl alcohol intoxication issues on a national scale in our country.[7]

This study has some limitations. The retrospective and single-center design, small sample size, lack of fomepizole usage, and missing recordings of methyl alcohol measurements were among these limitations. We could not comment on these issues since there was insufficient information about visual impairment and gastrointestinal symptoms from the group that resulted in mortality.

The critical factors for saving lives in cases of methyl alcohol poisoning are early diagnosis and the timely, appropriate, and aggressive administration of treatment. Since the treatment process after diagnosis was not examined in this study, these critical parameters are lacking.

In conclusion, it is believed that as the GCS decreases and the APACHE II score, the need for vasopressor agents, and the duration of stay in the ICU increases, patients' clinical condition worsens, and the risk of mortality increases. Methyl alcohol poisoning is a common and even accelerating problem in Türkiye, which results in high mortality and morbidity, as supported by the findings. The critical parameters to save lives in methyl alcohol poisoning are early diagnosis and timely, appropriate, and aggressive treatment. Both clinical, social, and economic strategies should be developed by national authorities to combat the issue.

Ethics Committee Approval: The study protocol was approved by the Dokuz Eylül University of Health Sciences Ethics Committee (date: 17.05.2022, no: 612). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

Author Contributions: Study design, material preparation, data collection and analysis were performed by H.A.U., H.G.; The first draft of the manuscript was written by H.A.U., and co-author commented on previous versions of the manuscript. All authors contributed to the study conception and design. All authors read and approved the final manuscript.

Conflict of Interest: The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

Funding: The authors received no financial support for the research and/or authorship of this article.

REFERENCES

1. Lanigan S. Final report on the safety assessment of Methyl Alcohol. Int J Toxicol 2001;20 Suppl 1:57-85. doi: 10.1080/109158101750300955.
2. Ashurst JV, Nappe TM. Methanol Toxicity. 2023 Jun 12. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024.
3. 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. J Toxicol Clin Toxicol 2002;40:415-46. doi: 10.1081/clt-120006745.
4. Kukul Güven F, Türkdoğan K, Eren Ş, Aydın H, Korkmaz İ, Coşkun A. Methanol poisoning in three cases:

Diagnosis and treatment in emergency department. İst Tıp Fak Derg 2012;75:25-7.
5. Yayci N, Ağritmiş H, Turla A, Koç S. Fatalities due to methyl alcohol intoxication in Turkey: An 8-year study. Forensic Sci Int 2003;131:36-41. doi: 10.1016/s0379-0738(02)00376-6.
6. Arslan MM, Zeren C, Aydin Z, Akcan R, Dokuyucu R, Keten A, et al. Analysis of methanol and its derivatives in illegally produced alcoholic beverages. J Forensic Leg Med 2015;33:56-60. doi: 10.1016/j.jflm.2015.04.005.
7. Celik S, Karapirli M, Kandemir E, Ucar F, Kantarcı MN, Gurler M, et al. Fatal ethyl and methyl alcohol-related poisoning in Ankara: A retrospective analysis of 10,720 cases between 2001 and 2011. J Forensic Leg Med 2013;20:151-4. doi: 10.1016/j.jflm.2012.05.009.
8. Pohanka M. Toxicology and the biological role of methanol and ethanol: Current view. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub 2016;160:54-63. doi: 10.5507/bp.2015.023.
9. Sefidbakht S, Rasekhi AR, Kamali K, Borhani Haghighi A, Salooti A, Meshksar A, et al. Methanol poisoning: Acute MR and CT findings in nine patients. Neuroradiology 2007;49:427-35. doi: 10.1007/s00234-007-0210-8.
10. Djulard A, Sahata ME. Methyl alcohol poisoning. World News Nat Sciences 2017;8:43-9.
11. Shah S, Pandey V, Thakore N, Mehta I. Study of 63 cases of methyl alcohol poisoning (hooch tragedy in Ahmedabad). J Assoc Physicians India 2012;60:34-6.
12. Kute VB, Godara SM, Shah PR, Gumber MR, Goplani KR, Vanikar AV, et al. Hemodialysis for methyl alcohol poisoning: A single-center experience. Saudi J Kidney Dis Transpl 2012;23:37-43.
13. Kurtas O, Imre KY, Özer E, Can M, Birincioglu I, Butun C, et al. The evaluation of deaths due to methyl alcohol intoxication. Biomed Res (India) 2017;28:3680-7.
14. Karadeniz H, Birincioglu I. Methyl alcohol poisoning in Trabzon (Turkey). J Forensic Sci 2011;56:822-4. doi: 10.1111/j.1556-4029.2011.01623.x.
15. Çetinkaya A, Aslan Sırakaya H, Aydın K. Methyl alcohol poisoning: An analysis of 18 consecutive cases. Turk J Nephrol 2021;30:57-62.
16. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: A severity of disease classification system. Crit Care Med 1985;13:818-29.
17. Jones C. Glasgow coma scale. Am J Nurs 1979;79:1551-3.
18. Nand L, Chander S, Kashyap R, Gupta D, Jhobta A. Methyl alcohol poisoning: A manifestation of typical toxicity and outcome. J Assoc Physicians India 2014;62:756-9.
19. Sutton TL, Foster RL, Liner SR. Acute methanol ingestion. Pediatr Emerg Care 2002;18:360-3. doi: 10.1097/00006565-200210000-00009.
20. Sahin S, Solak S, Akyol O, Vatansever S, Ozyuvaci E. Transdermal methyl alcohol intoxication cause of pain relief. West Indian Med J 2013;62:84-6.
21. Satar S, Alpay NR, Sebe A, Gokel Y. Emergency hemodialysis in the management of intoxication. Am J Ther 2006;13:404-10. doi: 10.1097/01.mjt.0000174344.51554.43.