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An unusual fatal case of mixed intoxication with ethanol and methanol, a case report

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Abstract

Methanol is toxic, with its harmful effects stemming from formic acid. Methanol poisoning, a significant public health issue, usually follows oral consumption. Such poisoning incidents are frequent in Iran and globally. Ethanol or fomepizole serves as the conventional treatment for methanol toxicity. Mixed intoxication involving both ethanol and methanol is relatively rare but can have severe consequences. This study detailed a 29-year-old man who died after consuming an alcoholic beverage and the incorrect hospital administration of ethanol. Postmortem toxicological tests showed high ethanol and methanol levels in femoral blood and vitreous humor. The cause of death was attributed to acute ethanol intoxication. The clinical presentation, toxicological findings, and postmortem examination are discussed. This highlights the need to improve surveillance and treatment for methanol poisoning episodes, particularly in Iran.

Key words: Fatal poisoning, methyl alcohol, ethyl alcohol.

Introduction

Methanol, commonly used in industrial processes, poses toxic effects due to its conversion by aldehyde dehydrogenase and alcohol dehydrogenase into formic acid. (1,2) Most methanol intoxication cases result from oral ingestion, making it a current public health issue in developing countries. (3,4) Worldwide, methanol mass poisoning incidents occur with alarming frequency, including a notable outbreak in recent decades. (5,6) The standard treatment for methanol ingestion involves inhibiting alcohol dehydrogenase (ADH) using either fomepizole or ethanol. (7) Fomepizole is the recommended first-line antidote for methanol intoxication. (8) Ethanol, encountered frequently in forensic toxicology, can lead to symptoms such as ataxia, incoordination, slurred speech, coma, and potentially respiratory depression and death in cases of acute ethyl alcohol intoxication. (9,10) Ethyl alcohol intoxication is common worldwide. (11) Normally, when a patient complains of methanol intoxication, the concentration of methanol and other alcohols should be measured. Then, treatment with an antidote, ethanol, or a drug such as fomepizole should be performed. This case highlighted the importance of early diagnosis and appropriate management in cases of combined alcohol and methanol poisoning.

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Case presentation

A 29-year-old man who was poisoned after consuming adulterated alcoholic beverages (including methanol) was admitted to the hospital with a history of dyspnea and a decreased level of consciousness following alcohol beverage consumption. There was no medical or psycho-social history.
Clinical findings on admission included blood glu-

cose of 80 mg/dl, blood pressure of 170/116 mmHg, and bradycardia. The hospital could not measure the concentrations of ethanol and methanol due to a shortage of laboratory facilities. Routine laboratory investigations were performed upon arrival. Arterial blood gas analysis revealed severe metabolic acidosis (**Table 1**). Serum electrolytes, blood cell count, coagulation tests (thrombin and prothrombin tests), hepatic, and kidney function tests were normal. Urinalysis, chest radiography, and cranial computed tomography showed unremarkable findings.

After 3 hours of admission, methanol intoxication was incorrectly diagnosed and treated with ethanol without the use of hemodialysis. Ethanol administration began with 80 milliliters per hour as conventional therapy for methanol poisoning. Due to the persistent severe shortage of fomepizole in Iran, it was not prescribed for this patient. Despite treatment, the patient developed apnea and cardiac arrest 4 hours after admission. Unfortunately, resuscitation efforts were unsuccessful, and the patient passed away.

After a complete autopsy, postmortem quantitative toxicological and pathological analysis conducted by the Legal Medicine Organization (LMO) revealed high concentrations of ethanol (femoral blood: 648 mg/dl, vitreous: 719 mg/dl) and increased concentrations of methanol (femoral blood: 27 mg/dl, vitreous: 56 mg/dl) in the samples, as measured by gas chromatography with flame ionization detector. In other Samples (bile, kidney, liver, stomach content), no drugs or opioids were detected as measured by gas chromatography with mass spectrometry and high-performance liquid chromatography with diode array detector. The histopathological evaluation of the liver was conducted using hematoxylin and eosin staining on a specimen preserved in 7% formaldehyde, which exhibited both microvesicular and macrovesicular changes (**Figure 1**).

The death was attributed to acute alcohol intoxication, which occurred due to the consumption of alcoholic beverages and an erroneous administration of ethanol in the hospital.

Discussion

The main objective of this research was to understand the management of methanol poisoning in Iran. This is especially crucial given the unique circumstances in Iran, including the absence of laboratory capabilities for alcohol measurement in hospitals and a critical scarcity of fomepizole. In this case, the measured ethanol concentration is unquestionably fitting to support ethanol intoxication as the cause of death. It seems that high ethanol concentrations, rather than formic acid, have led to the fatality. Given that the patient ingested alcohol contaminated with methanol, it was improbable that methanol would break down into formic acid in the presence of ethanol, thereby elevating formic acid levels.

The most widespread substance that is used both for relaxing and as an addictive drug is ethyl alcohol. (12) Chronic and high alcohol consumption of ethanol can cause liver disease, neuropathy, and cardiopathy. (13) Forensic pathologists are very acquainted with deaths due to ethyl alcohol poisoning. (14) Blood alcohol concentration and lethal doses vary among individuals. (9) The vast majority of acute ethanol toxicity deaths follow the ingestion of traditional alcoholic beverages. Ethyl alcohol can be obtained from commercial products, which often contain high levels of ethanol but are not manufactured for consumption. (15) Ethyl alcohol poisoning is potentially lethal and is common worldwide. (11) Death due to acute alcohol intoxication, compared with other deaths due to drug poisoning, lacks specific anatomical characteristics. (9) Adverse events occur commonly with intravenous ethyl alcohol infusions for the treatment of ethylene glycol and methanol intoxication, and ethyl alcohol titration is inefficient. (7)

Ethanol is used as a first-line antidote for methanol intoxication in some hospitals, especially due to its low costs, readily available, and physician experience. (16) Fomepizole (4-methylpyrazole) appears safer than ethanol for the treatment of methanol intoxication. (8)

With long-term action, fomepizole is an ADH inhibitor that does not appear to have the adverse effects of ethyl alcohol on administration. (17,18)

Recent data showed a high fatality rate of methanol intoxication in Iran following the consumption of adulterated alcoholic beverages. (19,20), especially in North Khorasan province. Toxicologists have very problems in the diagnosis and management of intoxicated patients with toxic alcohol in Iran. (21)

However, there are two main issues for the treatment of methanol intoxication in Iran: fomepizole and laboratory facilities shortage. This problem is specific to Iran. Many referral and educational hospitals in Iran have almost no laboratory facilities to detect blood concentrations of toxic alcohol. (21) So, a surveillance system for such outbreaks should be incorporated in countries that are liable to these problems. (19) In light of the findings, it is suggested that in addition to conducting more related research and study, new protocols for the safe use of ethanol for the treatment of methanol intoxication in Iran be devised.

Conclusion

In summary, considering the toxicity observed in this study related to methanol poisoning outbreaks in Iran during 2019, it is crucial to establish an effective monitoring system. This system should focus on measuring blood alcohol concentration, particularly during outbreaks, to prevent ineffective and potentially incorrect treatment.

Declarations

Funding: none.

Conflict of interest: The author declared no conflicts of interest.

Ethics approval: The study protocol conformed with the ethical guidelines of the 1975 Declaration of Helsinki, revised in 1983. The authors confirm that informed consent was obtained from the decedent's legal relatives prior to drafting this report. Private information, including name and surname, was removed from the datasheet to comply with ethical concerns.

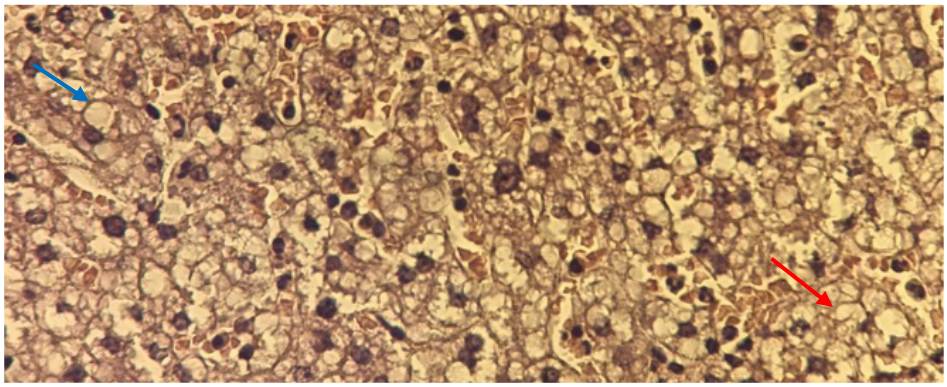
Consent to participate and for publication: none.

Table 1. Arterial blood gases result in fatal cases of mixed intoxication with ethanol and methanol

	1	2	3	4
pH	6.81	6.59	6.65	6.59
PaO2 (mmHg)	28	64.8	77.5	66.1
PaCO2 (mmHg)	30	44	61.5	49.2
HCO3 (mmol/l)	4.6	4	6.5	4.5
BE (mmol/l)	-29.5	-	-	-

Legend: 1=on admission; 2=one hour after ethanol administration; 3=two hours after ethanol administration; 4=three hours after ethanol administration.

Figure 1. Hematoxylin and eosin staining of the hepatic sample (400X, microvesicular changes [red arrow] and macrovesicular changes [blue arrow])



References

1. Dogan H, Karakus BY, Cabuk KS, Uzun O, Yenice H, Orucoglu A. Transdermal Spirit (methanol) poisoning: a case report. Iran Red Crescent Med J 2016;18:e23767.
2. Lister D, Tierney M, Dickinson G. Effectiveness of IV ethanol therapy combined with hemodialysis in the treatment of methanol and ethylene glycol poisoning. Can J Hosp Pharm 2005;58:142-7.
3. Oguz AB, Gunalp M, Polat O, Genc S, Gurler S. Transdermal Methanol Intoxication. Arch Iran Med 2019;22:671-2.
4. Chang S-T, Wang Y-T, Hou Y-C, Wang I-K, Hong H-H, Weng C-H, et al. Acute kidney injury and the risk of mortality in patients with methanol intoxication. BMC Nephrol 2019;20: 205.
5. Pelclová D, Zakharov S. Methanol: the threat of intoxication is still there. Vnitr Lek 2016;62: 616-9.
6. Mousavi-Roknabadi RS, Arzhangzadeh M, Safaei-Firouzabadi H, Mousavi-Roknabadi RS, Sharifi M, et al. Methanol poisoning during COVID-19 pandemic; A systematic scoping review. Am J Emerg Med 2021;52:69-84.
7. Wedge MK, Natarajan S, Johanson C, Patel R, Kanji S. The safety of ethanol infusions for the treatment of methanol or ethylene glycol intoxication: an observational study. CJEM 2012;14:283-9.
8. Mégarbane B, Borron SW, Baud FJ. Current recommendations for treatment of severe toxic alcohol poisonings. Intensive Care Med 2005; 31:189-95.
9. Wang H, Xu H, Li W, Li B, Shi Q, Ma K, et al. Forensic appraisal of death due to acute alcohol poisoning: three case reports and a literature review. Forensic Sci Res 2019;5:341-7.
10. Adinoff B, Bone GH, Linnoila M. Acute ethanol poisoning and the ethanol withdrawal syndrome. Med Toxicol Adverse Drug Exp 1988;3:172-96.
11. Aasebø W, Erikssen J, Jonsbu J, Stavem K. ECG changes in patients with acute ethanol intoxication. Scand Cardiovasc J 2007;41:79-84.
12. Dura S, Bădă V. The deaths in acute ethanol intoxication. Acta Medica Transilvanica 2018; 23:6-8.
13. de Carvalho Gonçalves Á, Soldi LR, Portari GV. Thiamine, oxidative stress, and ethanol. In: Patel VB, editor. Molecular Nutrition. Academic Press; 2020.
14. Wilson CI, Ignacio SS, Wilson GA. An unusual form of fatal ethanol intoxication. J Forensic Sci 2005;50:676-8.
15. Sperry K, Pfalzgraf R. Fatal ethanol intoxication from household products not intended for ingestion. J Forensic Sci 1990; 35:1138-42.
16. Sturkenboom MGG, van Rieke HM, Uges DRA. Treatment of ethylene glycol and methanol poisoning: why ethanol? Neth J Crit Care 2009;13:297-302.
17. Jacobsen D, McMartin KE. Antidotes for methanol and ethylene glycol poisoning. J Toxicol Clin Toxicol 1997;35:127-43.
18. Rietjens SJ, de Lange DW, Meulenbelt J. Ethylene glycol or methanol intoxication: which antidote should be used, fomepizole or ethanol. Neth J Med 2014;72:73-9.
19. Aghababaeian H, Araghi Ahvazi L, Ostadtaghizadeh A. The methanol poisoning outbreaks in Iran 2018. Alcohol Alcohol 2019; 54:128-30.
20. Alinejad S, Zamani N, Abdollahi M, Mehrpour O. A narrative review of acute adult poisoning in Iran. Iran J Med Sci 2017;42:327-46.
21. Banagozar Mohammadi A, Delirrad M. Problems with methanol poisoning outbreaks in Iran. Alcohol Alcohol 2019;54:338.

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