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Prevalence and predicting factors of acute kidney injury due to methanol intoxication; a systematic review

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ABSTRACT

Introduction: Methanol intoxication and subsequence acute kidney injury (AKI) can be dangerous and deadly in case of a missed or delayed diagnosis; therefore, identifying its prevalence and predictor factors is necessary.
Objectives: This study was conducted to identify the prevalence and predictor factors of AKI in methyl alcohol-intoxicated patients.
Methods and Materials: The search strategy was conducted with the standard keyword in the international database, including Web of Science, Scopus, PubMed /Medline, Embase, Cochrane, WorldCat, Dimension, OpenGrey, EBSCO, DOAJ, CINAHL, and Google scholar search engines. Studies that reported the prevalence of AKI due to methanol poisoning were included in this review study.
Results: Results demonstrated that six studies from five countries, with a sample size of 816 methanol intoxication patients, were included in this study. Mean AKI prevalence in all reviewed studies was 28.18%; Gender male, hypertension, older age, anemia, alcohol addiction, metabolic acidosis, high blood osmolality, high Formate concentration, alcohol overdose, sepsis, rhabdomyolysis, acute pancreatitis, and volume depletion were the reported AKI predictors in the reviewed studies.
Conclusion: Identifying the AKI prevalence and its predictor factors in patients with methanol intoxication can help in their quick diagnosis, timely treatment, and reduce the subsequent complications.

Implication for health policy/practice/research/medical education:
In a systematic review of studies that evaluated the prevalence and related factors to progressed AKI due to methanol poisoning, we found that its prevalence was 28.18%; demographic characteristics, including older age, gender male, hypertension, anemia, history of alcohol consumption, and clinical findings such as high blood osmolality, greater pH, acute pancreatitis, alcohol overdose, sepsis, rhabdomyolysis, and volume depletion were the most common predictors for incidence of AKI.

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Introduction

Methanol or methyl alcohol is an industrial substance with various uses, including automobile manufacturing, jet fuel, the perfume industry, copier fluids, antifreeze (1), laboratories (2), and washing fluid (3). Methyl alcohol is much cheaper than ethanol, and their morphological similarity encourages using methanol for making adulterate and illegal alcoholic beverages (3,4).

Methanol intoxication is a medical, social, and economic serious issue; severe intoxication is rare but

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has occurred in many cases and different countries (5). Since the beginning of the current century, methanol intoxication has caused many deaths and complication worldwide due to delays in diagnosis (4). Previous studies reported various complications of methanol poisoning, such as putaminal hemorrhage, metabolic acidosis, visual impairment (6), hypokalemia, renal failure, respiratory failure, neurological failure (7), troponin rising (8), hypothermia, hypotension, low consciousness (9), and acute kidney injury (AKI) (2, 8-11). Furthermore, some of these studies reported that, among methanol poisoning complications, AKI is one of the most common and related factors to mortality and morbidity (2,9,11). In this study we determine how much AKI is common in methanol intoxication and what factors can predict it.

Objectives

The most rational reason for conducting this study is the lack of a study that evaluated AKI prevalence as a systematic review and reported its worldwide prevalence. This review study aimed to evaluate the prevalence of AKI due to methanol intoxication and its predicting factors.

Methods

Study design

This systematic review aimed to assess the prevalence of AKI due to methanol poisoning and to identify its predictors. To explore the relevant studies, we performed a search strategy using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (12). The main question of this review study is the frequency of AKI in methanol poisoning and what factors influence its incidence.

Search strategy and studies selecting

Search libraries such as Cochrane and WorldCat and international databases, including Web of Science, Scopus, Pubmed, Ovid/Medline, Embase, Dimension, OpenGrey, EBSCO, DOAJ, CINAHL and Google scholar search engines, were used to find related studies. Standard keywords and using Medical Subject Headings (MeSH) were conducted for a complete search. Acute renal injury, acute renal failure, acute renal insufficiency, methanol intoxication, methanol poisoning, wood alcohol, carbinol, and methyl alcohol were applied as keywords in the search strategy. There were no time, language, and location limitations regarding this search strategy, and the search was upgraded until March 2023. Applied combination keywords included OR and AND. The following string shows PubMed search strategy protocol:

((((((((Acute renal injury[Title/Abstract]) OR (Acute renal failure[Title/Abstract])) OR (Acute kidny insufficiency[Title/Abstract])) AND (Intoxication[Title/Abstract])) OR (Poisoning[Title/Abstract])) AND (Methanol[Title/Abstract])) AND (Wood alcohol[Title/Abstract])) OR (Methyl alcohol[Title/Abstract])) OR (Carbinol[Title/Abstract]).

Eligibility criteria

Studies that evaluated the prevalence of AKI due to methanol intoxication were included in this study.

Exclusion criteria

Exclusion criteria included studies with missing required data, duplicates, full-text unavailable studies, studies of low quality, qualitatively assessed studies, studies with case reports, conference studies, and letter to editors' studies. Moreover, studies that evaluated the AKI prevalence in intoxicated patients with alcohols other than methanol, and studies that assessed methanol poisoning without reporting AKI prevalence were excluded.

Quality assessment of the studies

For each included study, a second reviewer investigated all extracted data during the study's quality assessment process. Two investigators independently evaluated the initial articles based on the STROBE (Strengthening The Reporting of OBservational Studies in Epidemiology) checklist for the observational studies. This checklist consists of 22 items covering different parts of the study. Each item has two points, and the total point was calculated by pooling these items. Therefore, values 1-15 indicate poor quality, 16-30 medium quality, and 31-44 highest quality. The cut-off point in our study was scored more than 15 (13). In case of disagreement, the third reviewer reassessed the article, and the discussion was resolved by reaching a consensus on a single option. It is noted that all included studies had good quality.

Data extraction

To avoid the risk of bias in data collection, two investigators, other than the individuals who searched the studies, independently extracted the required data using a checklist, including the authors' names, study design, publication year, country, mean age, male percent, study objective, sample size, frequency of AKI, and related factors to AKI. Data were re-evaluated by a third investigator in case of discrepancies.

Results

In the current systematic review research; studies that reported AKI prevalence after methanol intoxication were reviewed based on the PRISMA guideline. During the initial search, 905 articles were identified; Due to duplicate studies, 409 were removed. Out of the 496 remaining articles, 381 were excluded after the abstract review due to having no inclusion criteria. Out of the 115 remaining articles, 38 were not retrieved, and 77 were assessed for eligibility. Based on exclusion criteria, 71 articles were excluded, and six remained in the final analysis (Figure 1).

Results demonstrated that six studies from five countries around the world, with a sample size of 816 methanol

intoxication patients, were included in this study. The study by Thongprayoon et al (2) in the USA and the study by Salek et al (8) in the Czech republic were the biggest and smallest study in terms of sample size, with a sample size of 603 and 13 people respectively. Regarding study design, three were cohort, two cross-sectional, and one was case series. Most poisoning patients were male in all studies (Table 1).

The prevalence of AKI in the study by Chang et al was the most (66%), and in the study by Salek et al was the lowest (15.4%) without considering the sample size. When we pooled all sample sizes in all studies and also pooled all patients with AKI and calculated AKI prevalence, AKI prevalence was 28.18% in all included studies (Table 1).

Discussion

In six studies with a population of 816 methanol-intoxicated patients, 230 developed AKI (prevalence of 28.18%); Regardless of sample size, the lowest prevalence was 15.4%, and the highest was 66%. The most common AKI predictors were classified into three sections; gender male, hypertension, older age, anemia, and alcohol addiction regarding demographic characteristics; metabolic acidosis, high blood osmolality, and high formate concentration in terms of laboratories disorders; overdose state, sepsis, rhabdomyolysis, acute pancreatitis, and volume depletion in clinical findings.

In the study by Thongprayoon et al on 603 people, the prevalence of AKI was reported at 22.4%, and the most related factors were hypertension, anemia, volume depletion, sepsis, acute pancreatitis, and rhabdomyolysis. Considering the high sample size, this prevalence and also the reported AKI predictors can be trustable (2). The study by Salek et al had the lowest population (13 cases); in this study prevalence rate was 15.4%, and AKI predictors were not reported (8).

The second big study in terms of sample size was conducted on 93 intoxicated patients by Kumar et al in the Indian population. The prevalence of AKI in this study was reported at 27.9%, however AKI predictors were not reported (14). Male gender, alcohol addiction, alcohol overdose, and older age were reported by Chang et al as the most common risk factors for acute renal injury. In their cohort study, the prevalence of AKI was reported at 66% (11).

Lee et al in a nine-year cohort study stated that, out of 32 patients with methyl alcohol poisoning, AKI was found in 19 cases, which indicates a prevalence of 59.4%. Predicting factors for AKI were not reported in this study (9). Verhelst et al in a study in Belgium assessed 25 patients with methanol intoxication as a case series and reported greater blood osmolality, metabolic acidosis at baseline, and greater formate concentration as the most common predictor for acute renal injury; since the prevalence of AKI in this study was 60% (10).

Acute renal injury is an acute (less than 48 hours) decline in glomerular filtration rate (GFR) due to kidney injury that causes alterations in electrolyte and acid-base balance because of fluid and metabolic waste retention (15,16). Thus, AKI patients should be identified early and treated immediately to reduce serious morbidity and death.

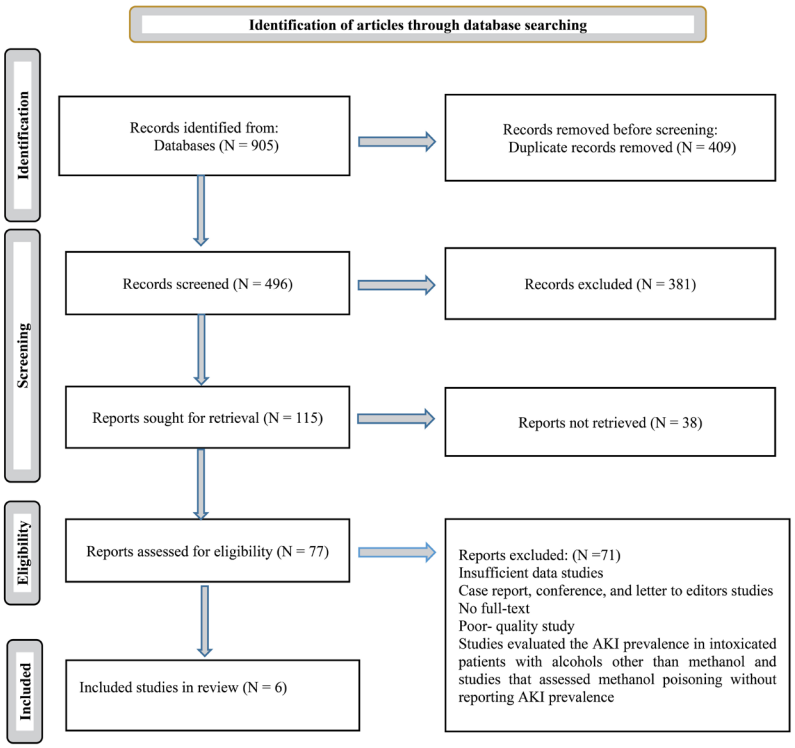

Figure 1. PRISMA diagram for reviewed studied.

Table 1. Information of included study, patients' characteristics, and AKI prevalence and predictors

First authors name	Study design	Publication years	Country	Mean age (year)	Male percent	Objective	Sample size	AKI frequency	AKI prevalence (%)	AKI predictors
Thongprayoon et al (2)	Cohort	2021	USA	37.9 ± 18.3	69.8	AKI prevalence, risk factors, and in-hospital outcomes of methanol poisoning patients	603	135	22.4	Anemia, hypertension, volume depletion, sepsis, rhabdomyolysis, and acute pancreatitis
Chang et al (11)	Cohort	2019	Taiwan	47.8 ± 14.9	74	Evaluation of AKI and mortality risk of methyl alcohol poisoning patients	50	33	66	Older age, male gender, alcohol addicton, and unintentional overdose
Kumar et al (14)	C-S	2019	India	38.9 ± 10.3	98.9	Determine the complication of methanol intoxication	93	26	27.9	NA
Lee et al (9)	Cohort	2014	Taiwan	46.1 ± 13.8	87.5	Evaluation of the value of multiple clinical characteristics in predicting the mortality of methanol intoxication patients.	32	19	59.4	NA
Salek et al (8)	C-S	2014	Czech Republic	53.38± 14.15	53.9	Comparison of eGFR, GFR, and metabolic parameters at baseline and recovery time of patients with methyl alcohol intoxication	13	2	15.4	NA
Verhelst et al (10)	Case series	204	Belgium	38.84	60	AKI prevalence and related factors in a series of methyl alcohol intoxication patients and possible mechanisms	25	15	60	Low blood pH at baseline, high blood osmolality, and greater Formate concentration

C-S: Cross-sectional; NA: Not-available; eGFR: Estimated glomerular filtration rate.

Conclusion

Knowing about the prevalence rate as well as identifying risk factors related to AKI in patients with methanol poisoning can help in their quick diagnosis, timely treatment, and reduce the subsequent complications especially reducing mortality.

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Authors' contribution

Conceptualization: Arash Izadpanah Ghahremani, Farinaz Fattahi, and Pegah Karami.
Data curation: Farshad Gharebakhshi and Aisan Ghasemi Oskui.
Formal analysis: Farshad Gharebakhshi and Mohammad Reza Rezaei.
Inverstigation: Mohammad Hesam Gharaeikhezri, Hamidreza Khodabandeh and Pegah Karami.
Methodology: Mohammad Hesam Gharaeikhezri, and Bareza Rezaei.
Project management: Mohammad Reza Rezaei.
Resources: Farinaz Fattahi and Bareza Rezaei.
Supervision: Mohammad Hesam Gharaeikhezri.
Validation: Hooman Rafiei and Hamidreza Khodabandeh.
Visualization: Aisan Ghasemi Oskui and Hooman Rafiei.
Writing–original draft: Mohammad Reza Rezaei, Farshad Gharebakhshi, Aisan Ghasemi Oskui, Hamidreza Khodabandeh, and Hooman Rafiei.
Writing–reviewing and editing: Bareza Rezaei, Arash Izadpanah Ghahremani, Pegah Karami, Farinaz Fattahi and Mohammad Hesam Gharaeikhezri.

Conflicts of interest

There are no competing interests.

Ethical issues

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the author. This study has been compiled based on the PRISMA checklist, and its protocol was registered on the PROSPERO (International Prospective Register of Systematic Reviews) website (ID: CRD42023417358).

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References

1. Katz KD, Ruha AM, Curry SC. Aniline and methanol toxicity after shoe dye ingestion. J Emerg Med. 2004;27:367-9. doi: 10.1016/j.jemermed.2004.07.002.
2. Thongprayoon C, Petnak T, Kaewput W, Mao MA, Boonpheng B, Bathini T, et al. Acute kidney injury in hospitalized patients with methanol intoxication: National Inpatient Sample 2003-2014. Hosp Pract. 2021;49:203-8. doi: 10.1080/21548331.2021.1882239.
3. Giovanetti F. Methanol poisoning among travellers to Indonesia. Travel Med Infect Dis. 2013;11:190-3. doi: 10.1016/j.tmaid.2013.03.013.
4. Pressman P, Clemens R, Sahu S, Hayes AW. A review of methanol poisoning: a crisis beyond ocular toxicology. Cutan Ocul Toxicol. 2020;39:173-9. doi: 10.1080/15569527.2020.1768402.
5. Paasma R, Hovda KE, Jacobsen D. Methanol poisoning and long term sequelae - a six years follow-up after a large methanol outbreak. BMC Clin Pharmacol. 2009;9:5. doi: 10.1186/1472-6904-9-5.
6. Permpalung N, Cheungpasitporn W, Chongnarungsin D, Hodgdon TM. Bilateral putaminal hemorrhages: serious complication of methanol intoxication. N Am J Med Sci. 2013;5:623-4. doi: 10.4103/1947-2714.120804.
7. Kaewput W, Thongprayoon C, Petnak T, Chewcharat A, Boonpheng B, Bathini T, et al. Inpatient Burden and Mortality of Methanol Intoxication in the United States. Am J Med Sci. 2021;361:69-74. doi: 10.1016/j.amjms.2020.08.014.
8. Salek T, Humpolicek P, Ponizil P. Metabolic disorders due to methanol poisoning. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2014;158:635-9. doi: 10.5507/bp.2013.074.
9. Lee CY, Chang EK, Lin JL, Weng CH, Lee SY, Juan KC, et al. Risk factors for mortality in Asian Taiwanese patients with methanol poisoning. Ther Clin Risk Manag. 2014;10:61-7. doi: 10.2147/tcrm.S51985.
10. Verhelst D, Moulin P, Haufroid V, Wittebole X, Jadoul M, Hantson P. Acute renal injury following methanol poisoning: analysis of a case series. Int J Toxicol. 2004;23:267-73. doi: 10.1080/10915810490506795.
11. Chang ST, Wang YT, Hou YC, Wang IK, Hong HH, Weng CH, et al. Acute kidney injury and the risk of mortality in patients with methanol intoxication. BMC Nephrol. 2019;20:205. doi: 10.1186/s12882-019-1404-0.
12. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. BMJ. 2009;339:b2535. doi: 10.1136/bmj.b2535.
13. Von Elm E, Altman D, Egger M, Pocock S, Gøtzsche P, Vandenbroucke J, et al. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies. Int J Surg. 2014;12:1495-9. doi: 10.1016/j.ijsu.2014.07.013.
14. 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. Int J Crit Illn Inj Sci. 2019;9:172-6. doi: 10.4103/ijciis.Ijciis_49_19.
15. Weng CH, Chen HH, Hu CC, Huang WH, Hsu CW, Fu JF, et al. Predictors of acute kidney injury after paraquat intoxication. Oncotarget. 2017;8:51345-54. doi: 10.18632/oncotarget.17975.
16. Andreucci M, Faga T, Pisani A, Perticone M, Michael A. The ischemic/nephrotoxic acute kidney injury and the use of renal biomarkers in clinical practice. Eur J Intern Med. 2017;39:1-8. doi: 10.1016/j.ejim.2016.12.001.