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Clinical Characteristics of Patients with Methyl Alcohol Intoxication Followed up in the Intensive Care Unit and Factors Affecting Mortality

Yoğun Bakım Ünitesinde Takip Edilen Metil Alkol İntoksikasyonlu Hastaların Klinik Özellikleri ve Mortaliteye Etki Eden Faktörler

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Abstract

Objective: Methyl alcohol is a solvent obtained by the fermentation of wood and used in various fields industrially. Due to its cheap and easy accessibility, it is frequently used to manufacture moonshine and can lead to severe morbidity and mortality. This study aims to evaluate the clinical features of patients with methanol intoxication followed in the tertiary center intensive care unit (ICU) and determine the factors affecting mortality.

Method: All patients aged 18 years and older who were followed up in the ICU for methanol intoxication between January 2016 and September 2022 were included in the study. Demographic characteristics, clinical data, and factors affecting mortality were evaluated retrospectively by classifying the patients as discharged and dead.

Results: A total of 32 patients, 11 (34.3%) in the discharged group and 21 (65.7%) in the dead group, were included in the study. The mean age of the whole population was 41.5±8.8 years, and all were male. Of the population, 37.5% had central nervous system findings, 34.3% had visual disturbances, and 15.6% had gastrointestinal system complaints. Renal replacement therapy was administered to 93.7% of the patients, ethyl alcohol or fomepizole to 40.6%, and folate to 28.1%. High anion gap metabolic acidosis (pH<6.95, base excess<-25.2, anion gap>23.2) and high lactate levels (lactate>5.27) were associated with poor outcomes.

Conclusion: Although methanol intoxication is an important public health problem affecting especially young-middle-aged men, it is a significant cause of mortality. We think that developing effective policies can prevent methanol intoxication and related deaths.

Keywords: Acidosis, intensive care unit, intoxications, methanol, mortality

Öz

Amaç: Metil alkol ahşabın fermentasyonu ile elde edilen ve endüstriyel olarak çeşitli alanlarda kullanılan bir çözücüdür. Ucuz ve kolay ulaşılabirliği nedeniyle kaçak içki yapımında sıklıkla kullanılmakta ve ciddi morbidite ile mortaliteye yol açabilmektedir. Bu çalışmanın amacı, üçüncü basamak bir merkezin yoğun bakım ünitesinde (YBÜ) takip edilen metanol intoksikasyonlu hastaların klinik özelliklerini değerlendirmek ve mortalite üzerine etkili faktörleri saptamaktır.

Yöntem: Ocak 2016 ile Eylül 2022 tarihleri arasında YBÜ'de metanol intoksikasyonu nedeniyle takip edilen 18 yaş ve üzeri tüm hastalar çalışmaya dahil edildi. Hastalar taburculuk grubu ve ölen grup olarak sınıflandırılarak demografik özellikler, klinik veriler ve mortaliteye etki eden faktörler retrospektif olarak değerlendirildi.

Bulgular: Çalışmaya taburculuk grubunda 11 (%34,3), vefat eden grupta 21 (%65,7) olmak üzere toplam 32 hasta dahil edildi. Tüm popülasyonun yaş ortalaması 41,5±8,8 yıl ve hepsi erkek idi. Tüm popülasyonun %37,5'inde santral sinir sistemi bulguları, %34,3'ünde görme bozuklukları, %15,6'sında gastrointestinal sistem şikayetleri mevcuttu. Hastaların %93,7'sine renal replasman tedavisi, %40,6'sına etil alkol veya fomepizol, %28,1'ine folat uygulandı. Yüksek anyon açıklı metabolik asidoz (pH<6,95, baz açığı<-25,2, anyon gap>23,2) ve yüksek laktat düzeyleri (laktat>5,27) kötü sonuçlarla ilişkili bulundu.

Sonuç: Metanol intoksikasyonları özellikle genç-orta yaş erkekleri etkileyen, ileri tedavi yöntemlerine rağmen hastaneye geç başvuru ve tedavide gecikme nedeniyle yüksek mortalite oranları görülebilen bir halk sağlığı problemidir. Etkili politikaların geliştirilmesinin ve bu konuda yapılacak çalışmaların hastaların yönetimine ve tedavi protokollerinin iyileştirilmesine katkı sağlayacağını düşünüyoruz.

Anahtar kelimeler: Asidoz, metanol, mortalite, yoğun bakım ünitesi, zehirlenmeler

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Introduction

Methyl alcohol (methanol) is an organic solvent obtained by wood fermentation (1). Since it is used in various industrial dry cleaning processes, glass cleaning solutions, and paint thinner, it is provided legally and efficiently. It is colorless, odorless, and tastes similar to ethyl alcohol but is cheaper than ethyl alcohol (2). Although methyl alcohol toxicity is often seen when it is used in the manufacture of illicit liquor, it can also be consumed for suicide or accidentally when people who are addicted to alcohol consume products such as cologne made from methyl alcohol (3). Although methanol is not toxic, its metabolites, formaldehyde and formic acid are responsible for methanol toxicity, which can lead to severe poisoning and death (4).

Gastrointestinal system findings such as nausea and vomiting, changes in consciousness, shortness of breath, tachypnea, chest pain and visual disturbances, complete vision loss, permanent neurological dysfunction, severe metabolic acidosis, and cardiac arrest can be seen in patients with methanol intoxication (5). The non-specificity of presentation complaints and the inaccessibility of laboratory tests (serum methanol, formic acid level, osmolality analysis) used in every health institution make the diagnosis difficult (6). High anion gap metabolic acidosis, confusion, and visual impairment are essential in diagnosing methanol intoxication (7,8). Antidotes with fomepizole or ethanol in treatment, hemodiafiltration to eliminate toxic metabolites, and buffers with folic acid and sodium bicarbonate are essential (9). Despite advances in treatment, it continues to be one of the significant causes of death due to poisoning due to difficulties in diagnosis and delayed admission to the hospital.

This study aims to evaluate the clinical features of patients with methanol intoxication who were followed up and treated in the ICU of a tertiary center and to investigate the factors affecting mortality.

Materials and Methods

This retrospective cross-sectional study was initiated following the principles of the Declaration of Helsinki after the approval of the Local Ethics Committee of University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital (date: 11.11.2022, number: 211). Patients aged 18 years and older who were followed up with the diagnosis of methyl alcohol intoxication between January 1, 2016, and September 1, 2022, in the ICU of the University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital were included in the study. Patients with missing data and referred to another healthcare institution during ICU follow-up were excluded from the study.

Although the best method for the definitive diagnosis of methanol intoxication is the measurement of the methanol level in the blood, the diagnosis was based on the patient's or relative's history, clinical findings, and blood gas values since they could not be examined in the emergency department of our hospital. Suspected alcohol intake history (unlabeled, homemade), abdominal pain, nausea, vomiting, impaired consciousness and vision, high anion gap metabolic acidosis in blood gas analysis, and increased anion gap (pH<7.30, HCO_3< 20 mEq^{-1}, anion gap>10 $mEqL^{-1}$), the diagnosis was made in the emergency department of our hospital. Differential diagnosis was made with other toxic alcohols using anamnesis, clinical findings, and blood gas findings (differential diagnosis was made from ethyl and isopropyl alcohol exposure with the absence of high anion gap metabolic acidosis, from ethylene glycol exposure due to increased anion gap metabolic acidosis and increased osmolar deficit).

Demographic data of the patients, comorbid diseases, reasons for applying to the emergency department, presence of visual complaints based on information obtained from themselves or their relatives in the emergency department or ICU, duration of stay in the ICU, the Glasgow Coma scale (GCS) routinely checked during ICU admission, and Acute Physiology and Chronic Health Assessment-2 (APACHE-2) scores, mechanical ventilation (Mv) requirements, length of stay in MV, laboratory findings and mortality during admission to the emergency department were recorded and analyzed through our hospital's information system and patient files.

Since the treatment plan of patients with methanol intoxication could change according to the patient's clinical condition, laboratory results, and the availability of drugs used in the treatment, there was no routine treatment protocol in our ICU during the study period. Renal replacement therapy (RRT), ethyl alcohol, fomepizole, and folic acid treatments were recorded and analyzed in the discharged and dead groups.

Statistical Analysis

The SPSS 29.0 (SPSS Inc., Chicago, USA) program was used to analyze the data. Descriptive data are expressed as the number of patients, percentage, mean and standard deviation (minimum-maximum). The conformity of

the variables to the normal distribution was evaluated analytically (Shapiro-Wilks test) and visually (histogram). Independent sample t-test was used to analyze normally distributed quantitative data between the two groups, and the Mann-Whitney U test was used to analyze non-normally distributed quantitative variables. The chi-square and Fisher's Exact tests were used to evaluate qualitative data. Multiple logistic regression analysis was used to analyze whether age, GCS, and APACHE-2 scores differed significantly between the groups and were independent risk factors for mortality. ROC curve analysis was performed to estimate mortality from blood gas parameters with significant differences between the groups and to determine cut-off values. The statistical significance limit was accepted as $p<0.05$.

Results

During the six years between January 2016 and September 2022, 32 patients with methyl alcohol intoxication who were followed up and treated in the ICU were included in the study. All of the patients were male. While 34.1% (n=11) of the patients were discharged after treatment, 65.9% (n=21) died. It was determined that methanol intoxication (n=5) was caused by the concomitant intake of ethyl alcohol and methyl alcohol in 15.6% of the population. The discharged group's mean age and distribution range were 36±8 (19-48) years, while the mean age and distribution range of the died group was 44.4±7.9 (34-60) years. The mean length of stay and range of stay in the ICU in the discharged patients were 5.6±5.8 (2-17) days, while it was 5.1±5.7 (1-26) days in the patients who died. While no comorbid disease was observed in the discharge group, comorbid disorder (hypertension, diabetes mellitus, chronic obstructive pulmonary disease) was detected in 23.8% (n=5) of the dead group. The mean GCS score and distribution range at the time of admission to the ICU in the discharged group was 10.2±4 (3-15), while that of the dead group was 3.3±8 (3-6). Mechanical ventilation was applied to 81.2% (n=26) and vasopressors to 68.7% (n=22) of the entire population. RRT was used in 93.7% (n=30) of the whole population, ethyl alcohol or fomepizole in 40.6% (n=13), and folic acid in 28.1% (n=9) of the whole population. It was determined that the treatment protocols were carried out in different sessions according to the clinical condition of the patients and the supply of the drugs used. The mean APACHE-2 score and range of distribution of the discharged group at the time of admission to the ICU were 16.2±4 (10-25), while the mean APACHE-2 score and range of issuance of the died group were 29.9±6 (20-41). Age and APACHE-2 scores of the discharged group were significantly lower than those of the dead group ($p=0.008$, $p<0.001$), while GCS scores were significantly higher ($p<0.001$) (Table 1). However, age, GCS, and APACHE-2 scores were not independent risk factors for mortality ($p=0.234$, $p=0.266$, and $p=0.439$), respectively (Table 2).

Table 1. Demographic data of patients, distribution of some clinical characteristics

Variable	All population (n=32)	Discharged group (n=11)	Dead group (n=21)	p
Age (years)	41.5±8.8	36.0±8.0	44.4±7.9	0.008*
Gender, n (%)				-
Male	32 (100)	21 (100)	11 (100)	
Comorbidity, n (%)	5 (23.8)	0	5 (23.8)	-
GCS score	5.2±5 (3-15)	10.2±4 (3-15)	3.3±8 (3-6)	<0.001†
APACHE-2 score	25.2±8 (10-41)	16.2±4 (10-25)	29.9±6 (20-41)	<0.001†
Duration of ICU (days)	5.3±5 (1-26)	5.6±5 (2-17)	5.1±5 (1-26)	0.667†
Mv, n (%)	26 (81.2)	5 (45.4)	21 (100)	0.01‡
Duration of Mv (days)	5.2±5 (1-26)	5.2±4 (1-10)	5.1±5 (1-26)	0.667†
Vasopressor, n (%)	22 (68.7)	1 (38.7)	21 (100)	<0.001‡
Ethanol and methanol intake, n (%)	5 (15.6)	2 (18.1)	3 (9.3)	-
Treatment				
RRT, n (%)	30 (93.7)	9 (81.8)	21(100)	0.05‡
Ethyl alcohol or fomepizole, n (%)	13 (40.6)	4 (36.3)	9 (40.9)	0.721‡
Folic acid, n (%)	9 (28.1)	3 (27.2)	6 (28.5)	1.000‡

Values are the number of patients (n), percentage, mean, standard deviation and distribution range (minimum-maximum) GCS: Glascow Coma scale, APACHE-2: Acute Physiology and Chronic Health Assessment-2, ICU: Intensive care unit, Mv: Mechanical ventilation, RRT: Renal replacement therapy, *Independent sample t-test, †Mann-Whitney U test, ‡chi-squared test

Considering the complaints of the patients who applied to the emergency department, 37.5% (n=12) had central nervous system findings (confusion, coma, seizures, and cerebrovascular events), 34.3% (n=11) had visual disturbances, 15.6% (n=5) had gastrointestinal system complaints and 12.5% (n=4) cardiac arrest was detected (Table 3). It was determined that the patients applied to the emergency services at the highest rate in the winter (65.6%) and spring (21.8%) seasons (Table 4).

When the biochemical and blood gas values of the patients at the time of admission to the emergency services were examined, creatinine, BE (base excess), anion gap, and lactate levels were significantly higher in the dead group (p=0.016, p<0.001, p=0.016, p<0.001, respectively). pH and HCO_3 values were significantly lower (Table 3).

When the patient's blood gas values were examined at admission to the emergency department, pH and HCO_3 values were significantly lower in the dead group. At the same time, lactate, anion gap, and BE (base excess) levels were significantly higher (p<0.001, p=0.003, p<0.001, p=0.016, and p<0.001, respectively) (Table 5). The ROC curves used to compare blood gas parameters to predict mortality are shown in Figure 1, and the analytical data of these curves are shown in Table 6. According to ROC

Table 2. Multiple logistic regression analysis of factors associated with patients' mortality status

Variables	OR	p	95% CI (min-max)
Age	1.435	0.234	0.791-2.600
GCS	0.509	0.266	0.155-1.672
APACHE-2	1.400	0.439	0.579-3.286
Constant	0.363	0.214	

OR: Odds ratio, CI: Confidence interval, GCS: Glasgow Coma scale, APACHE-2: Acute Physiology and Chronic Health Assessment-2

Table 3. Distribution of methyl alcohol intoxications according to hospitalization findings

Findings of admission to the emergency department	All population (n=32)	Discharged group (n=11)	Dead group (n=21)
Central nervous system findings*, n (%)	12 (37.5)	2 (18.1)	10 (47.6)
Visual impairment**, n (%)	11 (34.3)	3 (27.2)	8 (38.1)
Gastrointestinal system complaints, n (%)	5 (15.6)	5 (45.4)	0
Cardiac arrest, n (%)	4 (12.5)	0	4 (19)

Values are the number of patients (n), percentage, *Confusion, coma, seizures, and cerebrovascular events
**There was no visual finding in 7 (21.8%) of the patients, and it could not be evaluated in 14 (43.7) patients because of unconsciousness

Table 4. Seasons of admission to hospital

Seasons, n (%)	All population (n=32)
Winter	21 (65.6)
Spring	7 (21.8)
Autumn	3 (9.3)
Summer	1(3.1)

Values are the number of patients (n), percentage

Table 5. Some biochemical and blood gas values of methanol intoxications

Variable	All population (n=32)	Discharged group (n=11)	Dead group (n=21)	p
pH	6.8±0.2 (6.4-7.2)	7.1±0.1 (6.8-7.2)	6.7±0.1 (6.4-7.1)	<0.001*
Lactate (mmol/L)	7.46 (4.5)	3.29 (1.9)	9.65 (3.9)	<0.001*
Anion gap (mmol/L)	20±10.9	13.2±15.4	23.5±5.4	0.016*
HCO_3 (mmol/L)	6.6±5.0	9.8±7.3	5.0±1.9	0.003*
BE (mmol/L)	-24.8±8.5	-18.1±10.4	-28.3±4.5	<0.001*
Sodium (mmol/L)	138±5.8	138±3.4	138±4.0	0.938*

Values are the number of patients (n), percentage, mean, standard deviation and distribution range (minimum-maximum), BE: Base excess, HCO_3: Bicarbonate, *Mann-Whitney U test

analysis, mortality estimates of pH, lactate, anion gap, HCO_3, and BE parameters were all statistically significant. Among the predictive values determined by the area under the curve (AUC), the highest predictive value for mortality was found to be pH [AUC: 0.937, 95% confidence interval (CI) 0.855-0.909, p<0.001] and lactate (AUC: 0.935, 95% CI 0.852-1.000, p<0.001). When the cut-off values determined regarding the predictive power of mortality were examined, it was found that the highest sensitivity and specificity belonged to pH and lactate. When the cut-off value for pH is 6.95, the sensitivity is 85.7%, specificity is 90.9%; When the cut-off value for lactate was taken as 5.27 mmol/L, the sensitivity was 81%, and the specificity was 81.8%.

Discussion

Methanol intoxication can be seen as a collective or individual case. Mass intoxication is seen in countries with high alcohol tax rates that result in the illicit alcohol production. Methyl alcohol intoxications in Turkey generally develop with alcoholic beverages prepared and marketed illegally, and middle-aged men are more frequently affected (10). Gulen et al. (11) reported that 95.5% of the patients with methanol intoxication were male, and the mean age was 48.4±13.1. Çetinkaya et al. (12) reported that 88.8% of the patients were male, and the median age was 38. Although the surviving patients were younger than the deceased patients, no significant difference was observed (12). In our study, all patients were male, and the mean age of the whole population was 41.5±8.8, consistent with the literature. However, the mean age of the discharged group was found to be significantly lower than the dead group.

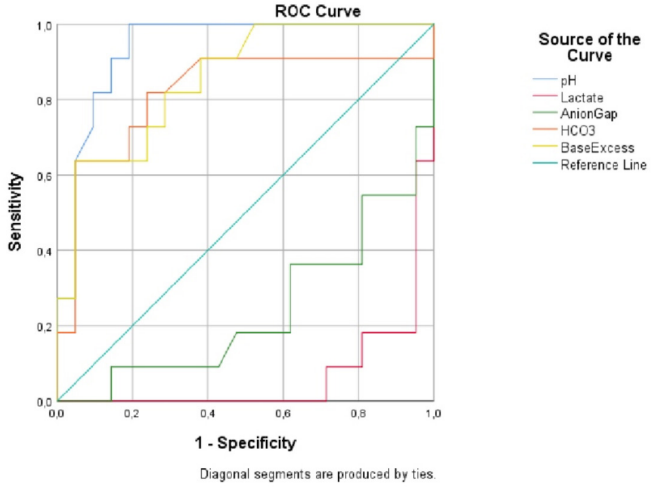

Figure 1. Comparison of blood gas parameters pH, lactate, anion gap, HCO_3, and base excess for predicting mortality

Methyl alcohol reacts enzymatically with alcohol dehydrogenase and turns into its metabolites, formaldehyde, and formic acid. Formic acid causes cellular dysfunction and end-organ damage by inhibiting cytochrome c oxidase in the electron transport chain (13). Clinical signs and symptoms related to methanol poisoning can be seen between 40 minutes and 72 hours, depending on the type of exposure, amount of methanol, and ethanol, the antidote. The diagnosis is made by the patient's and their relatives history, metabolic acidosis with an increased anion gap, increased osmotic gap, and methanol level measurement (14,15). However, methanol levels can only be studied in some centers. Since the methanol level could not be studied in our hospital, the diagnosis was made in the emergency department based on clinical findings, the history of the patient and his relatives, the presence of metabolic acidosis with an increased anion gap, and exclusion from other causes. Kute et al. (16) reported that the most common complaints of patients with methanol intoxication were gastrointestinal complaints (83.5%) and visual disturbances (60.4%). From Turkey, Özkarataş and Yeşilnacar (3) reported the most common complaint at admission as GIS findings, and Babuş et al. (10) and Gulen et al. (11) reported visual complaints. In our study, the most common (37.5%) CNS findings (confusion, coma, seizures, and cerebrovascular events), visual disturbances (34.3%), and GIS irritation findings (15.6%) were found in the patients in the emergency department. However, visual complaints may be in the first place since the visual findings

Table 6. ROC analysis of pH, lactate, anion gap, HCO_3, and base excess values for mortality

	AUC	SD	95% CI	Cut-off	Sensitiviy	Specifity	p
pH	0.937	0.042	0.855-1.000	6.95	0.857	0.909	<0.001
Lactate	0.935	0.042	0.852-1.000	5.27	0.810	0.818	<0.001
Anion gap	0.760	0.093	0.577-0.943	23.2	0.619	0.818	0.017
HCO_3 (mmol/L)	0.818	0.093	0-0.364	5.85	0.810	0.727	0.004
Base excess	0.855	0.068	0.012-0.278	-25.2	0.714	0.818	0.001

AUC: Area under the curve, CI: Confidence interval, HCO_3: Bicarbonate, SD: Standard deviation

could not be evaluated in 46.8% of the patients due to poor general condition. In our study, we could not investigate the effect on the prognosis of the patients because we could not determine the time of arrival to the emergency department as healthy. However, patients present to the emergency department late due to the higher frequency of CNS symptoms.

The basic approach to treating methanol intoxication includes the administration of fomepizole or ethanol to prevent the conversion of methyl alcohol to toxic metabolites, dialysis to remove the formed metabolite and methyl alcohol from the body, or administration of folate, and treatment of severe metabolic acidosis (17). Anion gap>30 mEq^{-1} or base gap<-15 mEq^{-1}, visual disturbances, development of renal failure, and persistent metabolic acidosis (pH<7.25) are indications for emergency hemodialysis after methanol exposure (18). Studies from Turkey have reported that 73% to 100% of patients with methanol intoxication received RRT, 47.7% to 58.1% ethyl alcohol, 48.4% to 64.1% folic acid, and 7.4% fomepizole (3,10,12). Hovda et al. (19) stated that RRT was used in 73% of the patients, and fomepizole was used in 71%. In our study, RRT was applied to 93.7% of the population, ethyl alcohol or fomepizole was applied to 40.6%, and folic acid treatment was applied to 28.1%. The patient's clinical status, the ICU physicians' preferences, and access to the agents used in the treatment were influential in the treatment plan. RRT was not applied to two patients discharged after treatment without severe metabolic acidosis (pH=7.20 and pH=7.23), and ethyl alcohol or fomepizole treatment was applied in addition to supportive treatment. Zakharov et al. (20) applied intermittent hemodialysis and continuous RRT in patients with methanol intoxication and suggested that intermittent hemodialysis is more beneficial than continuous renal replacement therapy. Since we did not have the opportunity to perform intermittent hemodialysis in our ICU, continuous RRT was applied to all patients.

Due to higher tax policies on labeled alcohol products, cheaper methanol has become a cheap and powerful blend of illicit alcohol products. This situation may cause an increase in cases in underdeveloped or developing countries in specific periods. A study from Turkey reported that methanol intoxications are primarily seen in the autumn and winter months. That illegal liquor may have been released via the port at certain times (10). In our study, 87.4% of methanol intoxications were observed in winter and spring.

It has been reported that late admission to the hospital after methyl alcohol intake, seizures, and coma are correlated with mortality (21). In addition, severe metabolic acidosis, severe base deficit, low bicarbonate, hyperglycemia, and respiratory arrest due to unconsciousness indicate a poor prognosis (22). In our study, the effect of early or late admission on mortality could not be evaluated since the time of admission to the emergency department could not be adequately determined. However, considering that the most common findings when patients come to the emergency department are CNS findings and coma, we can say that late admissions are at a high rate, thus worsening the prognosis. In the literature, it has been reported that the GCS score was significantly lower, and the APACHE-2 score was significantly higher in patients who died from methanol intoxication compared to those who survived (12). In our study, the GCS score, which we routinely evaluated during admission to the ICU, was significantly lower, and APACHE-2 scores were significantly higher in the mortality group. However, scoring systems did not find an independent risk factor on mortality. At the same time, considering that the treatment regimens did not differ significantly between the groups, this scoring system at the time of admission to the ICU did not affect the treatment.

Gulen et al. (11) reported that pH<7.07, BE<-31.4, and lactate>2.55 in patients with methanol intoxication were strongly associated with mortality. In our study, very severe metabolic acidosis (pH=6.6) was observed in patients who died, while pH<6.95, BE<-25.2, and lactate>5.27 were found to be strongly associated with mortality. Despite all treatment and efforts, mortality remains high in patients with methanol intoxication. Mortality rates have been reported between 22.2% and 38.8% in the literature (3,10,11,22). In our study, the mortality rate was found to be 65.7%. We think our patients' deep metabolic acidosis and possibly late admission to emergency services may be effective in our high mortality rates.

Study Limitations

The main limitations of our study are its retrospective, single-centered, and low number of cases. Methanol intoxication cases with non-specific diagnoses such as nausea and abdominal pain may have been overlooked. Diagnosis-based searches are done through our hospital's information system and patient files. In addition, the inability to measure methanol levels in our hospital, the fact that it is not known how long after the methanol intake of the patients came to the emergency room and the ICU,

intermittent RRT cannot be performed in our ICU, and the effect of treatment options on the prognosis cannot be investigated due to the lack of specific protocols in the treatment are other limitations of the study.

Conclusion

In our study, high anion gap metabolic acidosis (pH<6.95, BE<-25.2, anion gap>23.2) and high lactate levels (lactate>5.27) were found to be associated with poor outcomes in methanol intoxications, and it is essential to combat metabolic acidosis with aggressive treatment options. Methanol intoxications are an essential public health problem affecting especially the poor in developed and developing countries and require the implementation of effective policies. Despite all advanced treatment methods, high mortality rates can be seen due to late admission to the hospital and delays in diagnosis and treatment. We think that studies on this subject will contribute to the clinical management of patients and improve treatment protocols. Thus sequelae and deaths due to methanol intoxication can be prevented.

Ethics

Ethics Committee Approval: This retrospective cross-sectional study was initiated following the principles of the Declaration of Helsinki after the approval of the Local Ethics Committee of University of Health Sciences Turkey, Kanuni Sultan Süleyman Training and Research Hospital (date: 11.11.2022, number: 211).

Informed Consent: Patients consent form was waived (not required) because the study was a retrospective observational study.

Peer-review: Internally and externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: K.A., Concept: K.A., A.S.Ş., Design: K.A., A.S.Ş., Data Collection or Processing: K.A., Analysis or Interpretation: K.A., A.S.Ş., Literature Search: K.A., A.S.Ş., Writing: K.A.

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