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Poisoning with methanol and other non-beverage alcohols - an analysis of the issue based on hospitalizations in department of toxicology

Weronika Sosnowska

<https://orcid.org/0009-0003-4608-5521>

weronika.sosnowska07@gmail.com

Stefan Wyszyński Regional Specialist Hospital, Lublin, Poland.

Aleksandra Brzozowska

<https://orcid.org/0009-0008-7687-1140>

brzozola@onet.eu

Stefan Wyszyński Regional Specialist Hospital, Lublin, Poland.

Michał Tchórz

<https://orcid.org/0000-0002-1308-099X>

tchorz.michal@gmail.com

Toxicology Clinic, Medical University, Lublin, Poland.

Anna Radoniewicz–Tchórz

<https://orcid.org/0009-0009-9055-8895>

anna.radoniewicz@gmail.com

Stefan Wyszyński Regional Specialist Hospital, Lublin, Poland.

Rafał Tkaczyk

<https://orcid.org/0009-0001-0542-3374>

rafaltkaczyk@wp.pl

District Specialist Hospital in Stalowa Wola, Poland.

Jakub Tomczyk

<https://orcid.org/0009-0008-0586-5798>

jjtomczyk15@gmail.com

Stefan Wyszyński Regional Specialist Hospital, Lublin, Poland.

Gabriela Świątek

<https://orcid.org/0009-0004-8537-6249>

gabriela.swiatek21@gmail.com

District Specialist Hospital in Stalowa Wola, Poland.

Kornelia Trusz

<https://orcid.org/0009-0002-6291-6447>

kornelia.trusz@gmail.com

University Clinical Hospital named after Fryderyk Chopin in Rzeszów

Iwona Wanat

<https://orcid.org/0009-0003-7125-3611>

iw.wanat@gmail.com

Clinical Provincial Hospital No. 2 St. Queen Jadwiga in Rzeszów

ABSTRACT

Introduction: Poisonings with non-beverage alcohols remain a significant problem in contemporary toxicology. Due to the large quantity and severe course of intoxications with methanol, the authors of this study focused primarily on poisonings with this substance. Methanol is widely used in industry. Its toxicity is attributed to its metabolites - formaldehyde and formic acid. Poisonings with methanol often lead to the patient's death due to a wide range of complications associated with progressive metabolic acidosis.

Material and Methods: The study is of a retrospective nature. It involved the analysis of medical records of patients admitted to the department of toxicology in 2022 after the consumption of non-beverage alcohols, with a particular focus on methanol. Data on the number of individuals admitted due to non-beverage alcohol intoxication between 2018 and 2022 was also analyzed.

Results: Over the last 5 years (2018-2022), 36 individuals were hospitalized in the Clinical Toxicological-Cardiological Department due to non-beverage alcohol poisoning, with 16 (44.4%) cases involving methanol. In the year 2022, the department admitted 10 individuals

aged 18 to 68, and 5 (50%) of them consumed methanol. Among the hospitalized, 90% were male, and 60% came from rural areas. Deliberate intoxications accounted for 70% of the cases. Four hospitalizations (40%) resulted in patient death. All deaths were associated with methanol intoxication.

Conclusions: Non-beverage alcohol is often used by people with alcohol dependence syndrome. Among non-beverage alcohols, patients most often reached for methanol. Its consumption is associated with a high mortality rate and should be taken very seriously and treated immediately.

Keywords: methanol; poisoning; intoxication

Introduction

Among non-beverage alcohols, the following should be mentioned: isopropyl alcohol, methanol (methyl alcohol), ethylene glycol, diethylene glycol, and propylene glycol [1]. Due to the exceptionally severe nature of methanol poisonings, the authors primarily focus on the issue of intoxication with this non-beverage alcohol. Methanol has a wide range of industrial applications, making it relatively accessible for intentional poisonings. It is used in the production of antifreeze, cleaning fluids, dyes, aviation fuels, and photocopier fluids [2]. In some cases, especially in developing countries, food-grade alcohol (ethanol) can be contaminated with methanol [3]. The toxicity of methanol is attributed to the formation of formic acid as a result of metabolic transformations [4]. Formic acid causes metabolic acidosis and, by inhibiting the cytochrome oxidase complex, also leads to lactic acidosis [5]. The individual course of methanol intoxication varies and depends, among other factors, on the pool of folates, which play a role in the elimination of formic acid from the body [6].

Methanol itself induces central nervous system depression, leading to decreased cardiac output, stroke volume, and blood pressure reduction [7]. A characteristic symptom of methanol poisoning is visual impairment [8]. It is estimated that visual loss can occur with as little as 4 to 10 ml of a 40% solution of methanol [9]. It has been demonstrated that the severity of ocular changes and overall toxicity of methanol correlate with the degree of

metabolic acidosis [10]. The wide spectrum of accompanying symptoms in methanol poisoning results from the increasing metabolic acidosis caused by lactate accumulation [5]. Particularly unfavorable prognostic factors include decreased pH (especially <7.0), coma, and seizures [11]. The lethal dose of methanol is 15-30 ml of a 40% solution of methanol.

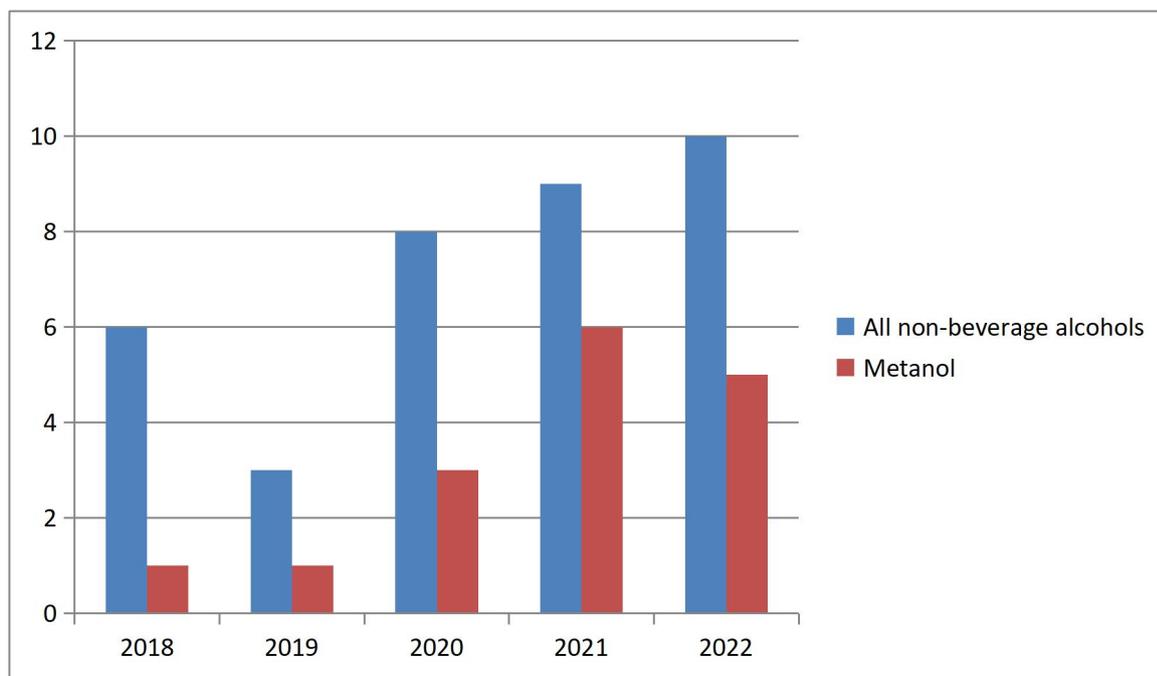
Material and Methods

The conducted study has a retrospective nature. The subjects of the study were patients hospitalized in 2022 at the Clinical Department of Toxicology and Cardiology of the Provincial Specialist Hospital named after Stefan Cardinal Wyszyński in Lublin, due to the consumption of non-beverage alcohols. The data was collected based on the analysis of medical records of the patients. During the analysis of medical records, various information such as gender, age, place of residence, the nature of intoxication, length of patients' stay in the department, and the quarter of the year in which the patient was admitted to the hospital were taken into consideration. Additionally, a specific group of patients intoxicated with methanol was isolated, and the laboratory parameters measured at admission, such as blood pH and methanol concentration in the blood, were analyzed. Moreover, the number of intoxications with non-beverage alcohols, with a particular focus on methanol, was compared over the last 5 years (2018-2022).

Results

In the years 2018-2022, a total of 36 individuals were admitted to the department after consuming non-beverage alcohols, of which 16 (44.4%) consumed methanol. The numerical distribution of hospitalizations in each year is presented in Chart 1.

Chart 1. The number of people hospitalized at the Clinical Department of Toxicology and Cardiology in Lublin due to non-beverage alcohol poisoning with a breakdown of methanol cases in the years 2018-2022.



In the year 2022, a total of 10 individuals were hospitalized at the Clinical Department of Toxicology and Cardiology in Lublin due to consumption of non-beverage alcohols. The age of the patients included in the study ranged from 18 to 68 years. Male intoxications accounted for a significant majority (90%). Among the participants, 4 (40%) were from urban areas, while 6 (60%) were from rural areas. In 7 (70%) cases, the intake of the toxic substance was incidental. Unintentional poisonings were caused by alcohol craving and mood-enhancing attempt among people with alcohol dependence syndrome or mistakenly consuming toxic substances poured into containers previously used for beverage packaging, such as mineral water or fruit juice. A diagnosis of alcohol addiction syndrome was made for 6 (60%) individuals. Throughout the year, 3 patients (30%) were admitted to the department in each of the second, third, and fourth quarters, while the lowest number of admissions occurred in the first quarter (10%). The average length of hospital stay was approximately 6 days, with the shortest stay being for patients discharged on the day of admission and the longest stay lasting 32 days. 4 (40%) hospitalizations resulted in patient deaths. All fatalities were associated with methanol intoxication. Out of the 10 cases, 5 (50%) individuals consumed methanol. All of

these cases involved male patients. 80% of them were residing in rural areas. In 3 cases (60%), the methanol consumption was intentional, with one of them being a suicide attempt. Table 1 presents the laboratory parameters measured upon admission, including blood pH and methanol concentration. As a result of methanol consumption, 4 individuals (80%) died.

Table 1. Information regarding measured methanol concentrations in the blood and blood pH values in patients intoxicated with methanol.

PARAMETER	AVERAGE	RANGE OF VALUES (MIN-MAX)	STANDARD RANGE
Methanol concentration (mg/dl)	227,63	60-473.52	-
Blood pH	7,12	6,94-7,29	7,35–7,45

Discussion

Among non-beverage alcohol poisonings, methanol poisoning is the most frequently observed and the most serious. Therefore, this study primarily focuses on methanol intoxication. The examined group of individuals reflects the issue of non-beverage alcohol poisonings only among those admitted to the Clinical Toxicology and Cardiology Department at WSS Hospital in Lublin. However, the results of this study allow for the observation of certain patterns regarding the type of substance consumed and the individuals affected by poisoning. In recent years, there has been an upward trend in non-beverage alcohol poisonings, particularly those involving methanol. The age structure of patients admitted to the department varies significantly, ranging from 18 to 68 years old. It is difficult to identify a specific age group that is more susceptible to methanol exposure. However, it can be noticed that poisonings occur more frequently in rural areas.

Out of 36 people admitted to the Clinical Toxicology and Cardiology Department at WSS Hospital in Lublin between 2018 and 2022, 16 individuals (44.4%) were there due to methanol poisoning. Significantly larger proportion of poisonings, about 90%, were among males (similar results were obtained by Ahmed F et al. [12]), with 60% of them being diagnosed with alcohol dependence syndrome. Alcohol dependence syndrome is more common in males [13] and is also more likely to lead to death and have a higher disability-

adjusted life years (DALYs) rate, which represents the number of years lost due to disability or premature death in the male population [13].

Given the increasing number of non-beverage poisonings, including methanol, one might ask why do poisonings occur? Methanol is cheaper and more readily available than ethanol, and some people use it in the production of homemade alcohol, which they then sell at a favorable price to individuals addicted to alcohol as an alcohol substitute [14]. This homemade alcohol may contain pure methanol, methanol diluted with water, or methanol with a mixture of ethanol [15]. At the beginning of the COVID-19 pandemic, there was a misconception among people that methanol had antiviral properties. In Iran, more than 1000 people consumed methanol to fight the virus, and over 300 people died from poisoning [16].

It is also common for methanol to be stored in non-original containers, such as being poured into bottles from water, beverages, or ethanol. This can lead to accidental consumption and poisoning. Methanol itself is not cytotoxic, but during its metabolism, formaldehyde and formic acid are produced, which can disrupt oxidative metabolism by inhibiting the cytochrome oxidase mechanism [16]. Symptoms of poisoning can include coma and respiratory arrest; hence, patients with severe poisoning require intubation and mechanical ventilation [17]. The most critical aspect of treatment for patients with suspected or confirmed methanol poisoning is the blockade of alcohol dehydrogenase (ADH), which prevents the formation of toxic metabolites [18] and intermittent hemodialysis used to eliminate both methanol and its metabolites, in addition, to compensate for blood gas and electrolyte abnormalities. The intermittent hemodialysis procedure is performed in patients with serum methanol levels above 50 mg/dl and/or with severe metabolic acidosis, deterioration of general condition despite adequate treatment, severe electrolyte disturbances refractory to conservative treatment, or acute renal failure.

Substances that block ADH are: ethanol, fomepizole, abacavir, and H₂ receptor blockers [16]. The most commonly used substances are ethanol and fomepizole [19].

Ethanol: 1 ml/kg of 96% alcohol diluted fivefold as the loading dose, 0.16 ml/kg/h as the maintenance dose orally or via NGT, or 10% ethanol: 10 ml/kg intravenously as the loading dose, then 1 ml/kg/h until achieving an ethanol serum level of 150 mg/dl. Patients receiving intravenous (IV) ethanol require admission to an intensive care unit (ICU) due to numerous

adverse effects caused by ethanol, such as hypotension, respiratory depression, erythema, hypoglycemia, pancreatitis, and gastritis [16].

Fomepizole: (4-methylpyrazole) at a dose of 15 mg/kg as the loading dose, 10 mg/kg as the maintenance dose every 12 hours for up to 4 doses, and then 15 mg/kg every 12 hours until the methanol concentration in the blood drops below 25 mg/dl. Fomepizole does not require monitoring as in the case of ethanol infusion since it does not cause intoxication and is associated with fewer side effects. However, it is an expensive drug [16].

Antidote administration is recommended as soon as possible, preferably during pre-hospital care at the scene of the incident, if possible. Potential misuse of oral ethanol is rare in cases of methanol poisoning, and the benefits of early antidote administration outweigh the potential risk of side effects [20]. Ethanol is used as the primary antidote in toxicology departments. Special clinical situations oblige the use of fomepizole [21].

Conclusions

1. Non-beverage alcohol is often used by people with alcohol dependence syndrome.
2. Methanol poisoning occurs most frequently.
3. The reasons for methanol consumption vary, and it is essential to quickly identify the poisoning and implement appropriate treatment due to the serious symptoms that can result in the patient's death.
4. The metabolites of methanol are toxic, not methanol itself, which is why inhibiting alcohol dehydrogenase is an effective treatment for poisoning.
5. The method of extracorporeal elimination of choice is the intermittent hemodialysis procedure, during which both the methanol itself and its metabolites are removed from the patient's vascular compartment.

Author Contributions

Conceptualization and methodology: W.S., A.B., A.R-T. and M.T.; formal analysis, data curation , writing: W.S., A.B., A.R-T., J.T.,I.W., K.T., G.Ś., R.T.; supervision M.T. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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