

ORIGINAL ARTICLE

A 13-Year Retrospective Study on Toxic Alcohol Poisoning in Middle Urals, Russia

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Abstract

Background: Toxic alcohol poisonings are responsible for high mortality and morbidity in Russia. This study was aimed to evaluate the trends of harmful ethanol (EtOH) drinking as well as methanol (MeOH), isopropanol (IPA) and ethylene glycol (EG) poisonings in the Middle Urals region of Russia.

Methods: In this retrospective study, the medical records of patients poisoned with MeOH, IPA and EG as well as those with harmful heavy EtOH drinking admitted to Regional Poison Treatment Center in Yekaterinburg during the period of 2002 to 2014 were reviewed.

Results: During this 13-year period, 17482 patients with acute poisoning (due to various toxic agents) were admitted, which 2244 of them (12.8%) were due to alcohol poisoning. Of all patients with acute poisoning, 502 cases died which 61 of them (12.2%) were due to alcohol poisoning. Most of the alcohol poisoned patients were men (1658, 73.9%). The male proportion of EG poisoned patients was higher than poisoned patients with other types of alcohol. Harmful EtOH drinking constituted the majority of alcohol poisoning cases (2076, 92.5%). Patients with EG poisoning were relatively older while patients with heavy EtOH intake were significantly younger ($P < 0.001$). The highest mortality rate (35.9%) was seen in patients with EG poisoning. During this period, heavy EtOH drinking had a slight increasing trend and MeOH poisoning had a sharp increasing trend. On the other hand, IPA poisoning had a constant trend and the trend of EG poisoning was decreasing. The majority of MeOH and IPA poisonings were due to ingestion of surrogate alcohols.

Conclusion: Particular attention of health authorities should be directed towards alcohol drinking prevention measures as well as production and availability of surrogate alcohols in the community.

Keywords: Ethanol; Ethylene Glycol; Methanol; Poisoning; Russia

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INTRODUCTION

Toxic alcohol poisonings are serious intractable toxicological problems (1). They cause significant morbidities and mortalities, and they are known as deadly ingestions for children as death or severe symptoms can occur with the ingestion of only a small amount in this age group (1,2). In Russia, harmful ethanol (EtOH) drinking and toxic alcohols ingestions have been responsible for up to about 50% of poisonings in different regions while they have been known for causing up to 62% of poisoning related mortalities (3-6).

Russian and eastern European people are prevalently known for being victim of harmful EtOH drinking and ingestion of surrogate alcohols contaminated with toxic substances (7-9). Moreover, methanol (MeOH) and ethylene glycol (EG) ingestions are often reported both as sporadic and mass outbreak exposures (10-12). Despite advances in the management, mortality and morbidity of toxic alcohol poisonings have remained significant and are likely to be greater when outbreaks occur in stressed environments (1,2).

Middle Urals (Sverdlovskaya oblast) is one of the major

industrial regions of Russia. This study was aimed to evaluate the trends of harmful EtOH drinking as well as MeOH, IPA and EG poisonings in the Middle Urals region of Russia.

METHODS

Catchment area

Middle Urals region located in the middle of Russia with an area of 194,307 km² has a population of 4,320,677 people based on 2014 census. The main city is Yekaterinburg with a population of 1,445,662 people. The Regional Poison Treatment Center (RPTC) located in Yekaterinburg is the main poisoning medical setting and psychiatric hospital of the region. This center includes a 35-bed main ward, 12-bed intensive care unit (ICU), a toxicological laboratory and a 24/7 poison information service. The center is equipped with 5 hemodialysis facilities and a continuous renal replacement therapy machine for extra-corporal detoxification. Alcohol gas chromatographic analysis, arterial blood gas and osmolality measurement are also available. Poisoned patients from the half of Yekaterinburg city are transferred to this center by ambulance (6), while the rest are transferred to the

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Yekaterinburg City Poison Treatment Centre located in the opposite side of the city. Moreover, patients with severe acute poisonings are transferred from local hospitals located in towns and cities of the Middle Ural region to the RPTC. Nizhniy Tagil with 358,000 population is the only other city in the region, having its own local poison treatment center.

Study design and variables

In this retrospective study, the medical records of patients poisoned with MeOH, IPA and EG as well as those with harmful heavy EtOH drinking admitted to RPTC during the period of 2002 to 2014 were reviewed. Although EtOH is not generally categorized among toxic alcohols, heavy drinking of this substance may lead to toxic levels of EtOH in blood causing acute clinical complications and even death. Heavy EtOH intake was defined as a pattern of alcoholic beverage consumption that elevates the blood alcohol concentration to $\geq 0.08\%$; which usually corresponds to ≥ 5 drinks on a single occasion for men or ≥ 4 drinks on a single occasion for women, generally within about 2 hours (13). All MeOH, IPA and EG poisoning cases were confirmed with gas chromatographic analysis. The data extracted from RPTC database includes age, gender and outcome of patients. Clinical findings of a series of patients with MeOH poisoning admitted to RPTC in recent years with complete medical profile and treatments delivered to them were also extracted and presented in this article.

Statistical analysis

The data collected were entered into Microsoft Excel software (Microsoft Corp., Redmond, WA, USA). The results are presented with frequency and percentage in tables and graphs. The age of patients in each type of poisoning is presented with median and interquartile range (IQR) and the difference of this variable among each type of poisoning is analyzed with Kruskal Wallis H-test. A p value of less than 0.05 was considered statistically significant.

RESULTS

General findings

During this 13-year period, 17482 patients with acute poisoning (due to various toxic agents) were admitted to RPTC, which 2244 of them (12.8%) were due to alcohol poisoning. Of all patients with acute poisoning, 502 cases died which 61 of them (12.2%) were due to alcohol poisoning.

The demographic details and outcome of patients with alcohol poisoning are shown in table 1. As can be seen, most of the alcohol poisoned patients were men (1658, 73.9%). The male proportion of EG poisoned patients was higher than poisoned patients with other types of alcohol. Harmful EtOH

drinking constituted the majority of alcohol poisoning cases (2076, 92.5%). Patients with EG poisoning were relatively older while patients with heavy EtOH intake were significantly younger ($P < 0.001$). The highest mortality rate (35.9%) was seen in patients with EG poisoning.

Alcohol poisoning trends

The trends of yearly poisonings and deaths due to MeOH, EG, IPA and heavy EtOH intake during 2002 to 2014 are shown in figure 1.

Poisoning cases due to heavy EtOH intake, except for the period of 2006-2009, generally showed an increasing trend (Figure 1A). It should be noted that in the mentioned period, the RPTC had to limit admission of EtOH poisoned patients and referring them to the other poison center in Yekaterinburg for two reasons: (a) polyhexamethylene guanidine hydrochloride (PHMG) mass exposures occurred during August 2006 to May 2007 which constrained the bed availability in the center, (b) ICU renovation process in the center during the years 2008 and 2009. Apart from heavy EtOH intake, other causes of toxic alcohol poisoning (MeOH, EtOH and IPA) were unexceptionally admitted to the center without any limitation within that time-frame.

As shown in figure 1B, the incidence of MeOH poisoning was increasing during this 13-year period, while the trend of number of deaths was relatively constant. For EG poisoning, except 3 peaks in the years 2003, 2007 and 2013, the general trend was decreasing and the number of deaths complied with this trend (Figure 1C). For IPA poisoning, if we overlook the year 2014, the general trend of total cases and related deaths was constant. In 2014, an outbreak of IPA poisoning occurred which slightly altered the monotonous of trend-line in figure 1D.

Clinical findings of methanol poisoned patients

After reviewing available medical records of patients with MeOH poisoning; only 19 cases were found to have complete information. These cases were admitted to RPTC during 2009 to 2014. As shown in table 2, the most common clinical manifestations were tachycardia (84.2%), metabolic acidosis (68.4%), impaired vision (63.1%), reduced consciousness (63.1%) and respiratory depression (63.1%). All patients were admitted to ICU and received sodium bicarbonate. Hemodialysis and EtOH (as antidote) administered to 18 patients (94.7%) and intubation was done for 12 patients (63.2%).

DISCUSSION

In the present study, the trends of toxic alcohol poisonings in Middle Urals region in Russia was presented and analyzed. It was found that heavy EtOH drinking had a slight

Table 1. Demographic details and outcome of patients with alcohol poisoning during 2002 to 2014 in Middle Urals, Russia (n = 2244)

Variables	Toxic alcohol			
	Ethanol (n = 2076)	Methanol (n = 40)	Ethylene glycol (n = 78)	Isopropanol (n = 50)
Percentage of all alcohol poisoning cases (%)	92.5	1.8	3.4	22.3
Male gender, n (%)	1516 (73.0)	36 (90.0)	71 (91.1)	35 (70.0)
Age (year), median (range)	23.0 (4-88)	40.5 (21-71)	47.0 (16-72)	42.5 (15-70)
Hospital mortality, n (%)	18 (0.9)	11 (27.5)	28 (35.9)	4 (8.0)

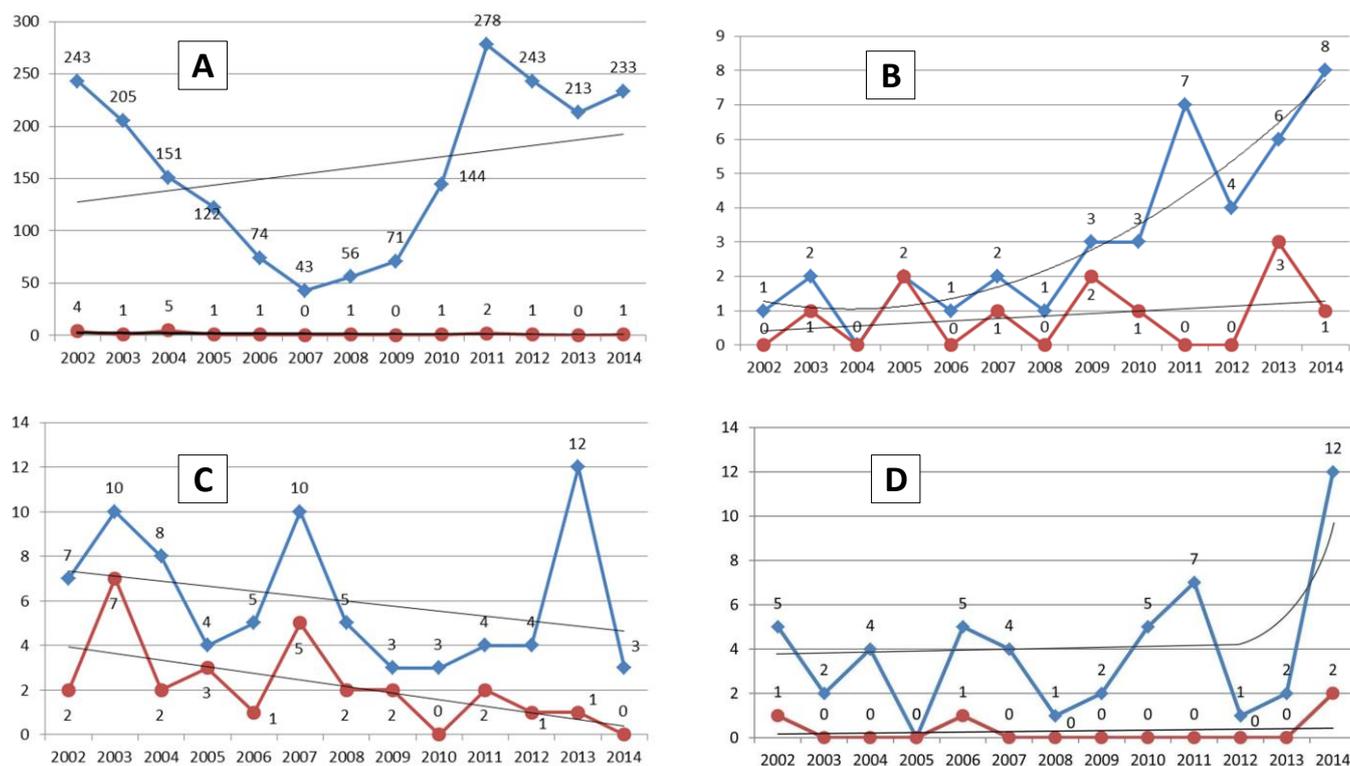


Figure 1. Trends of alcohol poisonings in Middle Urals, Russia, during 2002 to 2014: **A.** heavy ethanol inatke, **B.** methanol poisoning, **C.** ethylene glycol poisoning and **D.** Isopropanol poisoning. The total number of poisoning due to each type of alcohol in each year is indicated with "◆" and the number of related deaths in each year is indicated with "●" and the trendline is indicated with "—".

increasing trend and MeOH poisoning had a sharp increasing trend. On the other hand, IPA poisoning had a constant trend and the trend of EG poisoning was decreasing.

According to the newest World Health Organization report on global status of alcohol and health, Russia has been categorized among the countries with highest score for risky pattern of EtOH drinking (14). Acute EtOH poisoning rates have been shown to be increasing in this country (4,14). Some scientists have attributed this increase to social and economical transition in this country (15,16). Hence, alcohol drinking prevention measures should be prioritized.

Hazardous EtOH drinking and toxic alcohol ingestions play important roles in explaining high mortality in Russia, especially among men in working ages (3,17). MeOH poisoning increased sharply during the study period, although it remained to be in very limited numbers compared to EtOH poisoning. Epidemics of MeOH poisoning frequently occur across the globe (18). In countries like Iran and Bangladesh (19,20), outbreaks of MeOH poisoning cause high mortality and morbidity similar to Russia. However, there is slight difference between the causes of MeOH poisoning among these countries. While in Iran and Bangladesh illegal and uncontrolled production of alcoholic beverages results in MeOH contamination or sometimes adulteration (for attaining greater profit) (18-20), the MeOH-contaminated alcoholic drinks is not a (or at least a minor) health problem in Russia (21). In our cases, we found that a kind of glass washing liquid for cars was the cause of MeOH poisoning. According to Russian regulations this liquid should not contain MeOH,

though it contained. Most of our MeOH-poisoned patients consumed this substance as a surrogate alcohol.

Strict surveillance during production of this substance and proper labeling might have prevented these events. Nonetheless, it should be noted that consumption of surrogate alcohols is a serious problem in Russia (7-9). Most of individuals who drink such alcohols are those who fail to afford the cost of genuine alcoholic drinks. That might be why during 2006 and 2007, mass exposures to a PHMG-admixed EtOH product caused severe liver complications and thus a limitation of the number of beds available in our center (22). In this respect, raising public awareness on the toxic nature of surrogate alcohols should be taken into account by health authorities.

The number of IPA poisonings in our study suddenly increased in 2014. That fact may be connected with chemicals used accidentally by children, as surrogate alcohols by adults or for suicide purposes by adults.

In the present study, EG poisoning resulted in the highest mortality rate among all types of alcohols, which is due to its inherent high toxicity and rapid toxicokinetic (23).

The clinical findings of our MeOH-poisoned patients was comparable to other studies (10,19,20,23), however, the rate of impaired vision was remarkably higher in our patients (63.1%) compared to MeOH poisoning epidemics and outbreaks occurred in Estonia (12.2%), Iran (14.3%) and Bangladesh (20%) (10,19,20).

LIMITATIONS

The accuracy of data presented in this article is limited by the

Table 2. Clinical features of patients with methanol poisoning (2009-2014) in Middle Urals and treatments delivered to them.

Clinical features	N (%)
Tachycardia	16 (84.2)
Metabolic acidosis	13 (68.4)
Impaired vision	12 (63.1)
Altered mental status	12 (63.1)
Respiratory depression	12 (63.1)
Hypertension	11 (57.9)
Hypotension	6 (31.6)
Increased liver enzymes	5 (26.3)
Abnormal osmolal gap*	5 (26.3)
Tachypnea	4 (21.1)
Nausea/Vomiting	3 (15.8)
Acute renal failure	2 (10.5)
Seizure	0 (0.0)
Treatments	
ICU admission	19 (100)
Sodium bicarbonate	19 (100)
Ethanol	18 (94.7)
Hemodialysis	18 (94.7)
Assisted ventilation (intubation)	12 (63.2)
Gastric lavage	6 (31.6)
Activated charcoal	0 (0.0)
Fomepizole	0 (0.0)

*Analysis was available in 5 cases only

fact that patients who were admitted and treated in poison centers and tertiary care hospitals in the region other than RPTC were not included in this study. Moreover, the number of deaths due to toxic alcohol poisoning might be higher as we only reported the hospital mortality of our cases while the statistics of deaths on scene are not included in this study.

CONCLUSION

In Middle Urals region in Russia, increasing trends of hazardous EtOH drinking and MeOH poisoning have occurred during the recent 13 years while the rate of IPA poisoning was relatively stable and EG poisoning cases slightly decreased. Particular attention of health authorities should be directed towards alcohol drinking prevention measures as well as production and availability of surrogate alcohols in the community.

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