Forensic-Medical Criteria for Evaluation of Poisoning by Alcohol Surrogates

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Abstract

Introduction: According to statistical data, fatal poisoning by alcohol and its surrogates account for more than 55% of all poisonings. Fatal poisoning by alcohol surrogates equals for about 3-5%. The number of poisonings by organic solvents and technical fluids taken orally as alcohol surrogates has risen sharply. The widespread availability of these compounds and poor public awareness of their toxic properties lead to poisoning by these substances, and the frequency of such poisoning has a strong tendency to increase.

Materials and Method: 20 archival forensic medical reports on the corpses of people who received chemical intoxication due to poisoning by alcohol surrogates. The subject of the study was the effect of poisoning by alcohol surrogates on human systems and organs. Forensic medical examination of the corpses was carried out according to the generally accepted method in the first 10-18 hours, but no later than 24 hours after death. Quantitative determination of alcohol surrogates in biological material was carried out by gas chromatographic and spectrophotometric method.

Results: The most common signs of external examination of corpses in all cases studied during the study were clearly defined bluish-violet cadaveric spots (in 100% of cases), pale pink conjunctiva (in 86% of cases), and cyanosis puffiness of the skin of the face (in 74% of cases). Meanwhile, the most significant of the microscopic signs characteristic of most of the studied cases during forensic histological examination were: plethora of vessels in the lung tissue (in 100% of cases), edema of the pia mater and brain tissue (in 86% of cases), edema and focal hemorrhages in the lung tissue (in 84% of cases).

Conclusion: Respiratory, cardiovascular systems and pancreas are most vulnerable target organs for alcohol surrogates and leads to early morbidities in people who consume chronically. The changes can be found macroscopically as well as microscopically in corpses during forensic medical examinations.

Keywords: *Alcoholism, mortality, myocarditis, gas chromatography, cadaveric spots, alcohol substitute.*

Introduction

The term “surrogate alcohol” refers to a diverse array of products. Some researchers have defined surrogate alcohol as a subcategory of “unrecorded alcohol.” In addition to the definitions above for surrogate alcohol, unrecorded alcohol includes alcoholic beverages that are illicitly obtained or made legally for home use. Nonbeverage alcohol is another term used in the literature. Acute alcohol intoxication presents with a range of clinical challenges including behavioral disinhibition, metabolic derangements, and organ compromise. All acute alcohol intoxication may present with inebriation, gastroenteritis, and central nervous system depression. General management of ethanol-based alcohol intoxication consists of thorough history taking, supportive care, airway protection, trauma assessment, and correction of dehydration and electrolyte abnormalities. (Green et al, 2018)[1].

According to statistical reports, fatal poisoning by alcohol and its surrogates account for more than 55% of all poisonings (Ruziev & Yadgarova, 2018)[2]. Fatal poisoning by alcohol surrogates accounts for about 3-5%. The number of poisonings by organic solvents and technical fluids taken orally as alcohol surrogates has risen sharply (Iskandarov & Najmitdinov, 2018).[3] Poisonings with household and industrial fluids, which, apart from ethyl alcohol, include propyl, isopropyl, isobutyl and isoamyl alcohols (primus liquid, methylated spirits, brake fluid, technical glass washing liquid, various varnishes) are observed quiet often. Propyl alcohol poisoning accounts for 29% of all surrogate poisoning, 65% for isobutyl alcohol and 6.5% for isoamyl alcohol. Among these poisonings, the percentage of deaths is especially high (Shamsiev et al, 2017)[5].

The toxic effect of methanol is mainly associated with its metabolic products (formaldehyde, and especially formic acid), which suppress the cytochrome system and oxidative phosphorylation, thereby causing ATP deficiency, especially in the brain tissue and in the retina. Butyl alcohol causes a narcotic effect, acts mainly on the central nervous system (Ruziev, 2017)[4].Many surrogatesof alcohol, for example, ethylene glycol (EG) and its esters (cellosolves; CZ), at present, widespread use both in industry, in transport and in everyday life, and in the maintenance of various technical systems (Neufeld et al, 2016; Razvodovsky, 2017; and Rehm et al, 2015)[6]. The widespread availability of these compounds and poor public awareness of their toxic properties lead to poisoning by these substances, and the frequency of such poisoning has a strong tendency to increase.

In the Republic of Uzbekistan, this topic has not been studied enough; there is lack of information on exact definitions of which organs and how these organs are affected by poisoning with alcohol surrogates.

The aim of the research was to develop modern criteria for assessing acute poisoning by alcohol surrogates.

Materials and Method

Study Population: The objects of the study were 20 archival forensic medical reports on the corpses of people who received chemical intoxication due to poisoning by alcohol surrogates. The subject of the study was the effect of poisoning by alcohol surrogates on human systems and organs. The study was conducted at the Republican Scientific and Practical Center for Forensic Medical Examination of the Ministry of Health of the Republic of Uzbekistan.

Forensic Medical Examination: Forensic medical examination of the corpses was carried out according to the generally accepted method in the first 10-18 hours, but no later than 24 hours after death. Quantitative determination of alcohol surrogates in biological material was carried out by gas chromatographic and spectrophotometric method. For forensic histological examination, pieces of internal organs were fixed in 10-12% formalin solution and enclosed in paraffin blocks. Histological sections were stained with hematoxylin-eosin. In all expert cases, alcohol substitution poisoning was confirmed by case materials, the clinical picture of poisoning, the results of a forensic medical examination of a corpse, data from a toxicological laboratory, forensic chemical analysis and histological examination. The objects of toxicological analysis were the internal organs of the corpse, biological fluids, gastric lavage, vomit, as well as fluid residues in various containers found at the scene.

Results

Out of 20 materials, 12 men and 8 women aged from 30 to 50 years. Analysis of the distribution of victims by gender yielded the following results (Figure 1):

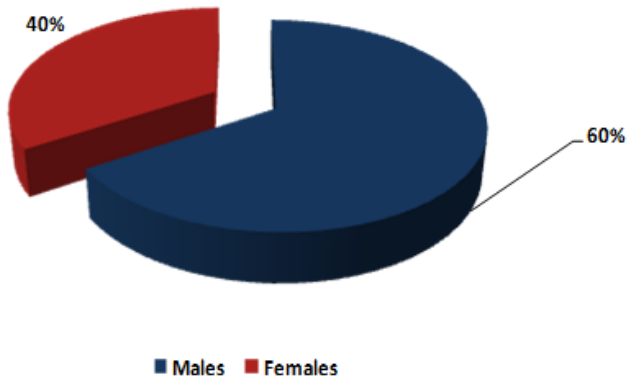

Fig. 1. Distribution of victims poisoned by alcohol surrogates by gender

The study of the results of an external study of corpses based on the materials of forensic medical examinations in cases of acute poisoning by alcohol surrogates allowed us to highlight some signs characteristic of a number of cases studied during the research. The frequency of occurrence of these signs is presented in table 1.

Table 1: The frequency of occurrence of signs characteristic for a number of cases of acute poisoning by alcohol surrogateslearned in an external study of a corpse

Signs	Absolute number of cases	Proportion of cases (%)
Cadaverous spots of cyanotic purple, well defined	20	100,0
Pale pink conjunctiva	17	86,0
Cyanosis and puffiness of the skin of the face	19	74,0
Mucus in the nasal passages and oral cavity	2	8,0
Exophthalmos	1	6,0

As it is shown in the table above, the most common signs of external examination of corpses in all cases studied during the study were clearly defined bluish-violet cadaveric spots (in 100% of cases), pale pink conjunctiva (in 86% of cases), and cyanosis puffiness of the skin of the face (in 74% of cases). Data on the occurrence of such signs as mucus in the nasal passages and oral cavity (in 8% of cases) and exophthalmos (in 6% of cases) in the materials of the study are not so significant.

An analysis of the results of forensic histological studies showed that in the microscopic picture of changes in acute poisoning with alcohol surrogates, some indicators characteristic of a number of cases studied can also be distinguished. The frequency of occurrence of these indicators is shown in table 2.

Table 2: The frequency of occurrence of microscopic changes characteristic of a number of cases of acute poisoning by alcohol surrogates studied in a forensic histological study

Signs	Absolute number of cases	Proportion of cases (%)
Edema of the pia mater and brain tissue	17	86,0
Vascular congestion in lung tissue	20	100,0
Perivascular hemorrhages in the tissues of the pia mater and brain	7	36,0
Edema and focal hemorrhage in lung tissue	17	84,0
Cardiosclerosis	15	76,0
Sclerosis of the blood vessels of the heart	14	68,0
Unbalanced pulp plethora in spleen tissues	8	42,0
Sclerosis of trabeculae and trabecular vessels in the tissues of the spleen	8	42,0
The process of pancreatic autolysis	14	68,0
Pancreatic hemorrhage	5	26,0
Fatty hepatosis	10	50,0
Dystrophic changes in hepatocytes	7	34,0
Dystrophic changes in the renal tubules	14	68,0
Uneven blood vessels in the kidney tissue	12	60,0

The data presented in the table shows that the most significant of the microscopic signs characteristic of most of the studied cases during forensic histological examination were: plethora of vessels in the lung tissue (in 100% of cases), edema of the pia mater and brain tissue (in 86% of cases), edema and focal hemorrhages in the lung tissue (in 84% of cases), cardiosclerosis (in 76% of cases), sclerosis of the blood vessels of the heart (in

68% of cases), the process of autolysis in the pancreas (in 68% of cases), dystrophic changes in the kidneys tubules (in 68% of cases) and uneven blood supply vessels in kidney tissues (60% of cases). Less significant were fatty hepatosis (in 50% of cases), uneven pulmonary congestion in spleen tissues (in 42% of cases), and sclerosis of trabeculae and trabecular vessels in spleen tissues (in 26% of cases). The least significant signs were signs of perivascular hemorrhage in the tissues of the pia mater and brain (in 36% of cases), dystrophic changes in hepatocytes (in 36% of cases), hemorrhage in the tissues of the pancreas (in 36% of cases). The figures given in these tables are characteristic for changes caused by chronic alcohol dependence, which indicates that the victims, in all studied cases of poisoning by alcohol surrogates, suffered from chronic alcoholism[10].

However, during the analysis of archival data, specific indicators were also found that were found in cases of poisoning with certain alcohol surrogates. In 6 cases of ethylene glycol poisoning, an external examination of the bodies of victims of acute ethylene glycol poisoning showed cyanosis of the skin and mucous membranes, as well as pinpoint hemorrhages on hyperemic conjunctiva of the eyes[11].

In an internal study of corpses, vascular endothelial damage, venous congestion of organs, hemorrhages in the pleura, epicardium, endocardium and gastric mucosa were observed[12]. The cyanosis of the membranes of the brain was detected. Expansion of the right heart regions and their overflow with blood were revealed, uneven blood filling and myocardial edema were noted. Puffiness and hyperemia of the mucous membranes of the upper respiratory tract, single subpleural and intrapulmonary hemorrhages, plethora, emphysema and pulmonary edema, swelling and plethora of the gastric mucosa with single small hemorrhages were observed[14]. An increase and swelling of the kidneys, tension of the capsule were detected. The tissue of the kidneys in the incision was cyanotic.

A study of the results of clinical and laboratory studies in cases of poisoning with alcohol surrogates showed that the most effective method for their determination are toxicological analysis and gas-liquid chromatography. The analysis of the results of chemical-toxicological studies allowed to distribute the victims of poisoning with alcohol surrogates as follows (Table 3.):

Table 3: Distribution of victims by identified alcohol surrogates

Alcohol surrogates	Number of cases	
	Abs	%
Ethylene glycol	2	10%
Methyl alcohol	3	15%
Amyl alcohol	1	5%
Chloral hydrate	1	5%
Dichloroethane	2	10%
Tetraethyl lead	1	5%
Propyl alcohol	7	14%
Butyl alcohol	1	5%
Acetone	2	10%

As the data in this table show, 4 detoxification method were used in victims of acute poisoning by alcohol surrogates. Moreover, hemodialysis was carried out in all cases of poisoning, hemosorption in 58% of cases, enterosorption in 36% of cases, and forced diuresis in only 14% of cases. This choice of detoxification method is explained, first of all, by the features of these method.

Among the microscopic signs, the most significant ones were: vascular congestion in the lung tissue, edema of the pia mater and brain tissue, edema and focal hemorrhage in the lung tissue, cardiosclerosis, sclerosis of the blood vessels of the heart, autolysis process in the pancreas, dystrophic changes in the renal tubules and uneven blood vessels in the tissues of the kidneys. In addition, specific signs and morphological features of poisoning by each of the alcohol surrogates were revealed.

Discussion

According to data we obtained during our study, cadaverous spots of cyanotic purple, pale pink conjunctiva and cyanosis and puffiness of the skin of the face are the most common macroscopic signs in corpuses died from unrecorded alcohol surrogates. Furthermore, the most significant of the microscopic signs characteristic of most of the studied cases during forensic histological examination were: plethora of vessels in the lung tissue, edema of the pia mater and brain tissue, edema and focal hemorrhages in the lung tissue, cardiosclerosis, sclerosis of the blood vessels of the heart, the process of autolysis in the pancreas, dystrophic changes in the kidneys tubules and uneven blood supply vessels in kidney tissues.

One clear example is that the index of lethal poisoning with ethyl alcohol and its surrogates in Russia remains one of the highest in the world. It is explained by high alcohol consumption in Russia (about 15 liters of pure alcohol per capita annually), consumption of mainly strong beverages (about 80%), extensive sales of adulterated strong alcoholic beverages (more than 25%), virtually no preventive work in the population, and other causes. The index of lethal poisoning with alcohol and its surrogates in the country and its regions is one of the most important parameters in evaluation of the socioeconomic well-being of the population (Tomilin et al, 1999)[7].

Unrecorded alcohol includes illegally distributed alcohol as well as homemade or surrogate alcohol which is unintended for consumption by humans (e.g., cosmetics containing alcohol). The highest unrecorded alcohol consumption occurs in Eastern Europe and some of these countries have an over proportional liver cirrhosis mortality. Compounds besides ethanol have been hypothesized as being responsible for this observation. On the other hand, chemical investigations were unable to prove that unrecorded alcohol regularly contains contaminants above toxicological thresholds (Lachenmeier et al, 2014)[8].

However, illegally produced spirits regularly contain higher percentages of alcohol (above 45% by volume), but for considerably less costs compared with licit beverages, potentially causing more problematic patterns of drinking. In this review, it is investigated whether patterns of drinking rather than product composition can explain the liver cirrhosis mortality rates.

Statistical examination of World Health Organization country data shows that the originally detected correlation of the percentage of unrecorded alcohol consumption and liver cirrhosis mortality rates disappears when the data is adjusted for the prevalence of heavy episodic drinking. It may be concluded that there is currently a lack of data to demonstrate causality between the composition of illicit spirits (e.g., higher levels of certain contaminants in home-produced products) and liver toxicity on a population scale. Exceptions may be cases of poisoning with antiseptic liquids containing compounds such as polyhexamethyleneguanidine, which were reported to be consumed as surrogate alcohol in Russia, leading to an outbreak of acute cholestatic liver injury, histologically different from conventional alcoholic liver disease (Lachenmeier et al, 2014)[9].

Conclusion

Among the microscopic signs, the most significant were: vascular congestion in the lung tissue, edema of the pia mater and brain tissue, edema and focal hemorrhage in the lung tissue, cardiosclerosis, sclerosis of the blood vessels of the heart, autolysis process in the pancreas, dystrophic changes in the renal tubules and uneven blood vessels in the tissues of the kidneys.

If morphological or histological changes characteristic of poisoning by surrogates of alcohol are detected, it is necessary to conduct comprehensive forensic toxicological studies of corpses.

Study Limitations: The amount of participant in both arms was less to prove the hypothesis. It might have affect some of our results. Furthermore, the type of surrogate was not clear in all cases. Some corpses did not have any relatives who might be asked for elucidation of the cases. Thus, further researches can be conducted with more amount of participants in each arm.

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Ethical Approval: The ethical approval for the study was granted by the Committee of Ethical Approval for Researches under the Ministry of Health of the Republic of Uzbekistan.

Consent: Written informed consent was obtained from the relatives of corpses of the research for publication of this paper and any accompanying information related to this study.

Conflict of Interest: The authors declare that they have no competing interests.

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