JOURNAL OF FORENSIC SCIENCES

*J Forensic Sci,* May 2011, Vol. 56, No. 3
doi: 10.1111/j.1556-4029.2011.01623.x
Available online at: onlinelibrary.wiley.com

**CASE REPORT**

**TOXICOLOGY**

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# Methyl Alcohol Poisoning in Trabzon (Turkey)

**ABSTRACT:** The aim of this retrospective study was to examine methyl alcohol intoxications in Trabzon (Turkey) and to determine any relations between the laboratory results and histopathologic changes. A total of 4492 forensic autopsies were performed from 1998 to 2008. Thirteen of the cases (0.3%) were because of methanol poisoning, and all were men. Their ages ranged from 25 to 62 years. The blood methanol concentrations ranged widely, from 15 to 482 mg/dL. In six cases, poisoning was because of consumption of the alcoholic beverage "Raki," while in five cases, poisoning was because of the ingestion of cologne. The products consumed were unknown in the other two cases because of insufficient history and data records. Mortality because of methanol poisoning may be prevented/decreased with the implementation of some precautions, such as public education regarding the harms of methyl alcohol, routine monitoring of the vendors that sell alcoholic beverages and cologne, and appropriate legal retribution for the illegal production of methanol.

**KEYWORDS:** forensic science, forensic autopsy, methyl alcohol, intoxication, Trabzon, mortality

Methanol is a clear, colorless, and volatile liquid with a weak odor, and it is slightly sweeter than ethanol. It is used in the industrial production of many synthetic organic compounds and is a constituent of a large number of commercially available solvents (1,2). Because it is cheap and easy to obtain, it is used in the production of illegal alcoholic beverages in Turkey (3).

The alcoholic beverage "Raki" is synonymous with Turkey and its culture and is consumed commonly by the population. The origin of the beverage is not exactly known. While its history is not as extensive as that of wine or beer, it can be dated back at least some 300 years. The art of distillation, which started in the Arab world and spread to the neighboring countries, was implemented when people considered utilizing the sugar in the residue of wine processing. With the addition of aniseed, Raki took on its Turkish characteristic (4). There are many proverbs that refer to Raki as the traditional Turkish drink. It is made from different fruits in different regions, but grapes, figs, and plums are generally used.

In Turkey, according to the distilled alcoholic beverages statement No. 6/a, the content of methyl alcohol in Raki must not exceed 150 g in 100% hectoliters of alcohol by volume (5). According to the Turkish Penal Code No. 186, producers of illicit alcoholic beverages using methyl alcohol are sentenced to 1–5 years' imprisonment (6).

From the toxicological point of view, methanol levels in commercially available alcoholic drinks are rarely relevant, as the drinks contain sufficient amounts of the antidote ethanol. In contrast, self-made alcoholic beverages or chemicals for hobby purposes, e.g., gasoline for model aircraft, often contain high methanol levels that can lead to accidental poisoning (7).

Poisoning with methanol may be the result of either accidental or intentional ingestion. Desperate alcoholics have intentionally substituted ethanol-containing substances for those containing methanol, in spite of being aware of its potentially harmful effects. The lethal dose of methanol in humans shows pronounced individual differences, ranging from 15 to 500 mg/dL (2).

The toxicity of methanol is because of its metabolites, formaldehyde and formic acid (formate), and further to carbon dioxide and water. Formic acid induces severe metabolic acidosis that leads to death and is the primary agent responsible for the ocular toxicity (8–10). Formaldehyde is highly toxic but has a short half-life and does not accumulate (11).

Clinical symptoms of methanol intoxication are drowsiness, headache, nausea, vomiting, severe epigastric pain, renal insufficiency, respiratory failure, and a central nervous system depression extending to coma. Laboratory investigations show a severe anion gap acidosis. Some of the early symptoms, such as impaired speech and coordination, can resemble acute ethanol effects. Visual disturbances or permanent visual damage is frequently present in cases with longer survival times (12).

The aim of this retrospective study was to examine and summarize a series of methyl alcohol poisoning cases in Turkey from a medicolegal aspect.

Trabzon is a city located in the northeast region of Turkey and is one of the largest cities in the country. The Black Sea Regional Center for Forensic Medicine, one of the seven regional forensic centers in Turkey serving different geographical areas, is located in Trabzon. The Center assists in medicolegal investigations in the region by offering expert opinions to facilitate legal authorization in understanding the medical implications of pathological examinations, including live medical examinations and postmortem examinations (autopsies), and pathological investigations.

## Materials and Methods

In this study, we reviewed the legal investigations and autopsy, toxicology, histopathology, and alcohol reports of 13 cases (0.3%) with methyl alcohol poisoning whose autopsies were performed at the Morgue Department of the Trabzon Branch of the Council of

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Received 26 Dec. 2009; and in revised form 8 Apr. 2010; accepted 17 Apr. 2010.

Forensic Medicine between January 1, 1998 and December 31, 2008. A total of 4492 medicolegal autopsies were performed during this period. Age, sex, methyl alcohol blood levels, source of methyl alcohol, place of death, laboratory results, and histopathologic tissue changes were recorded for each of the cases.

Blood samples were collected from the heart chamber for the measurement of methyl alcohol concentration. *N*-Butanol (0.5 mL, 150 mg/dL), as an internal standard, was added to 1 mL of whole blood sample. Analyses of methanol were performed on a PerkinElmer model Clarus 500 series gas chromatograph–flame ionization detector equipped with a PerkinElmer model Turbo Matrix 16 Headspace Sampler (PerkinElmer, Shelton, CT). The chromatographic column (60 m × 0.53 mm inside diameter) was innowax (polyethylene glycol) complete polar column. The operation conditions were as follows: injector temperature 120°C and detector temperature 250°C. During the analysis, the oven temperature program was kept at 40°C for 4 min. Then, the temperature was increased up to 90°C at increments of 10°C in 1 min and then again up to 240°C at increments of 30°C in 1 min, where it was maintained for 2 min. Nitrogen (20 psi) was used as a carrier gas.

## Results

During the 11-year period, the total number of forensic autopsy cases was 4492. The total number of deaths determined to be because of methanol poisoning was 13 (0.3%). All of the cases were men. Ages of the cases ranged from 25 to 62 years (40.0 ± 13.6), but the majority (61.5%) were between 25 and 44 years old.

According to toxicology results, the blood methyl alcohol concentration ranged widely, from 15 to 482 mg/dL. Methyl alcohol blood concentration was over 100 mg/dL in eight cases (61.5%), while it was below 50 mg/dL in five cases. Eight of 13 cases (61.5%) also had ethyl alcohol in their blood samples, ranging in concentrations from 55 to 244 mg/dL.

Microscopic histopathological investigations revealed findings including widespread tissue congestion, brain edema, hypertrophy and fatty degeneration in the myocardium, chronic passive congestion, edema and asphyctic bleeding in the lungs, and mild macrovesicular steatosis and chronic passive congestion in the liver parenchyma. The histopathological findings, poisoning-related findings, and miscellaneous findings not specific to cause of death are shown in Table 1.

TABLE 1—*Microscopic autopsy findings.*

| | Histopathologic Findings | Number of Cases |
|---|---|---|
| Brain | Subarachnoidal hemorrhage | 1 |
| | Intracerebral hemorrhage | 1 |
| Lung | Intra-alveolar hemorrhage | 6 |
| | Subpleural hemorrhage | 5 |
| | Pneumonia | 1 |
| Liver | Fatty change | 4 |
| | Cholestasis | 1 |
| Heart | Ischemic fibrosis | 3 |
| | Myocardial hypertrophy | 1 |
| | Myocardial infarct | 5 |
| | Atherosclerotic plaque causing mild tightness in coronaries ≤30% | 2 |
| | Atherosclerotic plaque causing advanced tightness in coronaries ≥80% | 1 |
| Pancreas | Hemorrhage | 1 |
| Organs (brain, lung, liver, heart, and kidney) | Congestion | 4 |
| | Autolysis | 1 |

In six cases, poisoning was because of consumption of the alcoholic beverage Raki, and in five cases, poisoning was because of the ingestion of cologne. The products consumed were unknown in the other two cases because of insufficient history and data records.

The scene investigation reports showed that six cases (46.2%) were found dead in their home, four cases (30.8%) were admitted to hospital in coma and died there, and three cases (23.0%) were found dead in an open area.

## Discussion

Methanol is readily available from many commercial products. Poisoning with methanol may be the result of either accidental or intentional ingestion (13). The case of chronic alcoholics is a significant problem in Turkey, and desperate alcoholics have intentionally substituted ethanol-containing substances for those containing methanol, in spite of being aware of its potentially harmful effects.

Birgen et al. reported an individual who died after consuming an illicit alcoholic beverage; a court in Istanbul sentenced each of the seven people involved in its production to life imprisonment (14,15).

According to Di Maio and Di Maio, the minimum lethal blood level in methanol poisoning is approximately 80 mg/dL (9). In the studies of Derrick et al. (16) and Mittal et al. (17), the lethal dose of methanol in humans showed pronounced individual differences, ranging from 15 to 500 mg/dL. In our study, the blood methanol concentration also ranged widely, from 15 to 482 mg/dL. There were eight cases (61.5%) with methyl alcohol blood concentration over 100 mg/dL, while in five cases, methyl alcohol blood concentration was below 50 mg/dL. Other studies of methyl alcohol concentrations have reported varying ranges as follows: 50–755 mg/dL by Yaycı et al. (3), 55–479 mg/dL by Azmak et al. (18), and 38–414 mg/dL by Fedakar et al. (19). In eight of the total methyl alcohol poisoning cases, ethyl alcohol was also determined as positive, while in the remaining five, no ethyl alcohol was detected. The present study only considered poisoning deaths because of methanol.

Inanici et al. (Personal Communication, Inanici MA, Birgen N, Anolay N, Methyl alcohol poisoning: an autopsy study, September 2000, Santiago de Compostela, Spain) reported the rate of methanolic poisoning due to alcoholic beverages as 40.5% and to cologne as 11.2%, while Azmak et al. (Edirne, Turkey) (18) reported that consumption of alcoholic beverages and cologne was seen in 66.6% and 22.2% of poisonings, respectively. In our study, six cases (46.2%) were poisoned after consuming illicitly produced Raki and five cases (38.5%) by colognes. The product consumed was undetermined in two cases (15.2%) because of insufficient data. In another study, Davis et al. (New Mexico, USA) (20) reported windshield wiper fluids as accounting for 60.8%, automotive sources for 23.7%, commercial nonautomotive sources for 12.2%, and pure methanol for 3.3% of methanolic poisoning deaths.

According to previous studies (3,18,21), the rates of deaths at home were found as 38.0%, 33.3%, 27.3%, and 16.6%, respectively. The high rates of death at home can be explained by the latent period of methanol exposure. Following consumption of the alcoholic beverage, individuals had an asymptomatic period of approximately 12–24 h (22–24). The cases continued to consume the alcoholic beverage until they recognized the intoxication symptoms, at which point it is too late for admission to hospital. This can explain the 77.5% fatality rate (3). On the other hand, according to Meyer et al. (21) and Inanici et al. (Personal Communication,

Inanici MA, Birgen N, Anolay N, Methyl alcohol poisoning: an autopsy study, September 2000, Santiago de Compostela, Spain), the hospital death rates were found as 20.0% and 20.9%, respectively. In this study, six cases (46.2%) were found dead in their homes, four cases (30.8%) died in different hospitals, and three cases (23.0%) were found dead in open areas.

In this study, nonspecific histopathological changes in organs such as edema, hyperemia, congestion, and hemorrhage were seen in most of the cases. Myocardial pathologies (myocardial infarct [five cases], ischemic fibrosis [three cases]); and/or pulmonary pathologies (pneumonia [one case], chronic congestion [one case]); and/or hepatocyte pathologies (fatty change [four cases], cholestasis [one case]); and/or pancreatic hemorrhage (one case), autolysis (one case), subarachnoidal hemorrhage (one case), and intracerebral hemorrhage (one case) were also determined. McLean et al. (25) reported cerebral histological findings of encephalitis (one case), intracerebral hemorrhage (one case), and cystic resorption of the white matter in the brain (two cases). All the cases involved were acute poisoning, and the general histopathologic characteristics of poisoning were reported. The other pathologies observed in different organs (i.e., pneumonia, myocardial hypertrophy, and ischemic fibrosis) were not considered as potential primary causes of death but rather as causing vulnerability to poisoning with lower methanol doses.

According to Mittal (17), who reported 97 cases of methyl alcohol intoxication, 85.7% of the cases displayed neuron degeneration and hemorrhage in the parietal cortex and 7.1% displayed lesions in the optic chiasm in the brain. In another study, histological cerebral cross sections showed intracranial bleeding in 1.6% of cases, as well as hyperemia and cerebral edema in 50% of the cases (3).

## Conclusion

In the present study, most deaths because of methyl alcohol intoxication were observed in middle-aged males. Heavy drinkers of low socioeconomic status likely consume the cologne and grain alcohol, which may contain harmful quantities of methyl alcohol, because of their low cost and availability. We believe that some preventive measures should be taken in an effort to reduce this mortality, such as public education programs about the harms of methyl alcohol, routine monitoring of the vendors that sell alcoholic beverages, and appropriate legal retribution for the illegal production of methanol.

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