



Research Paper

Methanol related deaths in Adana, Turkey

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ABSTRACT

Methanol is a clear, colorless, and highly toxic substance that is commonly used as industrial solvents, paints, varnishes, gasoline mixtures, and various solvents and antifreeze in automobiles. It is obtained from the destructive distillation of wood. Methanol, due to its taste and smell is a non-drinking type of alcohol. It is available for use orally after distillation techniques and frequently used in illegal drink production because of its cheapness and availability. It is also traditional for the people who are living in the villages, especially in Cukurova region, to produce their own 'RAKI' from either grapes, figs or plums. The production of homemade and handmade alcohol drink called "BOGMA RAKI" is frequent in this region. The goal of this study is to examine methanol-related deaths in the Adana, Cukurova region of Turkey. Autopsy records of the Forensic Medicine Council of Adana Branch, Morgue Department were reviewed. Seventy-eight (78) autopsy cases due to methanol poisoning were examined retrospectively in the Morgue Department, Council of Forensic Medicine Adana Group Administration from May, 2016 to 2017. These cases were classified according to their age, gender, death place, city and methanol blood levels. Illicit drugs were also examined in blood samples of these cases. This is a preventable condition. If early diagnosis and treatment is provided, permanent neurological disorders can be prevented. Hence, measures should be taken to prevent the construction and sale of illegal drinks, and public information be provided through public spots and city bulletin boards. Healthcare professionals should also be given training in this area, especially in cases of loss of consciousness, nausea, vomiting, or acute vision loss.

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INTRODUCTION

Methanol is a clear, colorless, and highly toxic substance that is commonly used as industrial solvents, paints, varnishes, gasoline mixtures, and various solvents and antifreeze in automobiles. It is obtained by destructive distillation of wood and not suitable for drinking because of its taste and smell. It is available for use orally after distillation techniques and frequently used in illegal drink production because of its cheapness and availability. Methanol intoxication usually occurs following inhalation or topical exposure of spirit, ingested accidentally or for suicide, homemade alcohol, or eau de cologne (Gulmen et al., 2006; Karaoğlu et al., 2017).

Although, methanol intoxication is most frequently reported due to oral intake, cases of inhalation and transdermal methanol intoxication are also reported (Karaoğlu et al., 2017). The toxicity of methanol is caused by its metabolites rather than methanol itself (Arslan et al., 2015). Methanol is quickly absorbed in the gastrointestinal tract, metabolized in the liver, and converted to formaldehyde by alcohol dehydrogenase (ADH), while the formaldehyde is converted to formic acid by aldehyde dehydrogenase. Formic acid, which has very slow metabolism is the main metabolite responsible for its toxicity. Formic acid causes metabolic acidosis and inhibits

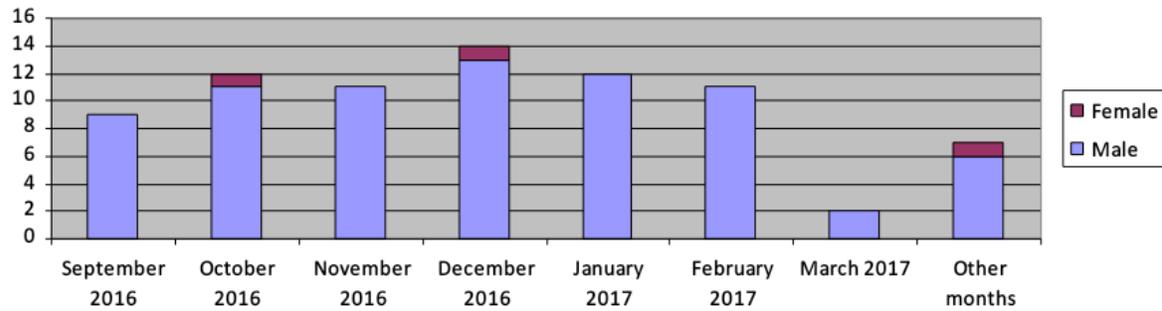


Figure 1: Annual distribution of methanol deaths.

mitochondrial cytochrome c oxidase, which leads to tissue hypoxia. In the late phase of poisoning, the lactate becomes more important when cellular aerobic respiration is blocked and anaerobic glycolysis and lactic acidosis develops (Tokgoz et al., 2012; Liesivuori and Savolainen, 1991; <https://emedicine.medscape.com/article/1174890-overview>, 2019).

Optic nerve demyelination has been reported to be due to formic acid destruction of myelin. The major damage occurs at the retrolaminar optic nerve, with intra-axonal swelling and organelle destruction. Little to no change is seen in the retina (Casarett et al., 1996). Methanol also affects the basal ganglia. Hemorrhagic and non-hemorrhagic damage to the putamen are common problems in cases of severe intoxication (Phang et al., 1988). Methanol intoxication is a relatively rare but potentially serious medical emergency case (Anyfantakis et al., 2012).

The clinical presentation of methanol intoxication varies greatly from one patient to the other. A latent period of 12 to 24 h (until methanol is transformed to its toxic metabolites) often follows methanol ingestion and signs and symptoms may vary depending on the methanol intake path. Most patients suffer from nausea, vomiting, headache, weakness, and visual loss, and changes in the affected areas may be seen in patients with dermal exposure. Large amounts of methanol ingestion may result in seizures, stupor, coma, and even death. The classical manifestations/symptoms of methanol poisoning include visual disturbance (decrease in visual acuity, photophobia and reduction in light reflex, etc), severe metabolic acidosis, and Central Nervous System (CNS) depression leading to respiratory failure (Karaoğlu et al., 2017). The prognosis is further dependent on the amount of formic acid accumulation in the blood, with a direct correlation existing between the formic acid concentration and morbidity and mortality (<https://emedicine.medscape.com/article/1174890-overview>, 2019).

Deaths due to liver failure, multiple organ insufficiency, vomiting, and aspiration are mentioned in the literature. There are different evidences in postmortem examination due to type of intake: congestion and hemorrhage are observed in stomach mucosa if it is taken orally; in the subpleural region, edema and bleeding take place if

methanol is inhaled. Congestion may occur in other organs: brain edema, hemorrhage, and necrosis (especially in putamen and white matter), cystic resorption of putamen, hemorrhage in pancreas, fatty change in liver, renal tubular degeneration, and optic nerve atrophy (Anderson, 1999; Finkelstein and Vardi, 2002). The minimal lethal dose of methanol in adults is believed to range from 0.3 to 1 g/kg of body weight (<https://emedicine.medscape.com/article/1174890-overview>, 2019).

It is also traditional for the people who are living in the villages, especially in cukurova region, to produce their own 'RAKI' from either grapes, figs or plums. The production of homemade and handmade alcohol drink called "BOGMA RAKI" is frequent in this region. Hence, the goal of this study is to examine methanol-related deaths in the Adana, Cukurova region of Turkey.

MATERIALS AND METHODS

Autopsy records of the Forensic Medicine Council of Adana Branch, Morgue Department were reviewed. There were seventy-eight (78) autopsy cases examined retrospectively due to methanol poisoning in the Morgue Department, Council of Forensic Medicine Adana Group Administration from the period of May, 2016 to 2017. These cases were classified according to their age, gender, death place, city and methanol blood levels. Illicit drugs were also examined in blood samples of the cases.

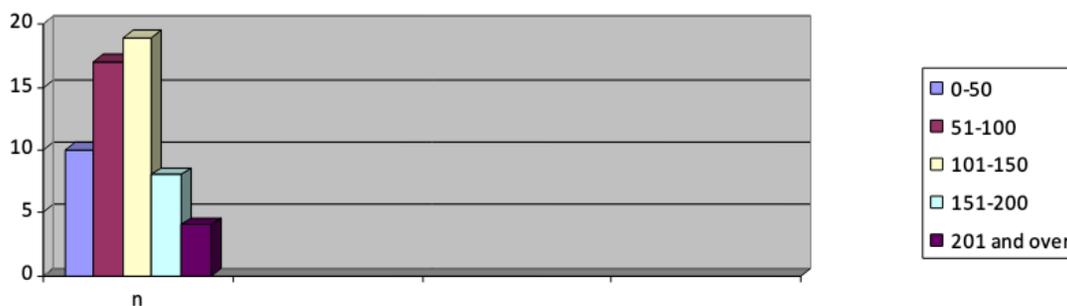
Blood samples were collected from the femoral vein for the measurement of methyl alcohol concentration. Blood samples were kept at +4°C until toxicological analysis.

RESULTS

Among the 2,925 deaths that occurred, 78 were due to methanol poisoning. The mean age of the cases was 52, while the youngest age was 15 years and the biggest 71 years. 85% of the cases were over 30 years old. Only three (3) cases were seen as women. Figure 1 shows the annual distribution of methanol deaths, while Table 1 shows the

Table 1: Distribution due to age and gender.

Age	Male	Female	Total	Percentage (%)
0-10	-	-	-	-
11-20	1	-	1	1.28
21-30	4	-	4	5.13
31-40	6	1	7	8.98
41-50	21	1	22	28.20
51 and over	43	1	44	56.41
Total	75	3	78	100

**Figure 2:** Methanol blood levels.

distribution due to age and gender. 57.6% of the cases originated in Adana, while 41% in Mersin and the other cases in Iskenderun, Niğde and Osmaniye (nearby cities).

The public prosecutor's office and scene investigation records were reviewed. Hospital deaths accounted for 78.2% of the cases. Nine deaths took place at home, six were found dead on open public places, while three were found dead in their workplace (one being a ship worker). Among 61 deaths, 21 occurred before arriving at the hospital or during resuscitation. The others received an hour medical treatment in hospitals for 30 days. Methanol blood levels of the cases were examined. In eight of the cases, the level was between 151 and 200 mg/dl, in 19 cases 101 and 150 mg/dl, and 51 and 100 mg/dl in 17 cases, while it was between 0 and 50 mg/dl in 10 of the cases examined. The highest methanol blood level was 465 mg/dl, while the lowest was 18.2 mg/dl. Methanol was not detected in toxicological analyzes due to hospitalization for three or more days in 25.6% of all cases. Figure 2 shows the methanol blood levels.

Two cases of death caused by methanol poisoning were foreign ship workers. They were both exposed to methanol as a result of shopping in the port when they came to rest. One of them died in the ship, while the other individual died in the course of receiving treatment at the hospital. In 60 cases examined, the victims were intoxicated with bogma raki, four cases with eau de cologne, and three with spirit. Consumed products were unknown in 11 cases.

In pathological examinations, macro-microvesicular hepatic steatosis of the liver, increase in portal area fibrous

tissue, brain edema, hemorrhage in the optic disc, subarachnoid hemorrhage, intraparenchymal hemorrhage and pyelonephritis were observed.

DISCUSSION

Adana is the sixth largest city of Turkey and the region of the city also known as Cukurova. With a population of 2,220,000, the city has been experiencing significant migration from rural regions. Poisoning cases due to organophosphate and methanol are very frequent in this region. The intoxication due to different toxic materials constitutes an important part in legal medicine practice (Azmak, 2006). In

This study evaluated various aspects of death among methanol poisonings in Adana. It is a well-known fact that the illicit availability of methanol is associated with an increase of methanol poisonings. Methanol poisoning is a serious social, medical and economic problem that can result to severe illness or death.

Methanol is sometimes abused as ethanol substitutes. Because it is cheap and easy to obtain, it is used in the production of illegal alcoholic beverages in Turkey (Yayci et al., 2003). Due to wide availability of these alcohols and the potential toxicity, people should be informed about the harmful effects of products that contain ethyl and methyl alcohols. Severe methanol poisoning is not rare in Turkey even if there is no traditional culture of distilling alcohol at home. Outbreaks of methanol poisonings, caused by

illegally produced alcohol, have been reported. The main source of methanol in these cases was the product of "eau de colognes" manufactured from cheap methanol rather than relatively expensive ethanol. People are intoxicated by drinking unregistered illegally bought industrial beverages in Turkey (Yayci et al., 2003). It is known that the blood methanol level in the methanol poisonings can not be detected as a result of the rapid conversion of the methanol to formic acid after the latent period, and the serious methanol poisoning can not be diagnosed in patients with clinical signs and symptoms. In the literature, it is seen that there are case reports in which the methanol intoxication is accepted but can not be detected. The patient with alcohol abuse or methanol intoxication was found to be free of ethyl and methyl alcohol in blood and urine tests, but total loss of vision, optic atrophy and damage to the spinal cord is possible (Moral et al., 2015).

Since methanol itself is not toxic, clinical signs and symptoms occur within 12 to 24 h after ingestion. If combined with ethanol, toxic effects may be delayed. Methanol poisoning is classically characterized by depression in the central nervous system, metabolic acidosis and visual changes. Most symptoms are associated with metabolic acidosis. Physical examination may help to exclude the other causes of visual impairment and mental state change, which are two of the most common symptoms of methanol intoxication. It may be difficult to diagnose patients without severe clinical suspicion in patients with intolerant methanol intake and mental state changes. In the first period of methanol intoxication, patients generally do not go to the hospital.

In cases of methanol intoxication, bilateral hemorrhagic necrosis, bilateral putaminal necrosis, bilateral basal ganglion necrosis, bilateral tegmental necrosis, diffuse cerebral edema, subcortical white and gray matter necrosis, optic nerve necrosis, subarachnoid hemorrhage, bilateral intracerebral and intraventricular hemorrhages are also present. Although the mechanism responsible for putaminal necrosis in methanol poisoning is unknown, different theories have been put forward regarding the prevalence of necrosis in this region. The first of these theories include intense accumulation of formic acid in the putaminal region due to poor venous return or hypotension and the other theory, being the increased diffusion of formic acid to putamene due to the deterioration of the blood-brain barrier after intoxication.

This is a preventable condition. If early diagnosis and treatment is provided, permanent neurological disorders can be prevented. Measures should be taken to prevent the construction and sale of illegal drinks, and public information should be provided through public spots and city bulletin boards. Healthcare professionals should also be given training in this area, especially in cases involving loss of consciousness, nausea, vomiting, or acute vision loss.

Recently, there have been serious, disaster-like deaths in our country and due to methanol poisoning in Istanbul, twenty-two people died with the alcoholic beverages produced illegally by individuals imitating the legal products. This is a very important and serious problem in Turkey that needs to be solved by developing new national policies.

These rakis, which are sold in illegal markets as cheap raki and cannot be differentiated from the original packaging are sold at a price of one fourth of the normal. For this reason, it becomes attractive for the users. The fact that people should not get illegal and fake drinks is to prevent the sale of these drinks where the authorities are known.

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