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Fatal methanol poisoning due to massive windshield screen washer fluid ingestion - case report

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Abstract

Methanol is a toxic alcohol that can imitate ethanol in smell and taste. It has many household and industrial applications but can also be present in informally-produced alcoholic beverages. Methanol poisoning feature with high mortality and may be seen due to its intentional or unintentional ingestion. Metanol doesn't have significant intrinsic activity but its metabolites, especially formate lead to severe metabolic acidis, visual disturbances and neurological deficit. Diagnosis is mainly based upon the typical clinical course, metabolic acidosis with high osmolar gap and detection of methanol in plasma or and its and its methabolites in urine. Recent guidelines

recommend therapy using the competitive alcohol dehydrogenase inhibitors - fomepizol or ethanol. In cases of severe poisoning hemodialysis should be considered.
We present a case of 39-year-old male who was considered to Clinical Department of Toxicology and Cardiology due to consumed high amount of windshield washer fluid containing methanol. Intoxicated patient was unstable with respiratory insufficiency and consciousness impairment. Despite of implemented treatment - hemodialysis, ethanol infusion and active respiratory therapy - patient died on seventh day after admission to a hospital. Methanol poisonings feature with high mortality even when the best healthcare is provided. It depends mainly on a dose of ingested alcohol and delay in admission to a hospital.

Key words: methanol poisoning, windshield washer fluid, multi-organ-failure

Introduction

Methanol is the simplest alcohol. It consists methyl group linked to a hydroxyl group. It can not be distinguished from ethyl alcohol with using a senses so it causes poisoning during drinking alcohol of unknown origin. Another possibility of methanol toxicity on the human body is consumption of methanol in the course of ethyl alcohol addiction or suicide attempt. Methanol is absorbed quickly from the digestive tract. Peak concentration in the blood occurs after 30-60 minutes after drinking. Enzyme which is responsible for metabolism of this alcohol is called alcohol dehydrogenase. The most deadly are metabolites of methanol: formaldehyde and formic acid. They cause metabolic acidosis and organ damage. Lethal dose of methanol is 0.5-1 ml per kg(1). Dose of ingested methanol and clinical symptoms of poisoning typically have a dose-response relationship however sometimes even a low dose of highly concentrated methanol may result in acute kidney injury, cardiopulmonary insufficiency, muli-organ failure or even be lethal (3). During the first 12 to 24 hours after ingestion of methanol the symptoms may be poorly expressed. This phase is described as the latent period. Later symptoms from gastrointestinal tract occurs. Nausea, vomiting, and abdominal pain ensue from a metabolic acidosis. Following symptoms are central nervous system depression and hyperventilation. For methanol toxicity vision abnormalities are characteristic. Typical patients are affected with blurry vision, decreased visual acuity and photophobia (2). The reason is damage of the retina and optic nerves. In most cases, damage to the eye is irreversible. In severe intoxication, there are: consciousness impairment, hyperventilation with Kussmaul's breath, decreased blood pressure, tachycardia; seizures, rarely acute pancreatitis (1). Without treatment, patients may progress to coma, respiratory or circulatory failure and death (2).
In early diagnostic process useful tests are arterial blood gasometry (pH <7.0, HCO_3 <10 mmol/l), anion gap (increased), osmotic gap (increased), lactic acid concentration, serum electrolytes (Na, K), activity serum transaminases, amylases and CK, fundus examination (1). Typical diagnosis is complete with toxicological tests - methanol concentration in plasma or serum and its methabolites in urine. Early diagnosis is essential for successful treatment in methanol poisoning. Serum formate level measurment is another sensitive and accurate method that can be used in methanol poisoning diagnostic process.

Case report

39-year-old male patient was admitted to the Toxicology Department on December 2013 due to consuming windshield washer fluid containing methanol. From the interview it appeared that

the patient could consume even 3 liter of this substance. In the past he was diagnosed with depression and alcohol addiction. During the first examination patient was in a critical general condition with impaired conscioussnes. Patient was intubated and respiratory therapy was started because of worsening in respiratory and circulatory function.
According to guidelines, due to very high level of methanol in blood (333 mg/d), metabolic acidosis (pH 6,74) and an onset of renal failure (Cr=1,85, eGFR=40,9) hemodialysis was applied. After hemodialysis methanol level decreased but remain high (40 mg/dl). Markers of metabolic acidosis also improved (pH=7,39 HCO3=21,7) Patient received specific antidote – ethanol in intravenous infusion. Despite of biochemical laboratory test improvement in regard to serum methanolee level and acid-base balance, during hospitalization patient still presented features of hipoxemic respiratory insufficiency (pO2=54, pCO2= 48) and acute kidney injury (Cr= 4,61mg/dl) so hemodialysis was repeated. At the moment of admission to the department patient was in coma. During treatment two episodes of seizures occurred. Patient underwent neurolgy consultation and CT scan which revealed cerebral edema. Therefore recommended treatment was implemented.
During hospitalization patient developed sepsis (CRP = 32,87, procalcytonine = 5,53 ng/ml ,body temperature = 42^0C) and multi organ dysfunctiuon syndrome including: renal failure (eGFR = 14 ml/min/1,72m2), circulatory collapse (BP=60/40 mmHg), liver insufficiency (AST=106 U/l, ALT=67 U/l, plasma urea= 130mg/dl, INR=2,0. After 4 days of intensive treatment control CT and control laboratory tests did not show any improvement. In eighth days of hospitalization, patient went into cardiac arrest in mechanism of asystole and despite of cardiopulmonary resuscitation died.

Discussion

According to World Health Organization reports globally approximately 225 litres of methanol are used every day. This toxic alcohol has many industrial and household applications including motorbike fuel, antifreeze and windshield washer fluid (4). Methanol poisoning can occur as isolated incident caused by unintentional or intentional ingestion, but also as major outbreaks. The most common reported intentional ingestions are secondary to drinking windshield washer fluid as a suicide attempt (5). In opposite to that major outbreaks are most prevalent in developing countries and arise from unintentional consumption of informally-produced alcoholic drinks (6). Multi-centre study held in Poland between 2009-2013 considers that methanol was the most common cause of fatal alcohol poisoning, accounting for 43.75% cases, followed by ethylene glycol – 39.29% and ethanol – 16.96% cases. Alcohol poisonings were the most frequently responsible for unintentional poisonings while rarer in intentional poisonings and those due to accidental causes (7). Reported data from the mass methanol poisoning in the Czech Republic presented outcome of 121 patients with confirmed methanol poisoning. From all intoxicated objects 16% died outside the hospital, 17% died in a hospital, 50% survived without and 17% with visual/central nervous system complications (8). The total and hospital mortality rates were 34% and 21%, respectively. In Poland, till 2013, methanol was available in the household products, such as windshield fluids, at concentrations above 3%. The Ordinance of 25 September 2013 issued by the Minister of National Economy, has banned the sales of substances containing methanol at concentrations over 3% (9). According to data from Clinical Department of Toxicology and Cardiology in Stefan Kardynał Wyszyński Province Hospital in

Lublin in years 2013-2017 number of hospitalization due to methanol poisoning slightly decreasing .

Table 1. Number of patients hospitalized due to methanol poisoning in the Department of Toxicology and Cardiology in General Regional Hospital in Lublin in years 2013-2017.

Year	Number of patients hospitalized
2013	22
2014	6
2015	5
2016	5
2017	5

In every case of methanol poisoning diagnosis should start with a basic laboratory tests including arterial blood gasometry, renal and liver function parameters and serum level of electrolytes. Determining the level of methanol concentration in plasma and its metabolites in urine is essential to confirm the diagnosis. The most efficient method is a gas chromatography but its usage is still limited by a costs and it is not available in every hospital. Serum formate level analysis is considered as an alternative method in advanced diagnosis of methanol poisoning but it is still not widely used.

In treatment of methanol poisoning two major methods are recommended. Oral or intravenous administration of ethanol (competitive inhibitor of alcohol dehydrogenase with a high affinity to enzyme) inhibits conversion of methanol to the toxic metabolites – formaldehyde and formic acid. In this case ethanol concentration in serum should be maintained at the level of 0,1%. Recent guidelines point at Fomepizol as a therapeutic option in cases of confirmed or suspected acute alcohol poisoning by methanol or ethyl glycol. This competitive alcohol dehydrogenase inhibitor is characterized by high efficiency and positive safety profile in monotherapy or combined therapy with ethanol and hemodialysis (13). However, high costs of the therapy with Fomepizol limit usage of this drug in the developing countries. In some patients hemodialysis need to be implemented. The American Academy of Clinical Toxicology recommends that hemodialysis should be considered in the presence of metabolic acidosis (blood pH 7.25 to 7.30), visual abnormalities, renal failure, or electrolyte imbalance unresponsive to conventional therapy and/or serum methanol concentration of >50 mg/dl (12).

In presented case profile of intoxicated patient (middle-aged man with alcohol addiction and depression in medical past) is typical for an intentional poisoning due to a suicidal purpose All presented symptoms were caused by accumulation of highly toxic metabolites - especially formic acid that cause metabolic acidosis.. Neurological symptoms including lack of consciousness, seizures and brain edema are common effects of central nervous system damage in severe poisoning (10). Renal failure and sepsis were the fatal consequences of abnormalities at the cellular and systemic level. Mentioned disorders effected in multiple organ failure and death. Due to massive intake of toxic substance and critical condition patient was considered to the group with high risk. He presented coma, seizures and metabolic acidosis with pH at the level of 6,74 which are associated with poor outcome in cases of methanol intoxication (11).

Patient have been qualified to combined therapy including intravenous infusion of ethanol and hemodialysis according to guidelines. During intensive treatment methanol level in the serum decreased but changes caused by its toxic metabolites led to cardiac arrest and death and led to cardiac arrest and patient' death.

Despite of knowledge advancement and providing patients with the best healthcare mortality in cases of methanol poisoning remains high in comparison to other common types of poisoning. The way to prevent cases of unintentional ingestion is raising public awareness of a danger linked to consuming alcohol from unknown origin and reducing methanol content in household chemical agents. On the other hand broaden the knowledge of health workers about symptoms and typical course of the disease may lead to decrease mortality in cases of intentional methanol poisoning. Limited access to the laboratory tests induces researchers to find modern diagnostic methods feature with equal efficiency and reduced costs. Considering suicidal poisonings high dosage of toxic substance, individual features and significant delay in admission to a hospital can be decisive for a fatal outcome.

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