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## HEMODIAFILTRATION EFFICACY IN TREATMENT OF METHANOL AND ETHYLENE GLYCOL POISONING IN A 2-YEAR-OLD GIRL

### SKUTECZNOŚĆ HEMODIAFILTRACJI W LECZENIU ZATRUCIA METANOLEM I GLIKOLEM U 2-LETNIEJ DZIEWCZYNKI

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#### Abstract

**Introduction:** Every year about 2.4 million people in USA are exposed to toxic substances. Many of them are children below 6 years of age. Majority of poisonings in children are incidental and related to household products including for example drugs, cleaning products or antifreeze products. Antifreeze solutions contain ethylene glycol and methanol. Treatment of these toxic substances involves ethanol administration, fomepizole, hemodialysis and correction of metabolic acidosis.

**Purpose:** The aim of the study was to check the efficacy of continuous venovenous hemodiafiltration in intoxication with ethylene glycol and methanol.

**Material and methods:** One year and 7 months old girl after intoxication with ethylene glycol and methanol was treated with continuous venovenous hemodiafiltration instead of hemodialysis because of technical problems (circulatory instability).

**Results:** Intravenous ethanol infusion with hemodiafiltration resulted in rapid elimination of methanol from the body and significantly reduced blood ethylene glycol level.

**Conclusions:** Continuous venovenous hemodiafiltration can be helpful in treatment of ethylene glycol and methanol intoxication.

**Key words:** continuous venovenous hemodiafiltration, methanol, glycol, intoxication, fomepizol

#### Streszczenie

**Wstęp:** Każdego roku około 2,4 mln ludzi w Stanach Zjednoczonych ma kontakt z toksycznymi substancjami. Wielu z nich stanowią dzieci poniżej 6. roku życia. Większość zatruc u dzieci ma charakter przypadkowy, spowodowany środkami przechowywanymi w domu, np. lekami, środkami czyszczącymi lub odmrażaczami. Odmrażacze zawierają metanol i glikol etylenowy. Leczenie zatrucia tymi toksycznymi środkami obejmuje: podawanie etanolu, fomepizolu, dializoterapię i wyrównywanie kwasicy metabolicznej.

**Cel pracy:** Ocena skuteczności ciągłej żolno-żylnej hemodiafiltracji w zatruciu metanolem i glikolem etylenowym.

**Materiał i metody:** Dziewczynka w wieku 1 rok i 7 miesięcy po spożyciu metanolu i glikolu etylenowego, u której z powodu trudności technicznych w prowadzeniu hemodializy (niestabilność krążenia) zastosowano ciągłą żylno-żylną hemodiafiltrację.

**Wyniki:** Zastosowanie dożylnego podażu etanolu i hemodiafiltracji spowodowały szybką eliminację metanolu oraz glikolu etylenowego z krwi.

**Wnioski:** Ciągła żylno-żylna hemodiafiltracja może być skuteczną metodą leczenia zatrucia metanolem i glikolu etylenowego.

**Słowa kluczowe:** ciągła żylno-żylna hemodiafiltracja, metanol, glikol, zatrucie, fomepizol

## INTRODUCTION

According to the American Academy of Pediatrics, about 2.4 million people including 50% of children <6 years of age are exposed to/or ingest toxic substances [1]. Most poisonings are incidental and related to household products. The most toxic substances include drugs, cleaning products, antifreeze, petroleum-based products, and alcohols. Among alcohols, the most dangerous are methanol and ethylene glycol poisonings [2].

Methanol is an alcohol used mostly in industry, but it may also be found in small amounts in cleaning products, antifreeze, solvents, and coolants. Methanol is slowly metabolized to formic acid and formaldehyde, which results in the development of clinical symptoms within 8-24 hours from ingestion. Severe manifestations of toxicity include severe metabolic acidosis and optic nerve damage [3]. Management of methanol poisoning includes administration of bicarbonates, ethanol, folic acid, and fomepizole, and hemodialysis [3-7].

Ethylene glycol, used as a component of coolants, brake fluids and solvents, is also very toxic. Due to its sweet taste and an odour resembling ethanol, it is sometimes inadvertently consumed. Ethylene glycol is metabolized by alcohol dehydrogenase to glycoaldehyde, glycolic acid, glyoxylic acid, and oxalic acid. It induces severe metabolic acidosis, hypocalcemia, central nervous system symptoms, gastrointestinal symptoms, and acute tubular necrosis. Management of ethylene glycol poisoning includes administration of fomepizole and bicarbonates along with hemodialysis [7-10].

## AIM

The aim of the study was to check the efficacy of continuous venovenous hemodiafiltration in intoxication with ethylene glycol and methanol.

## MATERIAL AND METHODS

A girl aged one year and 7 months was admitted after inadvertent consumption of windshield washer fluid during playing with an "empty" 5-liter container. It was not possible to determine the amount of ingested fluid that contained ethanol (25-35%), isopropanol (1-5%), methanol (2.5%), and ethylene glycol (0.5%). Before hospital admission, parents of the child gave her 30 mL of sunflower oil to provoke vomiting, 20 mL of milk, and about 20 mL of 40% ethanol solution. On admission, the child was in good overall condition, with normal vital signs (heart rate 99 per minute, blood pressure 100/70 mm Hg, oxygen saturation 99%). Laboratory tests performed 2 hours after ingestion of windshield washer fluid showed moderate metabolic acidosis (pH of 7.32, bicarbonate level of 15.5 mmol/l, base excess (BE) of -10.6 mmol/L), normal kidney function, ethanol level of 0‰, methanol level of 50 mg/dL, and ethylene glycol level of 125 mg/dL (Table I). Intravenous infusion of 5% ethanol solution was started, aiming for blood ethanol level of about 1‰. A decision was made to proceed with hemodialysis (HD). Under general anesthesia, an

8F Mahurkar catheter was introduced into the right jugular vein and HD was initiated using AK 96 machine (Gambro) and 0.4 m<sup>2</sup> hemofilter, with blood flow rate (QB) of 50 ml/min, and dialysate fluid flow rate (QD) of 500 ml/min. After 2 hours of HD, methanol was no longer detectable in blood. In contrast, blood ethylene glycol level remained high and HD was continued, complicated by blood pressure falls to 78/28 mm Hg, two episodes of dialyzer thrombosis, and an episode of supraventricular tachycardia which resulted in termination of HD. Due to poor tolerance of HD and technical problems, continuous venovenous hemodiafiltration (CVVHDF) was started using a Prismaflex machine (Gambro), 0.6 m<sup>2</sup> Prismaflex ST 60 filter, and AN69ST membrane, with OB of 50 mL/min, QD of 15 mL/min/m<sup>2</sup> (500 mL/h), and supplement flow rate of 300 mL/h. CVVHDF was performed for 18 hours. During both HD and CVVHDF, intravenous infusion of 5% ethanol solution was continued with monitoring of serum ethanol level. The patient also required transfusion of 2 units of packed red blood cells, and intravenous potassium and calcium supplementation.

## RESULTS

Follow-up of laboratory tests at 18 hours showed no ethylene glycol in blood, with kidney and liver function parameters, arterial blood gases, and blood glucose level all within normal limits (Table I). Blood ethylene glycol and methanol levels during renal replacement therapy are shown in Figure 1. Ophthalmological and neurological examination showed no abnormalities.

## DISCUSSION

Clinical symptoms of ethylene glycol and methanol intoxication depend on the amount of ingested substance and duration of intoxication [7]. Parents of this 1-year and 7 months old girl presented to the hospital immediately after ingestion of windshield washer fluid by the patient. It was difficult to determine the ingested amount of fluid, as it was not known how much of it was left in a 5-liter container. Time from ingestion to initial blood collection for laboratory tests was about 2 hours. Laboratory findings indicated moderate metabolic acidosis with no hypoglycemia and no hypocalcemia. Methanol elimination depends on the ingested amount [3, 7]. With blood methanol level of 10 mg/dl, elimination half-time is 2.5-3 hours, and with levels of 200-300 mg/dl, methanol is eliminated at a rate of 8.5-9 mg/dl/kg per hour [3]. If ethanol is administered, duration of methanol elimination may be increased to 30.3-52 hours [3]. Due to toxic effects of ethanol administered in the management of methanol intoxication, hemodialysis should be considered [4-5]. Elimination of ethylene glycol depends on patient renal function. With normal renal function, blood ethylene glycol is reduced by 50% after 8.6 hours, but with renal failure this elimination half-time may extend to 49 hours [6]. In recent years, alcohol dehydrogenase inhibitor fomepizole has been introduced to clinical practice [6, 7, 9, 10]. Administration of fomepizole prolongs methanol elimination half-time

Table I. Biochemical parameters during treatment.

Tabela I. Badania laboratoryjne w trakcie leczenia.

Evaluated parameter <i>Oceniane parametry</i>	2 hours after ingestion <i>2 godziny po zatruciu</i>	After 10 hrs of HD <i>10 godz. HD</i>	After 10 hrs of CVVHD <i>10 godz. CVVHD</i>	After 18 hrs of CVVHD <i>18 godz. CVVHD</i>
Urea (mg/dL)	20	12	5	15
Creatinine (mg/dL)	0.3	0.2	0.2	0.2
GOT (U/L)	51	46	41	42
GPT (U/L)	26	39	26	24
GGTP (U/L)	<10	<10		
Bilirubin (mg/dL)		0.3		0.3
Albumin (g/L)		3.6	3.1	3.1
Ph	7.32	7.37	7.46	7.46
BE (mmol/L)	-10.6	-10.8	-1.0	-0.3
HCO <sub>3</sub> (mmol/L)	15.5	14.5	22.8	22.8
Glucose (mg/dL)	66	95	80	80
Calcium (mmol/L)	5.0	4.5	4.7	4.9
Magnesium (mg/dL)	1.8	1.6		1.6
Chloride (mg/dL)	108	108		
Potassium (mmol/L)	4.9	4.1	4.7	3.8
Sodium (mmol/L)	142	145	142	141
WBC (x 10 <sup>3</sup> /mm <sup>3</sup> )	17.9	13.8	15.9	20.1
RBC (x 10 <sup>6</sup> /mm <sup>3</sup> )	4.44	4.26	3.79	4.21
Hematocrit (%)	36.3	36.1	32.1	36.7
Platelets (x 10 <sup>3</sup> /mm <sup>3</sup> )	381	205	155	107
Hemoglobin (g/dL)	12	11.5	11.4	11.0

HD – hemodialysis/hemodializa; CVVHDF – continuous venovenous hemodiafiltration/ciągła żylna-żylna hemodiafiltracja; BE – base excess/niedobór zasad, HCO<sub>3</sub> – bicarbonates/dwuwęglany.

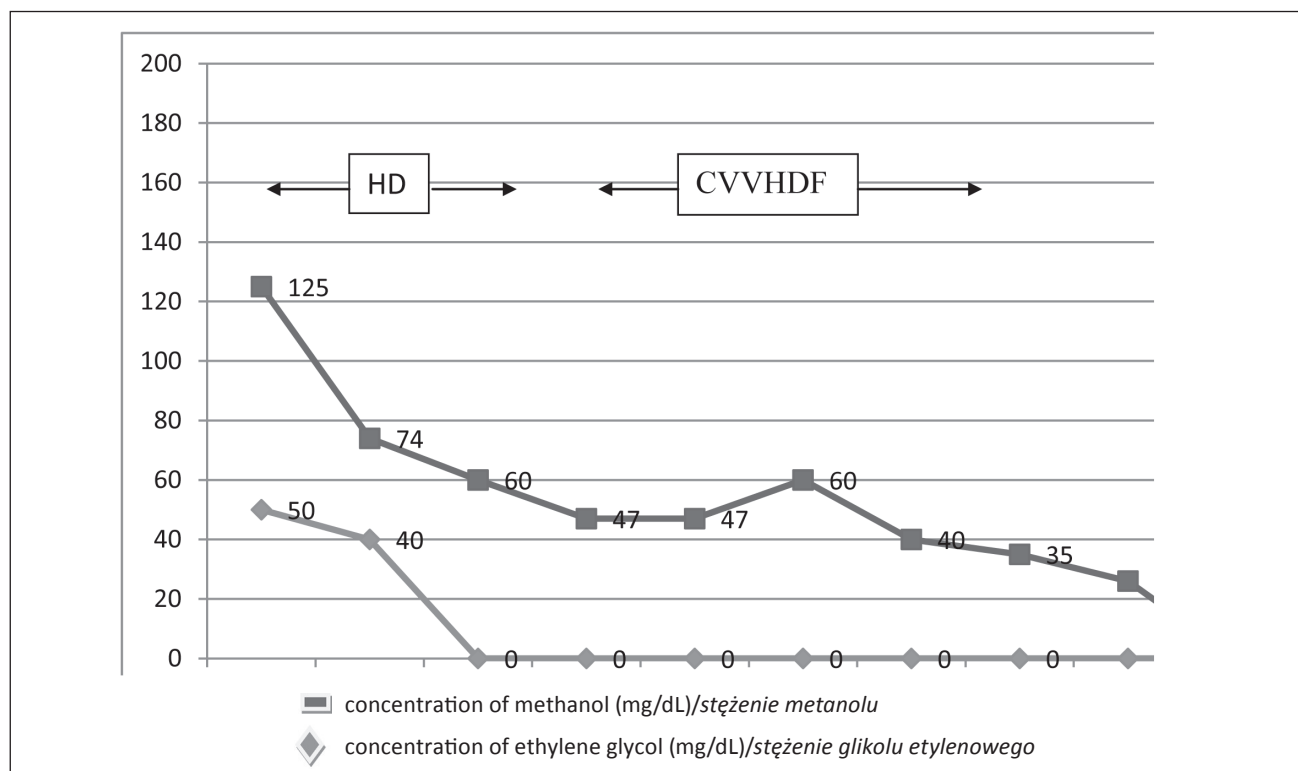


Fig. 1. Blood methanol and ethylene glycol levels during renal replacement therapy with hemodialysis (HD) and continuous venovenous hemodiafiltration (CVVHDF).

Ryc. 1. Stężenie metanolu i glikolu we krwi w czasie stosowania terapii nerkozastępczej: hemodializy (HD) i ciągłej żylna-żylną hemodiafiltracji (CVVHDF).

to about 54 hours, and glycol elimination half-time to 14-17 hours. We did not use fomepizole in our patient as the drug was not immediately available and could not be provided in a reasonable time. Instead, combination therapy including ethanol administration and HD was used. Hemodialysis is the best method of rapid elimination of methanol and its metabolites from blood, and it should be considered treatment of choice [4, 5]. This approach resulted in rapid lowering of blood methanol level in our patient. However, HD is not always feasible and may be associated with various complications. Hemodynamic instability and technical problems during dialysis necessitated change of the renal replacement modality from HD to CVVHDF. During this switch, a rebound increase of blood ethylene glycol level was observed. Although methanol elimination during HD is 5-fold faster compared to CVVHDF, methanol clearance during CVVHDF is still threefold higher compared to non-dialyzed subjects [5]. Similar observations were made in regard to ethylene glycol poisonings. Management of methanol and ethylene glycol intoxication should be continued until normalization of pH and lowering of blood methanol and glycol levels below 10-15 mg/dL or to undetectable values. In addition, CVVHDF allowed rapid elimination of ethanol given for therapeutic purposes in the management of intoxication. Rapid initiation of therapy after inadvertent consumption of a toxic substance by a child allowed avoiding multiple organ toxicities including vision and kidney damage. Intravenous ethanol infusion together with hemodialysis resulted in rapid elimination of methanol from the body and significantly reduced blood ethylene glycol level. CVVHDF allowed effective elimination of glycol and ethanol, reducing the risk of central nervous system toxicity.

## CONCLUSIONS

Continuous venovenous hemodiafiltration can be helpful in treatment of ethylene glycol and methanol intoxication.

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## Authors' contributions/Wkład Autorów

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