

Severe Ethanol Poisoning: A Case Report and Brief Review

M. SANAP*, M. J. CHAPMAN†

*Department of Critical Care Medicine, Flinders Medical Centre, Adelaide, SOUTH AUSTRALIA

†Department of Anaesthesia and Intensive Care, Royal Adelaide Hospital, Adelaide, SOUTH AUSTRALIA

ABSTRACT

A case of severe ethanol toxicity is described where a patient was admitted pulseless, apnoeic and deeply unconscious after ingesting a full bottle (1 litre) of 'methylated spirits'. The initial blood ethanol level was 1.127 g/dL. The patient was rapidly intubated and resuscitated with fluids and inotropic agents. Renal replacement therapy was initiated and a rapid reduction in the initial blood ethanol level occurred. Twenty-one hours after her admission she was conscious and cooperative and was discharged from the intensive care unit without any clinical evidence of brain injury.

Ethanol toxicity is common although ethanol poisoning leading to death is rare. Nevertheless, severe toxicity can cause medullary paralysis with respiratory failure and death. Rapid resuscitation and, in severe cases, renal replacement therapy may be warranted as the outlook for patients who recover is excellent. (Critical Care and Resuscitation 2003; 5: 106-108)

Key words: Ethanol poisoning, renal replacement therapy

In normal adults, clinical features of methanol intoxication range from slurring of speech and drowsiness to stupor and coma. Death from respiratory failure for an average adult is often believed to occur if a blood level of greater than 0.4 to 0.5 g/dL is present.¹

However, a number of cases have been recorded where survival has occurred at extremely high concentrations particularly where early resuscitation had occurred.¹ We report a case where early resuscitation and renal replacement therapy were associated with a rapid recovery from an extremely high ethanol level (i.e. 1.127 g/dL) without any long-term injury.

CASE REPORT

A 52-year-old woman was admitted to the emergency department deeply unconscious after ingesting a full bottle (1 litre) of 'methylated spirits' in an attempted suicide. She was pulseless, apnoeic, with a rectal temperature of 31°C and was rapidly intubated, mechan-

ically ventilated and resuscitated with intravenous fluid and noradrenaline.

Blood biochemistry performed on admission revealed a plasma sodium of 138 mmol/L, potassium 4.0 mmol/L, glucose 8.5 mmol/L and urea 3.9 mmol/L. Following intubation, the arterial blood gases revealed a PO₂ 192 mmHg, PCO₂ 23 mmHg, pH 7.32, bicarbonate 11.9 mmol/L and a lactate of 10.6 mmol/L. With a measured osmolality of 548 mOsm/kg and derived osmolality of 288 mOsm/kg the osmolar gap was calculated to be 260 mOsm/kg. The blood ethanol level was 1.127 mg/dL (245 mmol/L) and paracetamol, salicylate and methanol were undetectable in the plasma.

A central venous catheter (Vascath®) was inserted and she underwent renal replacement therapy using 'Hartmann's solution' as the dialysate and a zero balance for the first 16 hours. Her cardiorespiratory status improved with the noradrenaline infusion being discontinued after 4 hours. The blood ethanol levels

Correspondence to: Dr. M. Sanap, Department of Critical Care Medicine, Flinders Medical Centre, Bedford Park, South Australia 5042

were measured two hourly for the first 4 hours then, approximately half hourly for the next 12 hours (table 1). While the blood ethanol level fell by 0.367 mg/dL during the first 2 hours (while being dialysed), the decrease during the next 19 hours (from 1300 – 0800) was 0.716 mg/dL.

Table 1. Blood ethanol levels taken during the first 21 hours

<i>time</i> (hours)	<i>ethanol</i> (g/dL)	<i>time</i> (hours)	<i>ethanol</i> (g/dL)
1100	1.127	0030	0.271
1300	0.76	0130	0.224
1500	0.71	0230	0.193
1530	0.69	0330	0.171
1600	0.66	0430	0.134
1630	0.60	0530	0.106
1700	0.57	0630	0.083
1730	0.535	0800	0.044
1830	0.481		
1930	0.438		
2030	0.45		
2130	0.363		
2230	0.328		
2330	0.311		

The next morning (i.e. twenty hours later) her blood ethanol level was 0.044 mg/dL. She was conscious and co-operative and was extubated, and discharged from the ICU 27 hours later. She was discharged from hospital 8 days later in good health and with no clinical evidence of cerebral dysfunction.

DISCUSSION

'Methylated spirits' consists of 95% ethanol and small amounts of bitter impurities which include fluorescein, denatonium benzoate and methyl isobutyl ketone, but not methyl alcohol. The ethanol is rapidly absorbed by the stomach and small intestine to reach peak blood levels 20 - 60 minutes after ingestion.² The volume of distribution is 0.6 L/kg and is equal to the total body water.

Hepatocyte cytosolic alcohol dehydrogenase (ADH) metabolises ethanol in an adult at a constant rate ranging between 7 - 10 g/hr or 150 - 215 mmol/hr (reducing the blood ethanol level by 0.018 - 0.024 g/dL/hr), converting ethanol to acetaldehyde, NAD to NADH, changing the cytosol redox state and increasing the lactate:pyruvate ratio. However, different ADH isoenzymes exist in different populations causing large variations in ethanol elimination rates among individuals and racial groups. It was once thought that at blood levels above 0.1 g/dL,

zero order kinetics prevailed (i.e. the metabolic rate is independent of the blood concentration, which would be the case if only the classic ADH pathway participated). However, it is now known that at higher blood ethanol levels, first order kinetics exist (i.e. the elimination rate is proportional to the blood concentration) due to the participation of other enzyme systems including the microsomal ethanol-oxidising system (MEOS) located in the endoplasmic reticulum³ (which also requires NADPH to yield NADP thereby improving the redox state of the liver and enhancing hepatic ADH)⁴ and the hydrogen peroxide-dependent peroxisome catalase system.⁵ In the non-alcoholic, 90% and 10% of any ingested ethanol is metabolised by ADH (both gastric mucosal and hepatic) and MEOS, respectively.

However, in individuals who chronically ingest ethanol, the microsomal ethanol-oxidising system is enhanced and, in association with ADH and the hydrogen peroxide-dependent peroxisome catalase system, may allow ethanol metabolism up to rates of 20 g/hr or 430 mmol/hr (reducing the blood ethanol level by up to 0.048 g/dL/hr).^{4,6}

In normal adults, mild to moderate intoxication with slurring of speech and drowsiness usually occurs with blood levels of 0.05 - 0.15 g/dL. Moderate to severe intoxication with disturbances of balance, sensation, perception and coordination, usually occurs at blood levels of 0.15 - 0.3 g/dL, with stupor at blood levels of 0.3 - 0.5 g/dL and coma with blood levels greater than 0.5 g/dL. The fatal dose for an average adult (i.e. a dose that causes coma with respiratory failure) is often stated to occur if more than 400 mL of 100% alcohol (i.e. 320 g) is ingested, to produce a blood level of greater than 0.5 g/dL, although death at a concentration as low as 0.26 g/dL has been recorded.⁷

However, the effect of ethyl alcohol on consciousness is variable, with chronic ethanol ingestion causing tolerance to high blood alcohol (and acetaldehyde)⁶ levels as an adaptive process.^{8,9} A number of cases have been recorded where survival has occurred at extremely high concentrations. For example, a blood ethanol level of 1.127 g/dL was reported in a patient who had no history of chronic alcohol intake and who consumed two bottles of whisky. He had a stormy clinical course, developing respiratory failure, cardiac arrest, shock, pancreatitis and acute renal failure, although he survived without permanent neurological injury.¹⁰ However, a blood level of 1.501g/dL has also been reported in a patient who had ingested up to one bottle of 'hard liquor' daily who was admitted to hospital with abdominal pain and slight confusion, who was responsive to questioning and orientated to person and place.¹¹

Treatment is largely supportive (e.g. mechanical

ventilatory support, intravenous fluids, vasopressors, glucose and thiamine, folic acid and management of other injuries). Haemodialysis has also been used with prompt restoration of consciousness in patients with severe ethanol toxicity, respiratory failure, shock, lactic acidosis and persistent elevated blood levels (e.g. greater than 0.5g/dL).^{12,13} Fructose increases the rate of ethanol removal by up to 25% although it can also cause hyperuricaemia and lactic acidosis and therefore is not recommended.¹³ While naloxone (1.2 mg) in one study was reported to reverse coma of acute ethanol intoxication in 16% of patients,¹⁴ the ethanol-antagonising effects of naloxone have not been confirmed.^{15,16}

The patient we report represents a case of severe ethanol poisoning where early resuscitation and renal replacement therapy were associated with a rapid recovery from an extremely high ethanol level (e.g. 1.127 g/dL) without any long-term injury. While the blood ethanol level fell by 0.367 mg/dL during the first 2 hours during dialysis (from 1.127 g/dL to 0.76 g/dL), the decrease during the next 19 hours from 1300 - 0800 was 0.716 mg/dL (from 0.76 g/dL to 0.044 g/dL) and represented that which could have been explained by ADH metabolism alone.

Received 14 May 03

Accepted 27 May 03

REFERENCES

- O'Neill S, Tipton KF, Prichard JS, Quinlan A. Survival after high blood alcohol levels. Survival after high blood alcohol levels. Association with first-order elimination kinetics. *Arch Intern Med* 1984;144:641-642.
- Jones AW, Jonsson KA, Neri A. Peak blood-ethanol concentration and the time of its occurrence after rapid drinking on an empty stomach. *J Forensic Sci* 1991;36:376-385.
- Lieber CS. Microsomal ethanol-oxidizing system (MEOS): the first 30 years (1968-1998)--a review. *Alcohol Clin Exp Res* 1999;23:991-1007.
- Crabb DW, Bosron WF, Li TK. Ethanol metabolism. *Pharmacol Ther* 1987;34:59-73.
- Bradford BU, Seed CB, Handler JA, Forman DT, Thurman RG. Evidence that catalase is a major pathway of ethanol oxidation in vivo: dose-response studies in deer mice using methanol as a selective substrate. *Arch Biochem Biophys* 1993;303:172-176.
- Watanabe A, Kobayashi M, Hobara N, Nakatsukasa H, Nagashima H, Fujimoto A. A report of unusually high blood ethanol and acetaldehyde levels in two surviving patients. *Alcohol Clin Exp Res* 1985;9:14-16.
- Tremolieres J. International encyclopedia of pharmacology and therapeutics. New York. Pergamon Press. 1970, p 560.
- Davis AR, Lipson AH. Central-nervous-system depression and high blood ethanol levels. *Lancet* 1986;i:566.
- Perper JA, Twerski A, Wienand JW. Tolerance at high blood alcohol concentrations: a study of 110 cases and review of the literature. *J Forensic Sci* 1986;31:212-221.
- Berild D, Hasselbalch H. Survival after a blood alcohol of 1127 mg/dL. *Lancet* 1981;ii:363.
- Johnson RA, Noll EC, Rodney WM. Survival after a serum ethanol concentration of 1½%. *Lancet* 1982;ii:1394.
- Atassi WA, Noghnogh AA, Hariman R, et al. Hemodialysis as treatment of severe ethanol poisoning. *Int J Artif Organs* 1999;22:18-20.
- Koch-Weser J, Sellers EM, Kalant H. Alcohol intoxication and withdrawal. *N Engl J Med* 1976;294:757-762.
- Jeffreys DB, Volans GN. An investigation of the role of the specific opioid antagonist naloxone in clinical toxicology. *Hum Toxicol* 1983;2:227-231.
- Editorial. Naloxone for ethanol intoxication?. *Lancet* 1983;ii:145-146.
- Nuotto E, Palva ES, Lahdenranta U. Naloxone fails to counteract heavy alcohol intoxication. *Lancet* 1983;ii:167.