Available online at www.sciencedirect.com

ScienceDirect

journal homepage: www.elsevier.com/locate/mjafi

Case Report

Ethylene glycol poisoning

Lt Col I.V. Nagesh^{a,*}, Col K.C. Koley (Retd)^b, Col Subrato Sen^c,
Col Sanil Mohan^d, Maj Sujoy Sahu^e

^aClassified Specialist (Medicine), 92 Base Hospital, C/O 56 APO, PIN 901218, India

^bMD (Medicine), Sector 29 Noida, Uttarpradesh, India

^cSenior Advisor (Anaesthesia & Neuro Anaesthesia), 92 Base Hospital, C/O 56 APO, PIN 901218, India

^dSenior Advisor (Anaesthesia), 92 Base Hospital, C/O 56 APO, PIN 901218, India

^eGraded Specialist (Medicine), Military Hospital Meerut, Uttarpradesh, India

ARTICLE INFO

Article history:

Received 29 July 2012

Accepted 1 January 2013

Available online 6 June 2013

Keywords:

Ethylene glycol

Lowest arterial blood pH

High anion gap metabolic acidosis

Introduction

Ethylene glycol (EG) is a common constituent of anti-freeze, coolants and other solvents and is responsible for both inadvertent and intentional poisoning.¹ Ethylene glycol poisoning may pose diagnostic difficulties if the history of ingestion is not volunteered, or if the presentation is delayed. The toxicity is because of biochemical features of high anion gap metabolic acidosis and an osmolar gap. It usually resolves within 24–72 h as the ethylene glycol is metabolized to toxic metabolites. We are reporting a case which had rapid progression of symptoms and also encountered low arterial pH despite giving I/V sodium bicarbonate.

Case report

A 48-year old male patient was brought to the hospital in comatose state of approximately 5 h duration. Individual was

found in a state of breathlessness and semi conscious state in his room with a bottle containing ethylene glycol (EG) lying near him. Apparently he had consumed EG at night.

On admission, he was unconscious, responding to painful stimuli, Heart rate was 140/mt, BP was not recordable, respiratory rate was 8/min and was acidotic. SpO₂ was 50%. Systemic examination revealed bilateral chest wheeze, pupils were mid dilated, reacting sluggishly to light. The initial ABG revealed a pH 6.736, pCO₂ 23.3 mm of Hg, pO₂ 100.9 mm of Hg and H⁺ 183 mmol/l, HCO₃⁻ 3 mmol/l and SaO₂ 89.4%. His trachea was intubated and ventilated mechanically on PCMV mode (Rate 12/mt, Pressure control 12 cm, PEEP of 7 cm and Fio₂ 0.6). After intubation pink frothy tracheal secretions were noted. Dopamine infusion @10 µg/kg/mt was started along with I/V fluids. Chest X-ray revealed bilateral scattered NHO's. ECG showed sinus tachycardia. His haematological parameters, bedside 2D echo and USG kidneys were normal.

Nasogastric aspirate was 300 ml of light greenish yellow odourless fluid. In view of marked acidaemia he was administered sodium bicarbonate 100 meq I/V bolus followed by 20 meq/hr infusion was started. Serial ABG's (Table 1) revealed normoxia, Normo to hypocarbia with progressively worsening acidosis and increasing base excess. Urine routine and microscopic examination revealed oxalic acid crystals.

On the provisional diagnosis of EG poisoning, he was administered 42.8 W/V alcohol 120 ml 6 hrly through nasogastric tube. He remained oliguric despite bolus doses of lasix. Repeat chest X-ray showed clearing of opacities after 12 h. In spite of all efforts outlined he developed anuria, progressive

* Corresponding author.

E-mail address: ivaturi_venkata@rediffmail.com (I.V. Nagesh).

0377-1237/\$ – see front matter © 2013, Armed Forces Medical Services (AFMS). All rights reserved.

<http://dx.doi.org/10.1016/j.mjafi.2013.01.010>

Table 1 – Showing serial arterial blood gas reports.

	At admission	3 h after admission	12 h after admission (as shown in Fig. 1)	18 h after admission
pH	6.736	6.745	6.652	6.649
PaO ₂	100.9 mmHg	140.9 mmHg	107.5 mmHg	107.2 mmHg
PaCO ₂	23.3 mmHg	22 mmHg	31.4 mmHg	37.7 mmHg
HCO ₃ ⁻	3.0 mmol/l	2.9 mmol/l	3.4 mmol/l	2.0 mmol/l
H ⁺	183 mmol/l	180.0 mmol/l	223 mmol/l	224.6 mmol/l
BE	–39.0 mmol/l	–38.0 mmol/l	–41.0 mmol/l	–41.2 mmol/l
O ₂ saturation	89.4%	96.3%	88.4%	87.9%
On ventilatory support and I/V sodium bicarbonate infusion 20 meq/h.				

and refractory hypotension, persistent acidosis and expired after 26 h of admission.

Discussion

Ethylene glycol is widely used in anti-freeze mixture in aviation fuels. It is a polyhydric alcohol solvent being a clear, sweet tasting, viscous and odourless liquid. 80% of absorbed compound is metabolized in the liver by alcohol dehydrogenase to several acid metabolites (Glycolic acid, Glyoxylic acid, and Oxalic acid) which are responsible for high anion gap metabolic acidosis, calcium oxalate crystals and renal injury. Glycolic acid accumulates appreciably in the body and is primarily responsible for metabolic acidosis. The glyoxylic acid is toxic to renal tubular cells and gets metabolized to oxalic acid which combines with calcium to form calcium oxalate crystals and cause subsequent hypocalcaemia. The estimated lethal dose of 100% EG is approx 1.4 ml/kg.

Clinical features of EG poisoning occur in four stages.² Initial neurologic phase, second stage which occurs after 12–24 h is cardiopulmonary, third-renal phase which occurs after 24 h and fourth stage is characterized by delayed neurologic sequelae that occurs after 6–15 days. Initial CNS phase causing euphoria and intoxication (like alcohol) leading to slurred speech, encephalopathy and coma. Seizures may occur due to direct neurotoxicity of ethylene glycol or secondary to hypocalcaemia. In the next 12–24 h the acidosis and hypocalcaemia produce tachycardia, arrhythmias, myocardial depression and haemodynamic imbalance. Renal effects predominate after 48 h and are a reversible oliguric or anuric renal failure the exact mechanism of which is not yet clear.

Indications for treatment of EG poisoning include:

- (a) Documented plasma level >20 mg/dL
- (b) A history or suspicion of ingesting EG plus any two of the following:
 - (i) Arterial pH <7.3
 - (ii) Sodium bicarbonate <20 meq/l
 - (iii) Osmolal gap >10 mosm/l
 - (iv) Urinary oxalate crystals
- (c) A history or suspicion of consumption of EG ingesting within 1 h and osmolal gap >10 mmol/kg

Definitive management consists of inhibition of alcohol dehydrogenase which metabolizes EG into its toxic

metabolites. Two agents are available for this purpose. Fomepizole (4-Methylpyrazole)^{3–7} is a potent inhibitor approved by FDA for treatment of EG poisoning and ethanol which competes with alcohol dehydrogenase. The American academy of clinical toxicology (AACT)³ provides specific dosage recommendations for ethanol in patients receiving standard treatment and patients on haemodialysis. Ethanol is inexpensive and can be administered either by I/V or oral route.² Orally it can be administered as 43% solution. Loading dose is 0.6 g/kg for I/V use. Maintenance dose is:

- (i) In alcoholic patients 154 mg/kg/h
- (ii) In non alcoholic patients 66 mg/kg/h
- (iii) Double the dose if given orally with charcoal or during haemodialysis
- (iv) Continue until ethylene glycol or methanol concentrations are <20 mg/dl and the patient is asymptomatic with a normal pH

A key step in enhancing the elimination of EG in a setting of oliguric/anuric renal failure is haemodialysis which not only removes the toxic metabolites from the blood but also corrects the underlying metabolic derangements. Treatment with fomepizole without haemodialysis in massive ethylene glycol ingestion has been rarely reported in the literature. Buchanan et al administered fomepizole without haemodialysis which provides evidence that treatment with fomepizole without haemodialysis appears to be a viable alternative option in patients with even extremely high plasma ethylene glycol concentrations as long as their renal function is intact.⁸

Our patient was discovered quite late after his ingestion and has already progressed to the stage of coma and myocardial depression along with oliguria when presented to us. He was in hypotension and tachycardia which was corrected to a limited extent by the use of vasopressors and inotropes. The initial ABG was highly acidotic which aggravated the clinical course of the patient. Despite ensuring adequate gaseous exchange in alveoli by mechanical ventilation and ongoing sodium bicarbonate infusion, the acidosis could not be improved. In addition our patient manifested renal failure very early (presumed to be from the time of admission) and haemodialysis was not done as it was not available in our centre. Peritoneal dialysis could not be undertaken due to hypotension since the non availability of I/V ethyl alcohol in our hospital, a commercial preparation of rum (Old Monk) 42.8% W/V was administered orally though

nasogastric tube as an alternative to compete for alcohol dehydrogenase enzyme.

The complex problem of late detection, CNS depression, myocardial depression with refractory hypotension in the face of relentless academia and early onset renal failure had compromised the outcome of this case from the very onset.

Conclusion

This case report highlights the ready availability of potentially life threatening toxic compound in our daily lives, the difficulties posed by delayed and undetected ethylene glycol poisoning to both clinicians and clinical laboratories, lack of readily available antidote fomepizole in our settings. A strong index of suspicion will go a long way in early diagnosis and successful outcomes.

Conflicts of interest

All authors have none to declare.

REFERENCES

1. Pellegrino B, Parravani A, Cook L, Mackay K. Ethylene glycol intoxication: disparate findings of immediate versus delayed presentation. *W V Med J*. 2006;102:32–34.
2. Gupta Pritam, Gupta Ankur. Alcohol poisoning. In: Munjal YP, Agarwal AK, Gupta P, Kamath SA, Nadkar MY, Singhl RK, et al., eds. *Api Text Book of Medicine*. 9th ed. vol. 2.
3. Barceloux DG, Krenzelok EP, Olson K, Watson W. American Academy of Clinical Toxicology practice guidelines on the treatment of ethylene glycol poisoning. Ad Hoc Committee. *J Toxicol Clin Toxicol*. 1999;37:537–560.
4. Jacobsen D, McMartin KE. Antidotes formethanol and ethylene glycol poisoning. *J Toxicol Clin Toxicol*. 1997;35:127–143.
5. Brent J, McMartin K, Phillips S, et al. Fomepizole for the treatment of ethylene glycol poisoning. Methylpyrazole for Toxic Alcohols Study Group. *N Engl J Med*. 1999;340:832–838.
6. Baud FJ, Galliot M, Astier A, et al. Treatment of ethylene glycol poisoning with intravenous 4-methylpyrazole. *N Engl J Med*. 1988;319:97–100.
7. Package insert Antizol (Fomepizole). Minnetoka, Minn.: Orphan Medical, Inc; December 2000.
8. Buchanan A, Alhelail M, Cetaruk EW, et al. Massive ethylene glycol ingestion treated with fomepizole alone-a viable therapeutic option. *J Med Toxicol*. 2010 Jun;6(2):131–134.