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Brief Report

Inhalational abuse of methanol products: elevated methanol and formate levels without vision loss

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Abstract Inhalant abuse of methanol-containing products has increased over the last decade. We performed a prospective observational study of 7 subjects who presented to an ED after inhalant abuse of methanol-containing hydrocarbon products. Four patients had a methanol level greater than 24 mg/dL and 2 had an anion gap greater than 17 mEq/L. The mean formic acid level was 71 μg/mL, and 1 patient had a level considered high enough to induce retinal toxicity (>200 μg/mL). No patient had an abnormal ophthalmologic examination. All patients were treated with intravenous folate, 2 received alcohol dehydrogenase blockade, and no patient received hemodialysis or intravenous bicarbonate. All patients' acidosis resolved within 4 hours. The methanol and formic acid levels are lower than those reported after methanol ingestion. These preliminary data suggest that inhalant abusers of methanol products may have significantly elevated methanol and formic acid levels, but are at low risk for methanol induced complications of visual dysfunction and refractory acidosis.

1. Introduction

Inhalant abuse, also known as "huffing," "glue sniffing," and "solvent abuse" has increased 3-fold over the last decade [1]. It is considered a gateway to other illicit drugs and has been implicated in several deaths [1,2]. Although hydrocarbon intoxication has many recognizable effects, many of the commonly abused hydrocarbon-containing products have other ingredients that may also produce toxicity. Methanol is a commonly ingredient of carburetor cleaners. Although methanol itself is minimally toxic, formic acid, the product of methanol metabolism, is responsible for the metabolic acidosis and blindness characteristic of methanol poisoning [3]. The purpose of this study is to describe the relationship between serum methanol levels, serum formate levels, and the clinical course of patients with inhalational methanol exposure. Because current guidelines for the management of methanol poisoning are based on oral rather than

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Table 1 Demographic data and initial laboratory studies of patients enrolled for evaluation of methanol containing product abuse

Case	1	2	3	4	5	6	7
Age (y)	40	16	15	28	16	30	58
Sex (M/F)	M	M	F	M	M	M	M
Time elapsed since last abuse episode (h)	1	2	2	2	8	2	2
Abnormal visual examination (Y/N)	N	N	N	N	N	N	N[a]
Methanol (mg/dL)	26	25	17	18	10	25	86
Formic acid (μg/mL) (reference range, <12 μg/mL)	3.6	63	18	7	64	88	250
Anion gap (mEq/L)	14	22	31	16	13	16	16
Serum bicarbonate (mmol/L)	20	16	13	19	19	15	15

To convert methanol to millimoles per liter, multiply by 0.0312. M, male; F, female; Y, yes; N, no.
[a] Examination performed by the ophthalmology service.

inhalational exposure, we believe that this report will provide new insight into the most appropriate management for these patients.

2. Methods

This prospective observational study includes 7 patients who presented to the ED at 2 urban hospitals after inhalant abuse of methanol-containing products. The patients were managed by the primary service, and our medical toxicology service was consulted on each case. The first 2 cases received a standard medical evaluation; serum formate levels were measured on samples obtained during the routine care of the patient. After the first 2 patients were treated, we initiated a study that included a systematic evaluation of patients presenting with methanol levels after deliberate abuse of hydrocarbon products. The study was approved by our local institutional review board, and informed consent was obtained from all patients. The systematic evaluation included abuse history, visual complaints, serum electrolytes upon arrival to the ED and 4 hours later, formate and methanol levels, and treatment used. Patients also received a standard ophthalmologic examination by the primary provider upon presentation, including visual acuity and a funduscopic examination. Treatment continued to be directed by the primary service with medical toxicology consultation. Serum formate levels were measured by Specialty Labs (Santa Monica, Calif).

3. Results

Over 1 year, we consulted on 11 patients with inhalational abuse of hydrocarbons: data from 7 patients was collected successfully (Table 1). Four additional patients presented to the EDs with measurable methanol levels after hydrocarbon abuse, but these patients were not included because formate levels were not determined (Table 2).

Acute duration of inhalational abuse ranged from 6 to 12 hours. All patients had abused carburetor cleaner for more than 6 months and denied ingesting the product. No patient could recall the product name of the carburetor cleaner abused, and thus the methanol percentage and other constituents could not be determined. Each patient presented with somnolence, ataxia, and confusion that improved within 60 minutes of ED arrival. No patient had visual complaints at any point during their hospital course, and all had normal visual acuity determined by bedside testing. Four patients had a significant (>24 mg/dL) methanol level and 2 patients had an anion gap greater than17 mEq/L (Table 1) [4]. One patient had a serum bicarbonate less than 15 mEq/L. No patient had a measurable ethanol level. All patients had a measurable formic acid on presentation serum samples (mean, 71μg/mL; range 3.6-450 μg/mL). Case 7 had a serum methanol level of 86 mg/dL and a formic acid level above 200 μg/mL, placing the patient at risk for visual dysfunction [3]. However, this patient had no evidence of methanol-induced retinal damage evaluated by a formal dilated pupillary examination by the ophthalmology service. Case 7 was treated with fomepizole, and case 2 was treated with an ethanol infusion. Both cases were admitted; the other patients were discharged within 6 hours. All patients received intravenous folate (50 mg). No patient received intravenous bicarbonate or dialysis, and all had improved acidosis within 4 hours of arrival.

Table 2 Demographics and initial methanol level, anion gap, and serum bicarbonate for patients not enrolled in our study.

Case	1	2	3	4
Age (y)	16	25	17	22
Sex (M/F)	M	M	M	M
Time elapsed since last abuse episode (h)	3	2	1	2
Abnormal visual examination	None	None	None	None
Methanol (mg/dL)	13	15	21	20
Anion gap (mEq/L)	19	15	17	18
Serum bicarbonate (mmol/L)	16	20	19	17