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Case Report

A Methanol Intoxication Outbreak From Recreational Ingestion of Fracking Fluid

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Single-patient methanol intoxications are a common clinical presentation, but outbreaks are rare and usually occur in settings in which there is limited access to ethanol and methanol is consumed as a substitute. In this case report, we describe an outbreak of methanol intoxications that was challenging from a public health perspective and discuss strategies for managing such an outbreak.
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INDEX WORDS: Methanol; intoxication; toxic alcohol ingestion; poisoning; outbreak; fomepizole; folinic acid; hemodialysis; alcohol dehydrogenase inhibition; case reports; remote medicine; contact tracing; public health.

Single-patient methanol intoxications are common,[1-3] but outbreaks are rare, especially in developed countries.[4-12] They usually occur in settings in which there is limited access to ethanol due to its cost or ethanol is not available due to cultural, religious, or social reasons, and so methanol is consumed as an ethanol substitute.

Oxidation of methanol by alcohol dehydrogenase (ADH) and aldehyde dehydrogenase to formate causes an anion gap metabolic acidosis and may lead to end-organ damage, including retinal injury, central nervous system dysfunction, and death.[13] Rapid identification of methanol intoxication and inhibition of ADH with fomepizole[14] or ethanol is critical to preventing morbidity and mortality; hemodialysis (HD) therapy[15] might also be necessary.

Providing optimal effective therapy may be challenging during outbreaks of methanol intoxication when patient volume and acuity may exceed the availability of resources. In this report, we describe a series of methanol intoxications that was challenging from a public health perspective and suggest strategies that centers may apply to prepare and appropriately manage potential future outbreaks.

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CASE REPORTS

We report a series of 10 intentional methanol intoxications from the ingestion of a fluid used in the mining industry for fracking.[16] The 3 index cases included a 28-year-old First Nations man who presented to a nursing station in remote Northern Manitoba, Canada, with nausea and vomiting. He did not report any other symptoms. Approximately 24 hours prior to presentation, the man had recreationally consumed an undisclosed amount of "frosted white" with friends. The substance was later confirmed to be a fracking mining fluid consisting of 85% ethanol, 13.7% methanol, and 0.85% acetate. A toxic alcohol ingestion was suspected, and after consultation with a toxicologist, the patient was transferred by air ambulance to a tertiary-care facility with HD facilities in Winnipeg. No ethanol or fomepizole was given at the nursing station because they were not available.

Upon arrival to the tertiary-care facility, the patient's arterial pH was 7.19; anion gap, 28; osmolal gap, 41 mOsm/L; and methanol level, 30.1 mmol/L (96.4 mg/dL). Intravenous fomepizole (15 mg/kg) and intravenous folinic acid (50 mg) were administered to the patient, along with 5% dextrose mixed with 3 ampules of sodium bicarbonate per liter at a rate of 250 mL/h. A right femoral vascular catheter was inserted and HD was performed in the intensive care unit for 6 hours, the session time predicted by the Halifax formula (estimated dialysis time in hours $= [-V \times \ln(5/A)]/0.06k$, where V is the Watson estimate of total-body water in liters, A is the initial toxin concentration in millimoles per liter, and k is 80% of the manufacturer-specified dialyzer urea clearance in milliliters per minute at the initial observed blood flow rate[17,18]). The Halifax formula targets a serum concentration ≤ 5 mmol/L for methanol and ethylene glycol.[17,18] The patient recovered clinically and was discharged without adverse sequelae.

Given the history of group intoxication, we engaged the public health infrastructure and with contact tracing, identified 10 individuals who had ingested the fracking solution. Public health officials then contacted these individuals by telephone, or if this method was not possible, law enforcement officials conducted home visits. We ensured adequate staffing at the nursing station, aviation resources, and paramedic services to prevent delays in patient transportation to our tertiary center. The clinical summary of each patient is presented in Tables 1 and 2, and a timeline of events is displayed in Fig S1 (available as online supplementary material). Two of the 10 patients required fomepizole therapy with HD, and an additional patient required fomepizole therapy without HD.

Table 1. Demographics, Anthrometry, Medical History, Symptoms, and Timing of Medical Care

Pt No.	Age, y/Sex	Height, cm	Weight, kg	Medical History[a]	Symptoms	Time Since Ingestion to: Initial Contact With Health Care System	Time Since Ingestion to: Flight Dispatch	Time Since Ingestion to: Presentation to ED Triage in Tertiary Hospital
1	45/M	162	73.2	Rheumatoid arthritis	Nausea, vomiting	24 h 45 min	26 h 55 min	32 h 5 min
2	28/M	176	114	Smoker, marijuana use, LTBI	Nausea, vomiting, "hungover"	24 h 50 min	26 h 55 min	32 h 4 min
3	28/M	170	88.4	Healthy	"Hungover"	25 h	28 h 22 min	32 h 26 min
4	21/M	—	—	Healthy	"Hungover"	26 h 30 min	28 h 22 min	32 h 25 min
5	27/M	179	74.9	Asthma, HCV	NA	28 h 15 min	28 h 15 min	33 h 34 min
6	39/M	165	75.6	Chronic back pain	Nausea, vomiting	30 h 45 min	33 h 25 min	42 h 26 min
7	31/M	—	—	Migraines	NA	32 h	33 h 15 min	37 h 1 min
8	22/M	176	92	Idiopathic immune complex MPGN, HTN, eczema	NA	32 h	33 h 15 min	37 h 2 min
9	35/M	180	114	Peritonsillar abscess	NA	33 h 15 min	37 h 30 min	42 h 25 min
10	38/M	168	73	HTN, smoker, appendectomy, I+D, iron deficiency anemia	NA	34 h	37 h	40 h 42 min

Abbreviations: ED, emergency department; HCV, hepatitis C virus; HTN, hypertension; I+D = incision plus drainage; LTBI, latent tuberculosis infection; MPGN, membranoproliferative glomerulonephritis; NA, not applicable; Pt, patient.

[a]None of the patients were taking any medications at the time of presentation.

DISCUSSION

This methanol intoxication outbreak involved a variety of settings (nursing station, emergency department, and intensive care unit) and was managed by a multidisciplinary team composed of nurses, public health officials, paramedics, pharmacists, physicians, and a toxicologist. Fortunately, most patients presented without evidence of methanol toxicity and did not require interventions. We suspect that this was due to limited ingestion or inhibition of ADH by the 85% ethanol content of the fluid, resulting in delayed but controlled methanol clearance.

For these 10 cases, outcomes for all patients were favorable. However, if faced with a similar scenario of greater patient acuity or volume,[5,7,8] we would have found it challenging due to resource limitations. Our experience prompted a formal review of the processes at our center and resulted in the development of a regional framework for a methanol intoxication outbreak (Fig 1).

Rapid case finding and diligent contact tracing are critical to identify individuals at risk for harm, as well as to quantify the potential burden of an outbreak. Engaging all relevant stakeholders from the multidisciplinary team is important to mobilize resources to fit patient needs. If possible, determining a patient's pH, acid-base status, anion gap, osmolal gap, and neurologic status at initial presentation provides valuable information for predicting health resource use, such as the need for fomepizole, dialysis, and intensive care.[19,20] If the anticipated resources are thought to exceed an individual center's operating capacity, patients can be distributed upstream to other facilities with available resources. We suggest that while actively case finding, centers simultaneously account for their available fomepizole stock and dialysis capacity and verify these resources at nearby hospitals. Centers should create a contingency plan for ethanol treatment in cases in which fomepizole treatment is not possible. To avoid medication errors, we have established protocols for the dosing and monitoring of ethanol in case of fomepizole shortages.

Measuring methanol levels in patients identified in an outbreak is favored over using osmolal gap in toxic alcohol ingestions.[21-23] However, if methanol levels are not readily available, osmolal gap is a suitable surrogate for toxic alcohol burden and can help facilitate triage.[24] If laboratory investigations are not available during the patient's initial interaction with a health system and he or she is symptomatic or delayed transfer to a tertiary center is anticipated, empirical ADH inhibition with ethanol or fomepizole therapy should be considered.[25]

Individual therapy needs to be considered in the context of an outbreak and potential resource limitations. Although fomepizole may not carry a mortality benefit over ethanol for ADH inhibition,[26,27] we prefer it to ethanol because it is associated with fewer dosing errors, more reliable pharmacokinetics, and fewer adverse drug events and is well tolerated in most patients.[27,28] In addition, a single dose of fomepizole adequately inhibits ADH for several hours, allowing time for transport to a tertiary health care center.[14]

We chose to treat 2 patients with HD due to their methanol levels (30.1 mmol/L [96.4 mg/dL]

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