Table 2
Number of patients who received each treatment modality with corresponding CO levels.

	n (%)	COHb % (range)
All	23 (100%)	19.8% (7.1–35)
Oxygen (NC)	10 (43%)	19.4% (7.1–30.2)
Oxygen (NRB)	6 (26%)	19.4% (14.2–25)
Intubation	5 (22%)	23.5% (12.8–35)
Hyperbaric	5 (22%)	19.9% (11.9–35)

The most common presenting symptom was altered mental status (AMS; 43%), followed by headache (39%), nausea (35%), dizziness (30%), vomiting (22%), dyspnea (13%), malaise (4%), and syncope (4%) (Table 1). Two patients were asymptomatic; one of these was concerned about a potential exposure, while the other was advised by EMS to be evaluated because her spouse was symptomatic. The average pH of all patients was 7.40 (range 7.21 to 7.51). The average PCO2 was 33.2 mm Hg (range 22.8 to 41.1). The average COHb was 19.8% (range 7.1 to 35).

Ten patients (43%) were treated with oxygen by nasal cannula (NC), six (26%) with oxygen by non-rebreather (NRB), five (22%) were treated with hyperbaric oxygen, and five (22%) required intubation (Table 2). Eight patients were admitted, while the rest were discharged from the emergency department. A total of seven were transferred from other emergency departments, and one death occurred.

Although the total number of deaths due to all-cause CO toxicity has significantly declined in the United States from 1999 to 2014, CO toxicity following natural disasters continues to be a significant cause of poisoning in the U.S. due to improper use of gas-powered generators [14]. Further heightening the danger is the non-specific presentation of myalgias, headache, fatigue, nausea and dizziness, while more severe exposure may result in syncope, seizure, arrhythmia, coma or death [3].

CO toxicity appears to be common in the aftermath of natural disasters that disrupt the power grid, despite public announcements and educational efforts on proper use of consumer gas-powered electrical generators. Implementation of the Henretig recommendations to make portable generator use safer by pairing CO detector with purchase of a generator, longer cords to enable safe placement at a distance from structures, low CO emission generators, and automatic shutoff systems if elevated CO concentration is detected would help alleviate issues with newly sold generators [1]. Emergency physicians need to remain mindful of this common non-specific presentation of a potentially fatal environmental poisoning especially in a hurricane's aftermath.

Declarations of interest

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Which of hemodialysis and direct hemoperfusion is more recommended for treating severe caffeine poisoning?

In recent years, the number of patients intoxicated with caffeine, a xanthine derivative (1,3,7-trimethylxanthine), has increased in Japan, and severe or fatal cases have been reported [1]. Theophylline is another xanthine derivative (1,3-dimethylxanthine) that shares a similar pharmacokinetic profile with caffeine. For the treatment of severe theophylline poisoning, hemodialysis (HD) is the preferred recommended extracorporeal treatment, whereas charcoal hemoperfusion (CHP) is acceptable if HD is not available [2]. Thus, these hemopurification methods may also be recommended for treating severe caffeine poisoning. However, no studies have addressed whether HD or CHP is superior for

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treating severe caffeine poisoning through an assessment of caffeine clearance (CL). Here we discuss two cases of severe caffeine poisoning; one patient was treated by HD and the other by CHP.

The patient in Case 1 was a 24-year-old male (height, 170 cm; weight, 65 kg, non-smoker) who ingested six cans of Monster Energy® (852 mg caffeine) and 60 tablets of Estaron Mocha® (6000 mg caffeine), to a combined total of 6852 mg caffeine in a suicide attempt and was transported to our hospital. On arrival (3 h after drug ingestion), the patient vomited repeatedly and presented with irritation and shivering. He exhibited tachycardia (110 bpm), hypercreatinekinasemia (509 U/L), hypokalemia (2.4 mmol/L), and leukocytosis (22,440/μL). Serum caffeine concentration was 87.2 mg/L, as determined by liquid chromatography-tandem mass spectrometry using 3200QTRAP® (AB SCIEX, Framingham, MA, USA) and the Prominence® LC system (Shimadzu Corporation, Kyoto, Japan). Because he had ingested a lethal concentration of caffeine (>80 μg/mL) [3], HD was performed for 4 h at a blood flow rate (Q_B) of 200 mL/min and dialyzate flow rate (Q_D) of 500 mL/min, during which clinical signs and symptoms improved dramatically. One hour after HD, he became calm and his nausea and shivering subsided. Serum caffeine concentrations in the pre-HD column/post-HD column were 76.3/19.6 mg/L (0 hour period after beginning HD), 57.3/5.5 mg/L (1 hour period), 49.4/10.6 mg/L (2 hour period), 31.7/8.9 mg/L (3 hour period), and 27.3/8.2 mg/L (4 hour period). The following day, he was transferred to the Department of Psychiatry for mental evaluation and treatment.

The patient in Case 2 was a 24-year-old male (height, 164 cm; weight, 63 kg, non-smoker) who ingested 80 tablets of Estaron Mocha® (8000 mg caffeine) in a suicide attempt and was transported to our hospital. On arrival (7 h after drug ingestion), he vomited repeatedly and was agitated. He complained of nausea, epigastric discomfort, and peripheral numbness. He was tachycardic (136 bpm), and exhibited tachypnea (72 breaths/min), hyperglycemia (217 mg/dL), leukocytosis (24,310/μL), and metabolic acidosis (pH, 7.26; $PaCO_2$, 20.9 mm Hg; PaO_2, 30.1 mm Hg; BE, −17.5 mmol/L; and HCO_3^-, 9.5 mmol/L). Serum caffeine concentration was 76.2 mg/L as determined by gas chromatography–mass spectrometry (GC–MS) using QP-2020® (Shimadzu Corporation, Kyoto, Japan). Given the near lethal caffeine concentration (>80 μg/mL) [3], CHP was performed for 4 h with a Q_B of 150 mL/min, during which his clinical signs and symptoms improved notably. Immediately after CHP, he was calm without nausea and metabolic acidosis disappeared. Serum caffeine concentrations in the pre-CHP column/post-CHP column were 79.5/4.0 mg/L (0 hour period after beginning CHP), 61.2/0 mg/L (1 hour period), 42.3/4.5 mg/L (2 hour period), 32.7/0 mg/L (3 hour period), and 19.4/0 mg/L (4 hour period). On hospital day 3, he was discharged with no sequelae.

CL of caffeine were calculated using the following formula reported by Hirata et al. [4]:

$$CL_{\text{HD or CHP}} = \{(C_{\text{pre-column}} - C_{\text{post-column}})/C_{\text{pre-column}}\} \times Q_P$$

Q_P (plasma flow rate) is calculated as Q_B during HD or CHP (mL/min) × {100-Hematocrit (%)}.

As calculated from the above equation, CL_{HD} was 79.3–102.3 mL/min and the corresponding CL_{CHP} value was 67.4–75.5 mL/min. When comparing CL by column, CL_{HD} was higher than CL_{CHP} at all assessed time points. This suggests that removal efficiency is high with HD, likely due to the ability to adjust the Q_B during the procedure. Since internal circuit pressure of CHP increases readily, increases in Q_B over 150 mL/min are difficult. Therefore, HD was found to demonstrate higher estimated caffeine clearance, mainly due to a higher Q_B during the procedure.

It is well known that complications such as thrombocytopenia [5] occur at a much higher frequency with CHP than with HD. In Case 2, blood platelets decreased, from 297,000/μL to 122,000/μL during CHP.

There is a significant cost difference between CHP and HD in that the activated carbon column used for HP is roughly 100 times more expensive than the column used for HD in Japan (approximately 2000 yen vs 130,000 yen).

Considering the number of associated complications (e.g., thrombocytopenia), higher costs, fewer skilled experts, and lower clearance rate of CHP, HD may be the preferred procedure for treating severe caffeine poisoning.

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Methamphetamine psychosis: Lack of association with stimulant prescription ADHD medications

Methamphetamine use is increasing nationwide [1]. Recently, cases of methamphetamine psychosis have been increasing in frequency in Montgomery County, Ohio, with up to 40% of methamphetamine users affected [2,3]. Methamphetamine psychosis is characterized by hallucinations, uncontrolled movements and potential violent behavior, and in a subset of patients may result in recurrent psychotic episodes [4]. Poison death