Case Letter

An incident of chloroform poisoning on a university campus

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Dear editor,

University laboratory-related events include fire, explosion, chemical gas leakage, poisoning related to the loss of toxic reagents, specific pathogen infection, leakage of radioactive material, etc.[1] Chloroform is an important material used frequently in the laboratory, for organic synthesis or used as an organic glass binder and organic matter extractor.[2] As a widely used anesthetic in clinics in the 1950s and the 1960s, [3] chloroform was abandoned because of hepatorenal toxicity. We report a case of a 24-year-old suicidal female student with chloroform poisoning.

CASE

A 24-year-old coma female patient was sent to the emergency room of Qilu Hospital at 9 a.m. on April 24, 2017. The patient worked in the laboratory of an educational institution. She returned to the dormitory at about 5 p.m. on April 23, 2017. The following day, the cleaning staff found her unresponsive in the restroom at 8 a.m. Her skin felt cold and clammy. There was an opened 500 mL bottle of chloroform nearby; 200 mL of the contents were missing.

On arrival, the patient was in a coma with blood pressure 90/58 mmHg (1 mmHg=0.133 kPa), heart rate 80 beats/min, with shallow breathing (respiratory rate 16 breaths/min), and temperature 36.1 °C. Her bilateral pupil size was approximately 1 mm, and she was unresponsive to light. There was obvious cyanosis of her face and limbs. On admission, her diagnosis was coma - cause to be investigated, acute poisoning, and chloroform poisoning. The patient was immediately monitored using a vital signs monitor. Then we injected octahedral montmorillonite powder (30 g) and activated carbon (30 g) with 20% mannitol (250 mL) through a nasogastric tube instead of gastric lavage. This treatment continued for four days to absorb chloroform from the gastrointestinal tract and block its enterohepatic circulation. Hypoxemia occurred 3 h after her admission, and the nasal catheter was administered for oxygen inhalation at 6 L/min. However, her oxygen saturation (SPO_2) was 70%, which could not be corrected. Urgent arterial blood gas analysis showed pH 7.16, partial pressure of carbon dioxide (PCO_2) 51 mmHg, partial pressure of oxygen (PO_2) 117 mmHg, base excess (BE) 10.8 mmol/L, Ca^{2+} 1.02 mmol/L, and serum lactic acid (LAC) 3.20 mmol/L. The patient, who had disrupted consciousness and severe respiratory failure, was intubated with rapid sequence intubation and mechanically ventilated. Endotracheal intubation was performed 30 min later and her condition improved with SPO_2 96%. Urgent arterial blood gas analysis showed pH 7.23, PCO_2 41.00 mmHg, PO_2 156 mmHg, LAC 3.10 mmol/L, BE 9.9 mmol/L, and the patient's vital signs were stable. The other pertinent laboratory findings of the

first day as follows: white blood cell (WBC) 20.56×10^9/L, red blood cell (RBC) 3.3×10^9/L, polymorphonuclear granulocytes (PMN)% 89%, platelet (PLT) 57×10^9/L, urine occult blood 3+, alanine aminotransferase (ALT) 41 U/L, aspartate aminotransferase (AST) 76 U/L, creatine kinase (CK) 9,480 U/L, creatinine kinase-myocardial band (CK-MB) 77.70 ng/mL, lactate dehydrogenase (LDH) 1,091 U/L, cardiac troponin I (cTnI) 504.83 ng/L, serum creatinine (SCr) 57 μmol/L. Clotting series: prothrombin time (PT) 18.70 s, activated partial thromboplastin time (APTT) 30.70 s, D-dimer 2.82 μg/mL, fibrin degradation products (FDP) 9.06 μg/mL. Other lab indexes demonstrated normal. We administered 200 mg methylprednisolone intravenously for antitoxin therapy. At 2 p.m., we performed the right femoral vein catheterization, and hemoperfusion (HP) was used for our patient. We used an HA 330 resin HP device (Jafron Biomedical Co., Ltd., China) with heparin anticoagulant (Supplementary Figure 1), and the blood flow velocity was 150–180 mL/min. We adopted "plan 2-1-1" for HP treatment, that is, one perfusion every 12 h on the first day of admission, and one perfusion on the second and third days respectively. Five milliliter venous blood was collected for toxicological analysis before and after the first perfusion and after the second, third and fourth perfusion. The blood concentrations of chloroform before and after the first perfusion were 58 μg/mL and 37 μg/mL, respectively. Other supportive treatments were administered, including mannitol to reduce intracranial pressure and ceftriaxone for anti-infection. At 9 p.m., the patient regained her senses and admitted that she drunk 200 mL of chloroform and became agitated. The second HP was administered on the same day, and the blood concentration of chloroform was 24 μg/mL. The third and fourth HP were conducted on the mornings of the next days. After these treatments, the blood concentration of chloroform was 0 μg/mL (Supplementary Figure 2).

On the second day after admission, the patient was successfully removed from the ventilator and further, the endotracheal intubation was removed. Arterial blood gas analysis showed no abnormalities. On the third day after admission, her urine tube and gastric tube were removed, and somatostatin was stopped. On the same day, we discontinued intravenous methylprednisolone and switched to prednisone 60 mg per day orally, gradually reducing the dose to discontinuation. On April 29, 2017, laboratory results were as follows: WBC 12.78×10^9/L, RBC 2.75×10^9/L, PMN% 78.60%, PLT 64×10^9/L, urine occult blood 3+, ALT 624 U/L , AST 114 U/L, CK 1,107 U/L, CK-MB 2.9 ng/mL, LDH 634 U/L, total bilirubin (TBIL) 58.3 μmol/L, direct bilirubin (DBIL) 36.6 μmol/L, indirect bilirubin (IBIL) 21.7 μmol/L, amylase (AMY) 169 U/L, lipase (LIP) 429 U/L. Her chest and abdomen CT showed double lung texture thickened and abdominal pancreas full. Due to unclear voice, hoarseness, and dysphagia, laryngoscopy was performed on our patient, and the fixed unilateral vocal cord was found (Supplementary Figure 3), which was attributed to endotracheal intubation injury. The patient continued to receive comprehensive treatment.

On May 7, 2017, the 14th day of admission, her laboratory results were as follows: ALT 49 U/L, AST 35 U/L, CK 109 U/L, CK-MB 5.2 ng/mL, LDH 298 U/L, AMY 162 U/L, LIP 143 U/L; and chest CT and other examinations showed no obvious abnormalities. On May 14, 2017, the 21st day of admission, the patient underwent reexamination with AMY 104 U/L, LIP 62 U/L, and other hematological survey laboratory tests were normal. The patient recovered and was discharged after 21-day hospitalization. After a month, the patient visited the hospital for reexamination, and all the tests were normal.

DISCUSSION

Chloroform, molecular formula $CHCl_3$, is a colorless, volatile liquid at room temperature, slightly sweet; its molecular weight is 119.4. Chloroform is slightly soluble in water and can be miscible with alcohol, ether, benzene, petroleum ether, and other organic solvents in any proportion.[4] Chloroform is a moderately toxic reagent, and its acute toxicity includes central nervous system anesthesia, arrhythmia, and liver and kidney damage.[5,6] Oral chloroform poisoning can also cause nausea, vomiting, abdominal pain, and other digestive symptoms.[7]

Routine gastric lavage is not recommended because chloroform poisoning patients are usually unconscious.[8] Octahedral montmorillonite powder and activated carbon can effectively adsorb poison, and mannitol can induce diarrhea.[9] Therefore, we injected octahedral montmorillonite mannitol suspension and activated carbon mannitol suspension several times to absorb the residual chloroform in the gastrointestinal tract, and achieved effective results.

A large dose of chloroform can numb the central nervous system and inhibit breathing.[10-12] Our patient developed severe respiratory depression, characterized by severe hypoxia and cyanosis. While her hypoxia symptoms improved rapidly after rapid endotracheal

intubation and mechanical ventilation.

HP is one of the most commonly used blood purification method.[13,14] In the clinic, a proper blood purification method can be selected according to the physical and chemical properties of the toxicant, the characteristics of toxicant metabolism dynamics, and the specific condition of the patient. The HP devices include activated carbon perfusion devices, disposable resin perfusion devices, and disposable resin carbon perfusion devices. In this case, we adopted a resin HP device and achieved good effect.

Liver damage from chloroform is common, and liver enzyme elevation usually occurs 24–72 h after poisoning,[15-18] but muscle damage is uncommon. We have to take the following reasons into account in our patient. On the one hand, the patient had been in a coma for a long time, and there may be compression of limb muscles; on the other hand, it may be related to the muscular toxicity of chloroform. Fortunately, her renal function was normal, which played an important role in the metabolism and excretion of chloroform. In addition, the patient presented with severe lactic acidosis on admission, which may be related to the hypoxia caused by chloroform-induced respiratory depression. After the comprehensive treatment of poison removal, liver protection, mechanical ventilation, sodium bicarbonate, and infusion diuresis, the patient recovered.

Our case suggests that sufficient attention should be paid to poising accidents related to university laboratories. Supervision of the implementation of laboratory safety systems should be strengthened. Further, the psychological state of students is also important and routine counseling services are required.

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All the supplementary files in this paper are available at http://wjem.com.cn.

REFERENCES

1 Zhang X, Hu XF, Bai YP, Wu JS. Risk assessment of gas leakage from school laboratories based on the Bayesian network. Int J Environ Res Public Health. 2020;17(2):E426.
2 Cheng JX. Investigation and analysis of an acute trichloromethane poisoning accident. Occupational Health and Emergency Rescue. 2012;30(02):101.
3 Yang X, Luethy A, Zhang H, Luo Y, Xue Q, Yu B, et al. Mechanism and development of modern general anesthetics. Curr Top Med Chem. 2019;19(31):2842-54.
4 Zhang FL, Xing SX. Research progress and risk assessment of the toxicology of chloroform. Chin Pharm Aff. 2014;28(2):190-4.
5 Panetta M, Brightmore A, Waring WS. Delayed onset of liver injury after intentional chloroform overdose: a case report and literature review. Acute Med. 2019;18(3):192-6.
6 Wang L, Li XK, Chen C. 3-methyadenine attenuates chloroform-induced hepatotoxicity via autophagy activation. Biomed Res. 2018;39(2):87-94.
7 Jayaweera D, Islam S, Gunja N, Cowie C, Broska J, Poojara L, et al. Chloroform ingestion causing severe gastrointestinal injury, hepatotoxicity and dermatitis confirmed with plasma chloroform concentrations. Clin Toxicol (Phila). 2017;55(2):147-50.
8 Jian XD, Yu GC, Zhang ZC. Does acute oral toxicosis require routine gastric lavage? Occupational Health and Emergency Rescue. 2019;37(01):1-4.
9 Jian XD, Zhang H, Sui H, Guo GR, Ruan YJ, Zhao B, et al. "Qilu plan" for paraquat poisoning treatment (2014). Chinese Journal of Industrial Medicine. 2014;27(02):119-21.
10 Sridhar N, Krishnakishore C, Sandeep Y, Sriramnaveen P, Manjusha Y, Sivakumar V. Chloroform poisoning——A case report. Ren Fail. 2011;33(10):1037-9.
11 Dettling A, Stadler K, Eisenbach C, Skopp G, Haffner HT. Systemic inflammatory response due to chloroform intoxication--an uncommon complication. Int J Legal Med. 2016;130(2):401-4.
12 Ago M, Hayashi T, Ago K, Ogata M. Two fatalities associated with chloroform inhalation. Variation of toxicological and pathological findings. Leg Med (Tokyo). 2011;13(3):156-60.
13 Liu XB, Jian XD, Liu L, Chen XL. Advances in the application of blood purification in the treatment of acute poisoning. Medical Recapitulate. 2013;19(05):856-9.
14 Li H, Song L, Jian X. Efficacy of haemoperfusion therapy in patients with paraquat poisoning: a meta-analysis. Int J Clin Exp Med. 2017;10(8):11371-81.
15 Dell'Aglio DM, Sutter ME, Schwartz MD, Koch DD, Algren DA, Morgan BW. Acute chloroform ingestion successfully treated with intravenously administered N-acetylcysteine. J Med Toxicol. 2010;6(2):143-6.
16 Flanagan RJ, Pounder DJ. A chloroform-related death: analytical and forensic aspects. Forensic Sci Int. 2010;197(1-3):89-96.
17 Choi SH, Lee SW, Hong YS, Kim SJ, Moon SW, Moon JD. Diagnostic radiopacity and hepatotoxicity following chloroform ingestion: a case report. Emerg Med J. 2006;23(5):394-5.
18 Lionte C. Lethal complications after poisoning with chloroform——case report and literature review. Hum Exp Toxicol. 2010;29(7):615-22.

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