Clinical Case Report

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Mercury poisoning through intravenous administration

Two case reports with literature review

Qiuying Lu, MD, Zilong Liu, MD, PhD*, Xiaorui Chen, MD, PhD

Abstract

Rationale: Metallic mercury poisoning through intravenous injection is rare, especially for a homicide attempt. Diagnosis and treatment of the disease are challenging.

Patient concerns: A 34-year-old male presented with pyrexia, chill, fatigue, body aches, and pain of the dorsal aspect of right foot. Another case is that of a 29-year-old male who committed suicide by injecting himself metallic mercury 15 g intravenously and presented with dizzy, dyspnea, fatigue, sweatiness, and waist soreness.

Diagnosis: The patient's condition in case 1 was deteriorated after initial treatment. Imaging studies revealed multiple high-density spots throughout the body especially in the lungs. On further questioning, the patient's girlfriend acknowledged that she injected him about 40 g mercury intravenously 11 days ago. The diagnosis was then confirmed with a urinary mercury concentration of 4828 mg/L.

Interventions: Surgical excision, continuous blood purification, plasma exchange, alveolar lavage, and chelation were performed successively in case 1. Blood irrigation and chelation therapy were performed in case 2.

Outcomes: The laboratory test results and organ function of the patient in case 1 gradually returned to normal. However, in case 2, the patient's dyspnea was getting worse and he finally died due to toxic encephalopathy and respiratory failure.

Lessons: Early diagnosis and appropriate treatment are critical for intravenous mercury poisoning. It should be concerned about the combined use of chelation agents and other treatments, such as surgical excision, hemodialysis and plasma exchange in clinical settings.

Abbreviations: α- HBDH = α- hydroxybutyrate dehydrogenase, ALT = alanine aminotransferase, AST = aspartate aminotransferase, CT = computed tomography, DMPS = sodium dimercaptosulphonate, DMSA = dimercaptosuccinic acid, Hb = hemoglobin, LDH = lactate dehydrogenase, TP = total protein, WBC = white blood cell.

Keywords: intravenous injection, mercury poisoning, metallic mercury

1. Introduction

Mercury is the only metal that remains in liquid state at room temperature with high toxicity. It has 3 forms in nature: metallic, inorganic, and organic mercury compounds. Metallic mercury is volatile and highly lipophilic.[1,2] Metallic mercury poisoning is usually caused through inhalation of its vapor, which may occur at home or laboratory through the broken thermometers containing mercury.[3,4] Acute vapor exposure of metallic mercury can cause respiratory distress, and chronic exposure may induce damages in central nervous system and kidney.[2] Other causes of metallic mercury poisoning in medical practice settings have also been reported, such as the release of metallic mercury from dental amalgam,[5] and mercury leakage from medical devices.[6] Metallic mercury poisoning through intravenous administration is quite rare, especially for homicide.[7,8]

Injection of metallic mercury can lead to a rapid increase of circular mercury in a short time, and finally distributes throughout the body. Though injection of metallic mercury is considered to be harmless than inhalation of mercury vapor,[9,10] it is likely to result in various clinical manifestations which may alter with the progression of poisoning, appearing as systemic, respiratory symptoms, gastrointestinal disturbances, and liver and kidney damage, and ranging from nearly asymptomatic to death.[1–4,6–8,10–12] (Table 1). It can be easily misdiagnosed when no history of mercury exposure is available, especially in homicide cases.

2. Case report

2.1. Case 1

A 34-year-old male presented at emergency department with pyrexia, chill, fatigue, anorexia, productive cough, body aches, and a right dorsal foot pain. The symptoms started 7 days ago and had been deteriorated after initial treatment with dexamethasone, levofloxacin, and vitamin B6 with suspicion of erysipelas in another hospital. There was no significant past medical history and he was not on any prescribed medications. On presentation, his vital signs were: temperature 38.7°C, respiratory rate 33 breaths per minute, pulse 99 beats per minute, blood pressure

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Department of Forensic Medicine, Tongji Medical College of Huazhong University of Science and Technology, Wuhan, Hubei, China.

* Correspondence: Zilong Liu, Department of Forensic Medicine, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei 430030, China (e-mail: liuzilongfy@hust.edu.cn).

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Table 1

The acute and chronic symptoms of metallic mercury poisoning.

	Symptoms
Hours to days	Systemic symptoms: headache, pyrexia, chill, fatigue, sore throat, dizzy, itching, skin rash, body aches, and waist soreness, soft tissue necrosis
	Respiratory symptoms: chest pain, cough, bloody sputum sweatiness, hemoptysis, dyspnea
	Gastrointestinal disturbances: abdominal pain, nausea, vomiting, anorexia, diarrhea, oral ulcers and gingival bleeding
	Liver and kidney damage confirmed by laboratory tests
Months to years	Neurological deficits: mercurial tremors and cerebellar dysfunction, generalized tonic-clonic seizures, peripheral axonopathy.
	Mental abnormalities: erethism, delusions, screaming, irritability, groan and emotional instability, memory loss, neurocognitive disorders
	Others: interstitial lung impairment, asthenozoospermia, restrictive lung disease, aplastic anemia and cardiac granulomas

108/64 mm Hg. Physical examination was remarkable for enlarged lymph nodes in the right groin, tumidness, and necrosis in dorsal part of the right foot with purulent fluid, ecchymosis on the anterior tibia of right lower limb, and macular erythematous rash over the body. Laboratory test results revealed a leukocyte count of 13.31×10^9, neutrophil was 79.94%, the neutrophil count was 10.64×10^9, and hemoglobin (Hb) was 129.0 g/L. C-reactive protein was 78.46 mg/L. Aspartate aminotransferase (AST) was 67 U/L, alanine aminotransferase (ALT) was 181 U/L, creatinine was 115 μmol/L, lactate dehydrogenase (LDH) was 365 U/L, α- hydroxybutyrate dehydrogenase (α-HBDH) was 246 U/L, total protein (TP) was 55.9 g/L, albumin was 30.9 g/L, and the ratio of albumin to globulin was 1.2. Urine latent blood was + ++, red blood cell was 241.34/μL, and white blood cell (WBC) count was 53.3/μL. Total body computed tomography (CT) scan revealed multiple metal dense shadows of various organs in chest and abdomen, and bones (Fig. 1). There was no gross intracranial abnormality. X-ray showed radio opaque deposits in the 2 lungs and subcutaneous deposits in dorsal part of the right foot (Fig. 2). On further questioning, the patient's girlfriend, who works as a nurse, acknowledged that she had ever added hypnotics in his coffee, and then injected him 40 g mercury extracted from 40 thermometers through the veins at left elbow and back of right foot after he fell into deep sleep 11 days ago.

Based on an exposure history, symptoms, and imaging, a diagnosis of metallic mercury poisoning was established. The diagnosis was then confirmed with a urinary mercury concentration of 4828 μg/L. Chelation therapy was started on 12th day after mercury exposure with sessions of sodium dimercaptosulphonate (DMPS) and dimercaptosuccinic acid (DMSA) treatment: DMPS 250 mg was administrated intravenously every 12 hours with 7 days on and 3 days off, and DMSA 500 mg p.o. every 8 hours with 3 days on and 4 days off. Blood irrigation was performed once a day for 3 hours each time during first 5 days. Foreign body resections and debridement including ligating and excising the affected vessels at the injection sites were performed at the 16th, 35th, and 59th day. Alveolar lavage was performed at the 56th day, and the toxicity test of the alveolar lavage fluid was positive. In addition, sessions of plasma exchange were performed at the 47th, 65th, 84th, 107th, and 125th day; each session contains 3 times of plasma exchange in successive 3 days. At the end of the fourth month, toxicity test results showed that the mercury concentration in the blood and urine was decreased to 264 ng/mL and 940 ng/mL, respectively. Laboratory test results showed that the WBC count was 7.5×10^9, neutrophil was 58.5%, Hb was 136 g/L, ALT was 26 U/L, AST was 21 U/L, TP was 79.8 g/L, LDH was 165 U/L, α-HBDH was 144 U/L, creatinine was 70 μmol/L, urea was 3.83 mmol/L, 24-hour urine creatinine was 16290 μmol, 24-hour urine protein was 0.51 g,

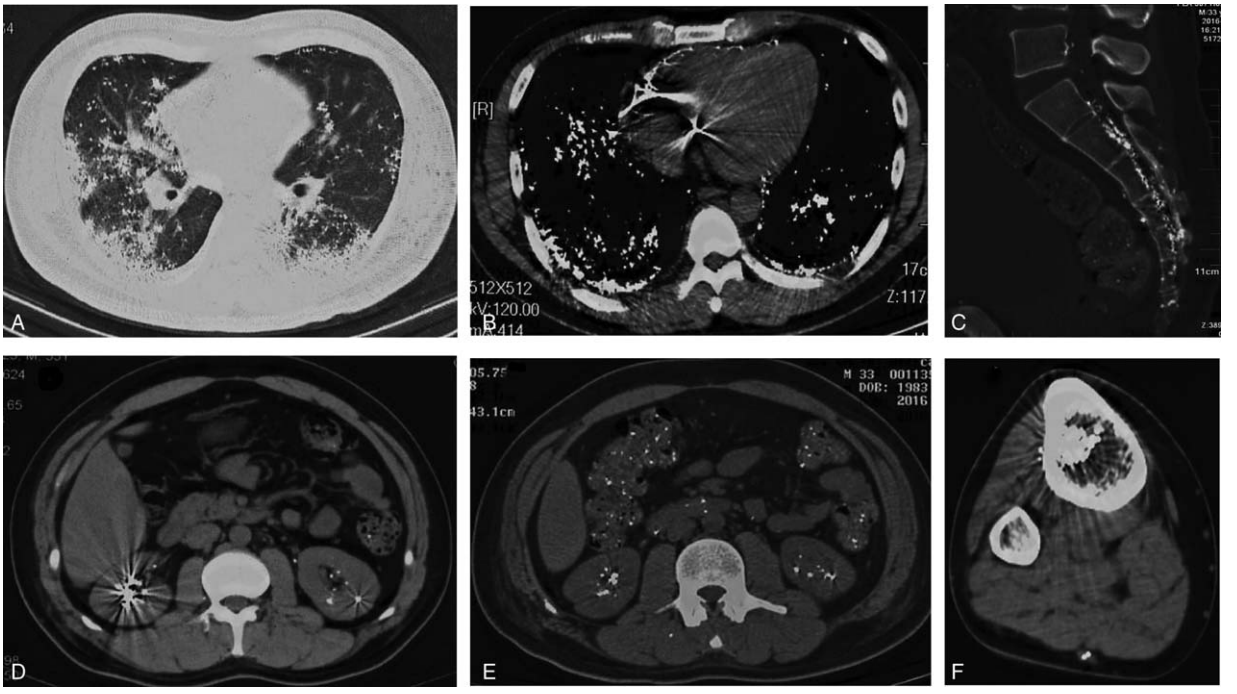

Figure 1. Computed tomography (CT) scans shows multiple metal dense shadow in both lungs (A), myocardium and inside the pericardium (B), spinal canal (C), the 2 kidneys (D), rectum and colon (E), and in marrow cavity of tibiofibular bones (F).

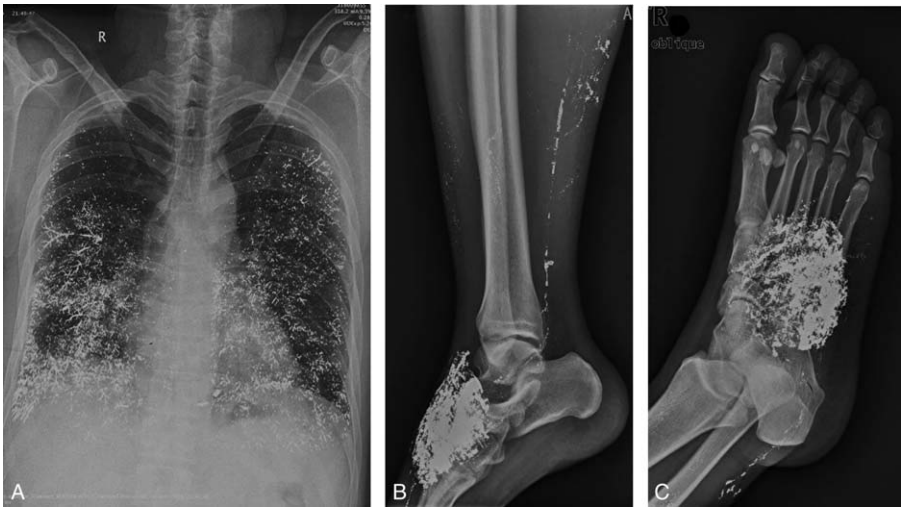

Figure 2. X-ray shows radiopaque deposits in the 2 lungs (A), and right foot back and vein (B, C).

24-hour urine beta 2-microglobulin was 0.39 mg, urinary N-Acetyl B-D-glucosamine was 22.56 U, 24-hour urine α 1-microglobulin was 12.38 mg, 24-hour urine nitrogen was 259.65 mmol, and the ratio of mercury to creatinine in the urine was 4294.5 μg/g. Pulmonary ventilation function was normal. Electrocardiogram and sonographic examination of heart was unremarkable. The patient has been continuously followed up after hospital discharge.

2.2. Case 2

A 29-year-old male was admitted to hospital because of dizziness, dyspnea, fatigue, bloody sputum, sweatiness, and waist soreness. He had been injected intravenously with metallic mercury 15 g extracted from about 15 thermometers by himself for suicide 1 day ago. On arrival, his body temperature was 39.4°C, respiratory rate 20 breaths per minute, pulse rate 108 beats per minute, and blood pressure 100/80 mm Hg. Physical examination was only remarkable for abnormal breath sounds and percussion tenderness over kidney region. Results of laboratory tests revealed a leukocyte count of 13.0×10^9, 77.40% was neutrophil, AST was 43 U/L, ALT was 29 U/L, LDH was 424 U/L, creatinine was 103 μmol/L, urea nitrogen was 4 mmol/L, and uric acid was 424 μmol/L. Creatine phosphokinase was 440 U/L, hydroxybutyric acid hydroxyl enzyme was 405 U/L, and urinary mercury concentration was 458 nmol/L. Routine urine examination and head CT scan found no obvious abnormality. X-ray images revealed vast high-density deposits in the left cubital fossa (Fig. 3), heart, abdomen, and pelvis. A diagnosis of mercury intoxication was established based on the history, symptoms, laboratory tests, and images. During hospitalization, intramuscular injection of 250 mg DMPS was administrated every 6 hours for 3 days, and then adjusted to every 8 hours for 1 week, finally maintained at an interval of 12 hours. Simultaneously, adenosine disodium, anti-infection drugs, and fluid-replacement therapies were administrated for his conditions. Blood irrigation was performed only for 1 time lasting 2 hours; however, photographic observation found nothing in the precipitate of the perfusate. His bloody sputum stopped at the 7th day, and his liver and kidney function, and myocardial enzyme gradually recovered at the 21st day. However, his dyspnea deteriorated, with sweating and salivation during mild activity. The patient presented some mental symptoms such as screaming, irritability, groan, and emotional instability. He developed symptoms of toxic encephalopathy gradually over the course of 6 months such as concentration difficulties, memory loss, bilateral upper limb trembling, involuntary movements (parkinsonism), holding instability, unsteady gait, and increased muscle tone. There was no abnormality in the CT images of the head, but the electroencephalogram showed mild abnormality. X-ray showed the deposits of mercury in the lungs was the same as

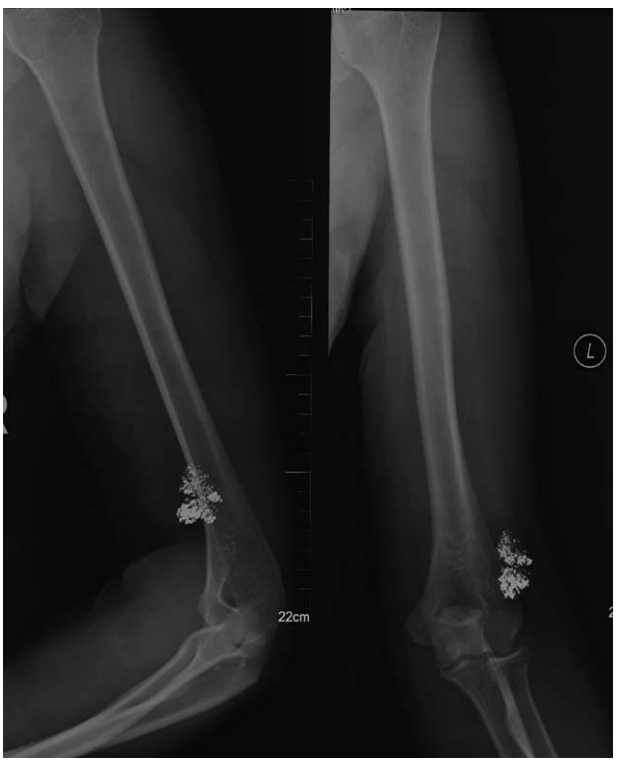

Figure 3. X-ray shows subcutaneous radiopaque deposits in left antecubital fossa.

before. Other laboratory tests revealed no obvious abnormality. Chelation therapy with DMPS was performed continuously, combined with citicoline ester, adenosine disodium, ginkgodipyidamolum, mecobalamine, novohexidyl, nitrazepam, sodium valproate, and almitrine. The patient finally died for mercury toxic encephalopathy and chemical pneumonia about 9 months after mercury intoxication.

Written informed consent was obtained by both patients for publication of this report and any accompanying images.

3. Discussion

Metallic mercury has a stable nature in blood, and can remain element for a long time in the form of mercury globule,[11] causing arteriolar embolism. Autopsy performed 10 months after intravenous injection of metallic mercury found widespread metallic mercury globules in the pulmonary blood vessels.[7] After injection, the considerable amount of mercury enters the pulmonary circulation along the affected vein and passes through the pulmonary capillary bed, and finally distributes throughout the body. Since the metallic mercury is highly lipophilic, it can enter into the bronchial alveolar cavity, and when the injection amount is enough, the toxicity test of the alveolar lavage fluid can be positive as in our case 1.

Because of gas exchange, the capillary network of the lungs is sizable,[13] and the lung is the only organ through which the body blood flow back to heart, leading to the lungs an enrichment device of the exogenous mercury, and often more seriously affected than the other organs in the imaging performance. The injection amounts of mercury in our 2 cases are several tens of times more than those previously reported cases, especially the first case. Our cases demonstrated significant amount of mercury deposition in many organs as compared with the ones with low dose of mercury toxification. We observed diffused high-density nodules in the full lung field, especially at the bottom and the periphery lung, because of its anatomical structure and the gravity of the blood, which was far more than the past reported ones. In addition, the other organs in the thorax and almost all of the organs in the abdomen and the pelvic cavity were obviously affected.

Metallic mercury can easily pass through biological membranes including the blood-brain barrier and red cell membrane.[2] Metallic mercury will be oxidized to Hg^{2+} through peroxidation by complex I in mostly all the tissue. Subsequently, Hg^{2+} cannot penetrate the biological membranes as before and will accumulate in the cells, causing a series of important functional proteins inactivation.[1,14] In the brain tissue, it can gradually accumulate to cause neurotoxicity.[15] Chronic metallic mercury intoxication may induce symptoms from the central nervous system including tremors, delusions, parkinsonism, memory loss, and neurocognitive disorders.[2] The correlation between the declining neurological function and the increasing exposure has been reported.[16] Severe exposure may result in a lasting effect on nervous system and brain function.[14] The sequelae of nervous system damage have been showed in second case where the patient developed a toxic encephalopathy several months later after intravenous exposure of a large amount of metallic mercury.

Elemental mercury poisoning for a homicide attempt is rare and can easily be misdiagnosed because of atypical symptoms and non-specific pathogenesis.[7,8] The signs and symptoms of intravenous mercury poisoning are nonspecific and difficult to classify. Despite the positive imaging findings, the subject in the first case was able to confirm the diagnosis until his girlfriend told the truth. The clinician had best take mercury poisoning into consideration, and toxicity detection may be needed when the imaging results shows radiopaque deposits beyond unexpected explanations.

Most metallic mercury poisoning cases have good prognosis (with or without a mild symptom or some sequelae), and only a few patients eventually died.[3–12,16–22] There are several effective methods of removing the mercury in the body. Surgically clear is useful for getting rid of the "mercury bank" in the injection site and has an effective effect in reducing circulating mercury levels and improving symptoms.[5,6,10,12,17] Ligating and excision of the affected vessels, as we did in case 1, can be used in the early phase of mercury intoxication to prevent mercury spreading. Metal chelation treatment is considered to play a major role in the management of mercury toxic patient. It reduces the blood level of mercury and relieves clinical symptoms.[10,20] DMPS and DMSA are the major chelating agents used in clinical settings. However, mercury was secreted from the body so slowly, at a speed of 1 mg per day through kidney, that chelation therapy may take years, even whole life, to clear the toxicant completely.[18] Hemodialysis and plasma exchange have been reported as effective treatment to decrease the blood mercury level.[19,23] In combination with chelation, hemodialysis can remove the large structures of Hg_2 (DMSA) and Hg $(DMPS)_2$ in condition of a large pore dialyzing membrane was used.[23] Plasma exchange can remove the macromolecules up to several million Daltons in size from the blood,[24] such as protein-bound mercury and chelator-mercury complexes. Plasma exchange combined with chelation appears to be the most efficient therapy for eliminating inorganic mercury currently.[23] The subject in case 2 had extremely poor outcome even with continuous chelation treatment. Interestingly, even though the amount of mercury injected in case 1 is several times higher than that in the case 2, the subject survived. This is most likely due to early diagnosis and combination of various treatments, including surgical resection of injection site, continuous chelation treatment, hemodialysis, and plasma exchange.

4. Conclusions

It should be noted that it is difficult to remove mercury from the body completely in a short time with any current available treatment options. Residual mercury may cause various complications such as interstitial lung impairment, asthenozoospermia, peripheral axonopathy, aplastic anemia, and cardiac granulomas.[21,22,25] Therefore, early diagnosis and appropriate treatment are critical, it should be concerned about the combined use of chelation agents and other treatments, such as surgical excision, hemodialysis and plasma exchange in clinical settings, long-term follow-up to monitor complication and consequences from mercury intoxication with appropriate treatment approaches is warranted.

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