Familial chronic metallic mercury intoxication due to a broken sphygmomanometer, a case report

Louise Callewaert [a], Laurine Steurbaut [b], Luc Régal [b,c], Ann Casteels [c], Kurt Anseeuw [d]

[a] University of Ghent, Ghent, Belgium
[b] Free University of Brussels, Brussels, Belgium
[c] UZ Brussel, department of Paediatrics, Brussels, Belgium
[d] ZNA Campus Stuivenberg, Emergency department, Antwerp, Belgium

lmacalle.callewaert@ugent.be

Keywords

Chronic mercury intoxication; metallic mercury; acrodynia; DMPS; case report.

Abstract

Background. Chronic intoxication with metallic mercury is rare in children in industrialised countries and is usually accidental.

Case. We report the case of a 10-year-old boy who presented with thigh pain, maculopapular rash, acral skin desquamation and hypertension (acrodynia) and neuropsychiatric symptoms such as insomnia and behavioural changes (erethism mercurialis). In addition, four other family members showed similar symptoms. A broken mercury sphygmomanometer was found in their house. Urinalysis revealed elevated mercury levels. They were treated with chelation therapy using DMPS.

Conclusion. Knowledge of the disease is crucial for diagnosis. Prompt therapy start is necessary to avoid residual neurological damage.

Introduction

Mercury intoxication is a rare phenomenon that can occur acutely or chronically. Mercury exists in different chemical forms: elemental or metallic (Hg^0), mercurous (Hg_2^{2+}) and mercuric (Hg^{2+}). The mercuric state is found in different inorganic and organic compounds (1). Elemental mercury, also called metallic mercury or quicksilver, is found e.g. in medical measuring instruments (thermometers) and dental amalgam. Inorganic mercury is used as a preservative in vaccines (ethylmercury, thimerosal) and organic mercury is found in seafood (methylmercury) (2).

In industrialised countries, the cause of metallic mercury intoxication in children is usually accidental (2). When a source of liquid mercury breaks, toxic vapours (Hg^0) are released. These are absorbed mainly by inhalation into the lungs (80%) and thus into the bloodstream. Also, there is a minimal absorption of metallic mercury via the gastrointestinal system (10%) and the skin (1%). In pregnant women, mercury also passes transplacentally to the foetus. Hg^0 preferentially passes through the blood-brain barrier into the central nervous system. In the bloodstream, Hg^0 is oxidised to the more toxic Hg^{2+} state. From there, it spreads to several organs and leads to organ dysfunction. Consequently, organs such as adrenal glands, kidneys, liver, muscles, skin and peripheral nervous system are damaged (1).

'Acrodynia', also called 'Pink's disease', is considered a hypersensitivity reaction to mercury in young children. It involves a maculopapular skin rash with swelling and subsequent acral desquamation. There is itching, tingling and burning pain in the extremities. There are also headache, fever, anorexia, diaphoresis, hair loss and gingivitis with hypersalivation. Hypertension and tachycardia are also observed. Chronic intoxication with mercury vapours mainly results in neuropsychiatric symptoms, called 'erethism mercurialis'. Features include insomnia and asthenia, behavioural changes with irritability, memory impairment, personality changes and tremor or ataxic gait. Prenatal intoxication causes delayed foetal development resulting in neurocognitive and motor deficits (2,3).

Case presentation

Patient information

A 10-year-old boy presented to the emergency department with thigh pain, a maculopapular rash on the trunk and acral skin desquamation as chief complaints. Figure 1 shows the course of complaints over time. The complaints arose after a paucisymptomatic covid infection three months before and evolved progressively. The thigh pain was bilateral, described as pressing, and continuously bothersome. Simultaneously, a truncal maculopapular rash developed as well as swelling of the fingers and toes with subsequent skin desquamation. He further complained of hypoesthesia of the extremities and tremor of the hands. Also, there was fatigue and anorexia with weight loss. He experienced occasional frontal headaches. He had attacks of diaphoresis and generalised pruritus and, recently, hypersalivation. Psychologically, the school noted attention and concentration disorders. He had not attended school for one month because of these problems. This was also noted at home with concomitant agitation as behavioural changes and insomnia for three months.

Four other family members showed similar symptoms. The 3-year-old brother had insomnia and deteriorating behavioural changes since three months. He also presented with a rash with acral desquamation, tingling legs, pruritus, anorexia with weight loss and hair loss. The 8-year-old sister presented with anorexia, extremity pain, behavioural changes and nightmares. The 42-year-old father had complained of difficulty concentrating, irritability, insomnia and fatigue for five months. The 39-year-old mother had similar complaints as the father to a lesser extent. No visible peculiarities were found in the 8-month-old daughter.

Clinical findings

On clinical examination, the boy looked uncomfortable and dystrophic. As shown in Figure 2, a papular rash with excoriations was visible on the trunk and the skin on the hands and feet showed swelling, erythema and desquamation. Detailed general clinical examination was reassuring. A blood pressure of 140/94 mmHg and a heart rate of 150 bpm were noted. The boy was hospitalised for further investigations.

Diagnostic assessment

An infectious or toxicological cause was considered most likely as other family members displayed similar symptoms.

Except for mild leucocytosis, blood analysis was not abnormal. Inflammatory-immunological parameters (such as CRP, ESR, ferritin, immunoglobulins and complement factor) and rheumatological markers (such as RF, CCP, ANA, ANCA, ENA, CK and aldolase) were negative. Transaminases and complete blood count with differential were normal. Evaluation for infectious pathogens on urine sample, nasal swab, throat culture, serology and stool sample was negative. Blood pressure monitoring and ECG confirmed arterial hypertension and sinus tachycardia. Blood analysis for renal function, thyroid tests, aldosterone, renin and electrolytes were within normal values. Urinalysis showed elevated catecholamines, mild haematuria and no proteinuria. Abdominal ultrasound and doppler revealed neither masses nor vascular abnormalities. Toxicology screening for common heavy metals (Cu, Zn, Pb, Se, As, Tl) was negative. Furthermore, in the context of headache and behavioural problems, EEG and brain MRI were performed that were normal. To investigate the pain in the thighs, an EMG and MRI of the upper legs were done. Microscopic examination and culture of the skin showed no abnormalities.

Finally, a broken mercury sphygmomanometer was found in the garage. Mercury was then determined in a 24-hour urine collection with a positive result of 33.0 µg/g creatinine. After the diagnosis, the whole family was tested. The other children and parents also showed excessive mercury levels in the urine, see Table 1. In the blood, the mercury levels were within normal values.

Therapeutic intervention

Because of the suspicion of mercury intoxication, the family moved house to end the exposure. Mercury chelation was started with DMPS (2,3 dimercapto-1-propanesulphonic acid) intravenously 5mg/kg according to this schedule: day 1 6x/24h, day 2 4x/24h and day 3 3x/24h. From day 4 1x/24h taken orally until the urinary mercury levels normalise. As seen in Table 1, a significant increase in urinary mercury levels was observed in the children after starting chelation therapy. Levels also increased in the parents. Amlodipine at 0.67mg/kg/day provided good control of hypertension. For neuropathic pain, gabapentin at 40mg/kg/day offered relief. For the itching, desloratadine and topical corticoid cream were given.

Follow up and outcomes

The complaints decreased with treatment. Urinary mercury levels were also on a downward trend, see Table 1. The family was closely monitored and their symptoms fully disappeared.

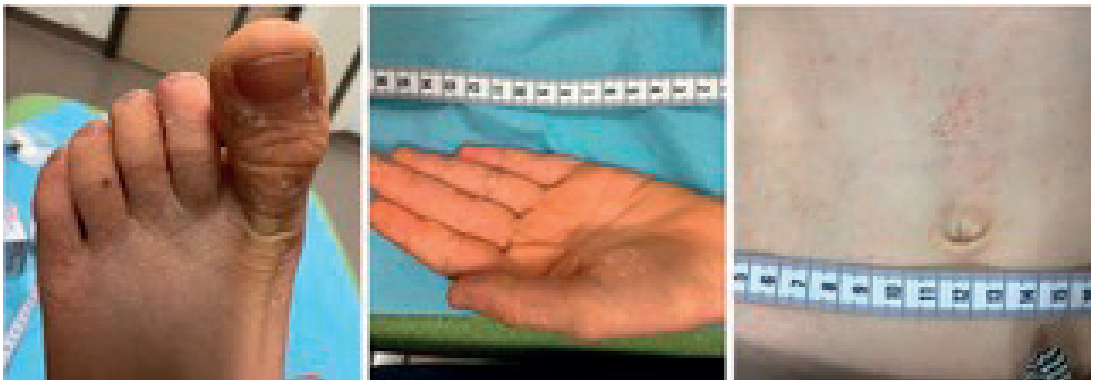
Discussion

Children are vulnerable

The urinary mercury levels were higher in the children than the parents and the children had more symptoms than the parents. Children typically have higher body concentrations at similar exposures than adults. Their vulnerability lies, on the one hand, in increased exposure to mercury vapours. Being heavier than air, they sink to the ground, hence closer to the smaller child. Children also inhale more vapours due to their higher respiratory rate. Also, they come into contact with the peculiar substance more because of their curiosity. On the other

Figure 1: Timeline: the course of complaints over time until presentation at the emergency department.

Figure 2: Pictures of acrodynia: swelling, erythema and desquamation of the acra and truncal rash.



hand, children are more susceptible to intoxications due to their still developing nervous system. Consequently, persistent neurological damage is more common in children (2,4). Note that the detection of neuropsychiatric changes in a baby can be more challenging.

Neither children nor adults should have any mercury in their bodies because it provides no physiological benefit. Prenatal and postnatal mercury exposures occur frequently in many different ways. Paediatricians, nurses, and other health care providers should understand the scope of mercury exposures and health problems among children and be prepared to handle mercury exposures in medical practice. Prevention is the key to reducing mercury poisoning.

Diagnosis

Chronic mercury intoxication is diagnosed based on environmental history, clinical presentation and response to chelation therapy (2). Normally, the urinary mercury determination is done on a 24-hour collection but for the two youngest children, a single sample was used because of practical considerations. Urine and blood mercury levels only reflect recent exposure. Therefore, they do not correlate well with disease severity. Urine mercury levels after provocation with a chelator correlate better with total body burden in the organs (1,5). For non-professional exposure, urinary values are normally <3 µg/g creatinine or <10 µg/L. For professional exposure, they increase to <30 µg/g creatinine. Values >10-20 µg/L are indicative of overexposure. All family members had elevated pre-therapy urinary mercury levels consistent with overexposure. After provocation with DMPS, there was a significant increase in urinary mercury levels in the children, implying a large body burden. See Table 1. All blood levels were within normal ranges (<10 µg/L). One explanation may be that the blood samples were taken days after the mercury exposure ended (2,6).

Chelation therapy and response

Chelation therapy aims to bind the accumulated mercury in the organs for faster renal clearance. DMPS was chosen because of its high affinity for metallic mercury, its safety and its frequent use in Europe compared to DMSA (dimercaptosuccinic acid) (1,5). The dosing schedule of UMC Utrecht antivenom centre was used (7). Therapy response was evaluated by symptom reduction and urinary mercury levels. The levels usually show an increase at therapy initiation due to release of mercury from the kidneys followed by a gradual decrease (5). Additionally, a decrease in urinary catecholamines can be expected as mercury no longer inhibits their catabolism (8).

Conclusion

Chronic mercury intoxication is rare in industrialised countries and therefore little known. Greater awareness is crucial for diagnosis,

Table 1: Mercury levels in urine and blood pre- and post-chelation therapy.

family members		10-year-old boy	8-year-old sister	3-year-old brother	8-months-old sister	39-year-old mother	42-year-old father
urine (µg/g creatinine)	pre-therapy (normal value <3 µg/g creatinine)	33.0	22.4	69.6	66.3	21.0	13.8
	post-therapy						
	day 0	2727.1	2397.6	1676.6	1035.0	57.2	34.0
	day 1	301.7	143.0	125.6	437.4	48.2	34.9
	day 3	43.7	42.2	41.3	73.9		
	day 12	29.7	23.9				
blood (µg/L)	pre-therapy (normal value <10 µg/L)	4.8	2.4	5.7	5.8	3.9	2.5
	post-therapy						
	day 2	2.3	2.5	4.7	5.2	1.7	1.2
	day 10	2.0	1.1	2.8	2.3		

saving resources, appropriate therapy and avoiding complications. In children presenting with neuropathic pain, skin rash with desquamation, insomnia, behavioural changes and hypertension, one should always consider mercury intoxication. Once the diagnosis is considered based on clinical presentation, it is easily made by urine mercury levels before and after provocation with chelation therapy. Prompt therapy start with DMPS reduces the risk of permanent neurological damage.

Informed consent

The family provided verbal informed consent for publication.

Acknowledgments

The authors gratefully acknowledge the contribution of the doctors and staff working on this case at the Paediatrics Department of the Brussels University Hospital. Also, they would like to thank the professionals contacted for toxicology advice and English translation.

Competing interests

The authors state no conflict of interests.

REFERENCES:

1. Bernhoft RA. Mercury Toxicity and Treatment: A Review of the Literature. J Environ Public Health. 2012;1–10.
2. Bose-O'Reilly S, McCarty KM, Steckling N, Lettmeier B. Mercury exposure and children's health. Curr Probl Pediatr Adolesc Health Care. 2010;40(8):186–215.
3. Clarkson TW, Magos L, Myers GJ. The Toxicology of Mercury-Current Exposures and Clinical Manifestations. N Engl J Med. 2003;18:1731–8.
4. Carman KB, Tutkun E, Yilmaz H, Dilber C, Dalkiran T, Cakir B, et al. Acute mercury poisoning among children in two provinces of Turkey. Eur J Pediatr. 2013;172(6):821–7.
5. Bjørklund G, Mutter J, Aaseth J. Metal chelators and neurotoxicity: lead, mercury, and arsenic. Arch Toxicol. 2017;91(12):3787–97.
6. Chuanyl ML.Mercury Test [Internet]. Seattle: One Care Media; 2021 [Updated 2023 Feb 02; cited 2023 March 18]. Available from: https://www.testing.com/tests/mercury/
7. Nationaal VergiftigingenInforpatie Centrum. DMPS toedienen [Internet]. Utrecht: UMC Utrecht; 2022 [cited 2023 March 18]. Available from: https://www.vergiftigingen.info/
8. Michaeli-Yossef Y, Berkovitch M, Goldman M. Mercury intoxication in a 2-year-old girl: a diagnostic challenge for the physician. Pediatr Nephrol. 2007; 22:903-906.