

Case reports

Occupational lead intoxication from terracotta tiles manufacturing: a case study

Cristina-Manuela Mocanu¹

¹Clinical Ophthalmology Emergency Hospital, Bucharest, Romania

Corresponding author

Cristina-Manuela Mocanu

mocanu.c_manuela@yahoo.com

Abstract

We report the case of a 63-year-old terracotta tiles manufacturer who presented with acute abdomen and normocytic anaemia. The patient presented with elevated levels of urinary delta-aminolaevulinic acid without any increase in the levels of urine porphobilinogen or urine coproporphyrin. Detection of elevated lead blood levels (1939 µg/dL one month before hospital admission in the occupational medicine clinic and 44.70 µg/dL at hospital admission, values come from two different laboratories) confirmed the diagnosis of chronic lead poisoning due to occupational exposure. Chelation therapy with D-penicillamine resulted in the improvement of clinical symptoms and lead blood levels. Clinicians should be aware that lead poisoning caused by occupational exposure can still occur sporadically in terracotta tiles manufacturing workers, lead poisoning being a neglected diagnosis in abdominal pain.

Keywords: *terracotta manufacturer, occupational exposure, abdominal pain, gastrointestinal symptoms, normocytic anaemia*

Introduction

Known to the ancients as early as the fourth millennium BC, lead use soared during the Roman era, when it became a health threat due to air pollution, or because of its utilization in plumbing, as household goods, or in cosmetics, medications, and paintings. Several lead products were known to the Romans, such as cerussite (lead carbonate), galenite (lead sulfide), litharge and cerusa. Litharge (lead oxide, yellow lead) was used in construction, while cerusa (lead carbonate, white lead) was an industrial product occasionally used as medicine. Romans also used lead acetate as a sweetener or for wine and food preservation [1, 2].

The amount of lead in human bones increased dramatically during the Roman era, but only to a level of 41 %–47 % of that seen in current Europeans. The lead content of bones is evaluated with the help of atomic absorption spectrophotometric analysis, and this information is used to estimate a person's total lead exposure during their lifetime. When this analysis is made, it must be considered that bone lead levels are higher in children than in adults, and in older specimens of bones than in younger ones, for a given lead intake [1, 3].

Due to these issues, lead toxicity was mentioned by Roman writers as most miners suffered from the harmful effects of lead. Therefore, Romans generally used enslaved people to work in mines, and studies

made since then estimate that hundreds of thousands died of acute lead poisoning [4, 5]. However, chronic lead poisoning was first described in the seventh century AD. [1, 6]

Case report

We present the case of a 62-year-old male patient who was admitted to a local hospital with a severe abdominal colic. From his medical history, we cite the following findings: transhiatal herniation (4 cm), erosive gastroesophageal reflux disease, grade II reflux esophagitis and chronic normocytic anaemia. On admission, he was conscious and alert, and his physical examination showed diffuse abdominal tenderness with no peritoneal signs. There were no other notable medical findings. A complete blood count revealed normocytic anaemia. Abdominal ultrasound demonstrated no abnormalities. During his stay in the general surgery ward, the patient received symptomatic therapy, analgesics and glucose 10% intravenous infusion with a significant improvement of symptoms. He was released with the recommendation of a haematological consultation. The haematologist raised the suspicion of occupational lead intoxication. The blood lead level had a value of 1939 ug/dL, indicative of occupational lead intoxication (normal range: 0 – 28 ug/dL). He was recommended hospitalization in the occupational medicine ward for treatment and future investigations.

On admission to our clinic, we reassessed the patient's occupational history. As a result, we found out that currently, the patient is the administrator of his own company, an at-home business, where he is not only

involved in the administrative part of his business, but he also participates in the manufacturing process of terracotta tiles, namely in the glazing of terracotta tiles.

Terracotta tiles are made from a mixture of clay, quartz sand and water. This mixture is homogenized in a sealed mixer, poured into plaster moulds, and allowed to dry at room temperature for two weeks. The second layer of kaolin, quartz sand and water is poured over the dry products and will form the front face of the tiles. The glazing of terracotta tiles is done on dry (unburned) tiles. The glaze paste is composed of the following ingredients: litharge, quartz sand, kaolin, water, and it is obtained by mixing for two days these ingredients in an airtight mixer with the help of porcelain balls. After the preparation is done, the mixture is stored in barrels. This process is performed every two months. The paste thus obtained is poured with the help of a cup on the surface of the terracotta tiles, and it is left to dry for an hour. The glazed pieces are then placed in the electric oven on separate shelves (oven capacity: about 150 pieces). The baking of the terracotta pieces lasts 17 hours. The maximum temperature reached during baking is 900 Celsius degrees (the temperature increases every hour). During this process, the patient wore a simple mask and not a specialized one for his work. Furthermore, he mentions eating in the same room as the oven.

We reassessed the findings of the patient's physical examination and retook all laboratory tests. The clinical examination revealed the presence of Burton's line, a 2 mm wide blue-purple line bordering the upper gums, skin pallor, diffuse arthralgias (present especially in the lower limbs, diminished by local pressure and accentuated by movements), diffuse abdominal sensitivity.

Table 1. Laboratory data on Admission

Blood cell count	Value	Normal range
White blood cells	6.14	4.00 – 11.00 *10 ³ /μL
Red blood cells	3.80	4.50 – 6.20 *10 ⁴ /μL
Hemoglobin	10.80	12.30 - 17.00 g/dL
Mean corpuscular volume	85.30	80.00 - 100.00 fL
Mean corpuscular haemoglobin concentration	28.40	27.00 - 32.00 pg
Red cell distribution width	17.10	10.00 – 15.00 %
Nucleated red blood cells	0.51	0.00 – 0.00 *10 ³ /μL
Nucleated red blood cells	0.20	0.00 – 0.00 %
Platelet	302.00	150.00 – 450.00 *10 ³ /μL

As depicted in Table 1, the complete blood cell count showed the presence of normocytic, normochromic anaemia, with a haemoglobin level of 10.80 g/dL (normal range: 12.30-17.00 g/dL), a mean corpuscular volume of 85.30 (normal range: 80.00-100.00 fL) and mean corpuscular haemoglobin concentration of 28.40 (normal range: 27.00-32.00 pg). There was

noted the presence of nucleated red blood cells. The white blood cell count, as well as the platelet count, were normal. The serum iron, as well as ferritin, were normal (Table 2). The peripheral blood smear showed anisocytosis, red blood cells with basophilic stippling, and the rare presence of teardrop-shaped red blood cells. The Coombs' Test was negative.

Table 2. Laboratory data on Admission

Biochemistry	Value	Normal range
<i>C-reactive protein</i>	0.52	mg/dL
<i>Aspartat aminotransferase</i>	21.40	0.00 – 40.00 IU/L
<i>Alanine aminotransferase</i>	35.40	0.00 – 41.00 IU/L
<i>Lactate dehydrogenase</i>	163.90	100.00 – 200.00 IU/L
<i>γ-glutamyl transferase</i>	54.00	10.00 – 61.00 u/L
<i>Blood urea</i>	62.80	17.40 – 40.00 mg/dL
<i>Uric acid</i>	5.10	3.40 – 7.00 mg/dL
<i>Amylase</i>	106.00	28.00 – 100.00 U/L
<i>Creatinine</i>	1.00	0.70 – 1.20 mg/dL
<i>Iron</i>	114.20	55.00 – 150.00 µg/dL
<i>Ferritin</i>	378.00	30.00 – 400.00 ng/mL

The lead blood level on admission to our clinic was 44.70 ug/dL (normal range: 0 – 25 ug/dL). The urine levels of lead, delta-aminolaevulinic acid, uroporphyrin, coproporphyrin and total porphyrin

were also recorded. As shown in Table 3, this revealed elevated urine lead levels of 210 ug/dL (normal range: 0 – 100 ug/dL) and elevated delta-aminolaevulinic acid 13.40 (normal range: 0 – 5 ug/dL).

Table 3. Laboratory data on Admission

Test	Value	Normal range
<i>Serum-lead</i>	44.70	0.00 – 25.00 µg/dL
<i>Urine lead</i>	210.00	0.00 – 100.00 µg/L
<i>Urine δ-aminolevulinic acid</i>	13.40	0.00 – 5.00 mg/L
<i>Uroporphyrin</i>	15.80	0.00 – 25.00 µg/L
<i>Coproporphyrin</i>	71.10	0.00 – 100.00 µg/L
<i>Total porphyrin</i>	86.90	0.00 -125.00 µg/L

The final diagnosis was that of chronic lead intoxication due to occupational exposure to lead vapours. There was also noted the presence of asthenoneurotic syndrome (insomnia, fatigue, anorexia), digestive syndrome (nausea, anorexia, Burton's line, diffuse abdominal sensibility), pseudo-rheumatic syndrome (diffuse arthralgias, present especially in the lower limbs, diminished by local pressure and accentuated by movements) and anaemic syndrome (normocytic, normochromic anaemia, anisocytosis, red blood cells with basophilic stippling).

Chelation therapy was initiated at admission. D-Penicillamine was given orally at a dose of 1000 mg per day, for 9 days, in association with bilastine and i.v. perfusions with glucose, C vitamin, benfotiamine and pyridoxine hydrochloride. After the commencement of chelation therapy, the patient's haemoglobin levels improved to 11.50 g/dL compared with 10.80 g/dL at admission. The blood lead level also improved, the value at hospital discharge being 29.70 ug/dL (normal range: 0 – 25 ug/dL). The patient's prognosis at discharge is positive, given the absence of neurological complications and renal failure.

Discussion

The case herein presented and its clinical presentation, which includes abdominal colic and normocytic anaemia, raise several clinical and public health issues regarding occupational lead poisoning. Foremost, it is worth mentioning that, even though lead poisoning is a rare diagnosis, it can still occur in specific work environments, as is the case of terracotta workers, a craft still greatly practised in some areas of today's Romania, this being the reason why occupation-related questions should always be a part of a thorough clinical examination. One of the reasons why occupational lead intoxications can still occur is poor compliance with safety regulations. A 2014 lead-safety guide published by the Health and Safety Authority [7] clearly states that personal protective equipment, which includes respiratory protective equipment (RPE), barrier cream, gloves, eye protection, safety footwear and disposable overalls should be used when working with lead.

Occupational lead exposure generally occurs through inhalation of toxic lead vapours and in a smaller quantity through the oral route, and its clinical manifestations greatly vary depending on the absorbed dose of lead. In our case, the respiratory tract was thought to be the main route of contamination, and with a smaller contribution, intoxication due to ingesting meals in a lead-contaminated environment

was also thought to be present.

Another keystone in lead intoxication diagnosis is the history of lead exposure, as lead is an inorganic compound with a long body half-life, and in intermittent exposure, as in our case, where the glazing of the terracotta tiles is done roughly every two months, the current blood lead levels reflect both recent and past lead exposures [8]. Other ways of significant lead exposure, that might adversely affect patients already exposed to lead in their work environments, include consumption of vegetables from family gardens, contact with interior lead paint dust, smoking and home-distilled alcoholic beverages such as "țuică", a traditional Romanian hard liqueur [9]. In our case, the patient is a non-smoker known to consume occasionally "țuică" made at home.

As seen in Figure 1, the mechanism of lead poisoning is complex, and it is based on lead's ability to bind and alter proteins' function, such as the enzymes involved in heme biosynthesis, which can lead to misdiagnosis [10]. Lead inhibits ferrochelatase and δ -aminolevulinic acid dehydratase, increasing free erythrocyte protoporphyrin and leading to an overproduction of δ -aminolevulinic acid, which is associated with a normal level of porphobilinogen [9]. On the other hand, in acute intermittent porphyria, a potential differential diagnosis for lead poisoning, porphyrin is not altered, thus an overproduction of δ -aminolevulinic acid and porphobilinogen takes place, as they are both precursors of porphyrin, this being the reason why testing for heme precursors is key when a differential diagnosis is made [11-13]. In our case, the laboratory tests were indicative of lead intoxication and not porphyria, which was confirmed through increased blood lead levels.

The anaemia present in occupational lead intoxication, which is a result of the medullary suppression of erythropoiesis, as well as the lead's direct effect on red cell membranes and enzymes, may be microcytic or, as in our case, normochromic normocytic. The presence of hemolytic anaemia has been excluded through a negative direct Coombs test. Another important paraclinical finding for our case was the presence of basophilic stippled red blood cells in the peripheral blood smear, which is caused by the lead-induced damaging of erythroblasts' mitochondria and ribosomes. However, while this finding is very common in lead intoxication, it can also be found in other pathologies such as thalassemia, vitamin B12 deficiency, and pyrimidine 5' nucleosidase deficiency, all being forms of microcytic anaemia [14,15].

Figure 1. Heme biosynthesis [10]

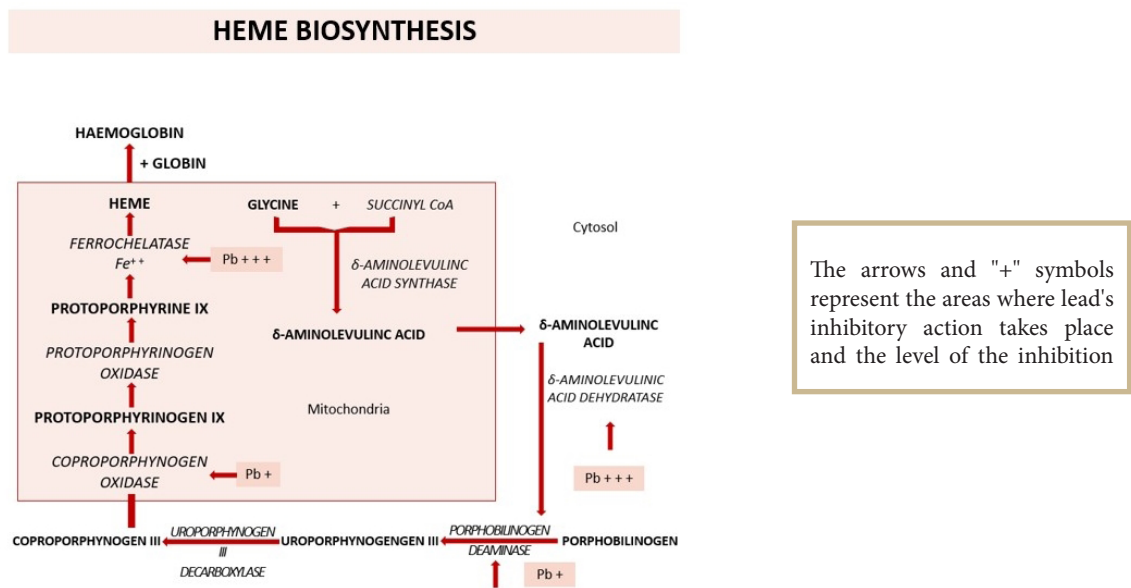
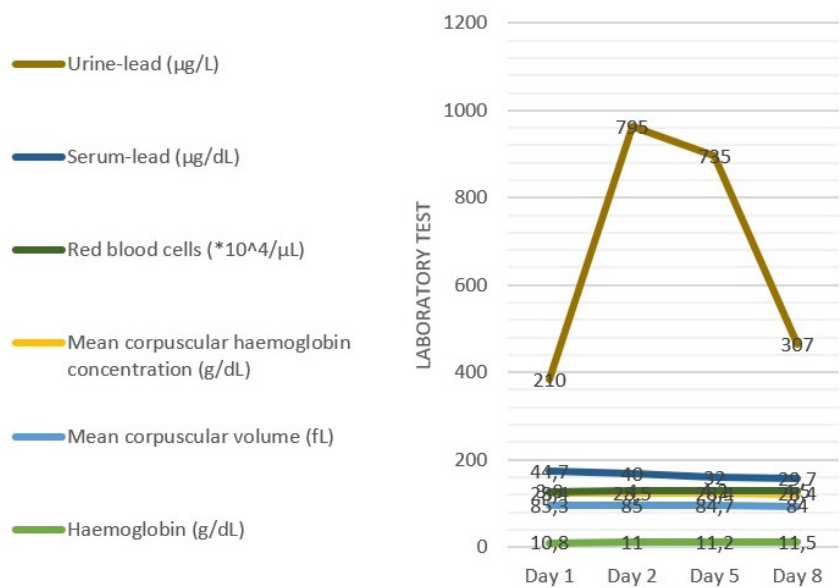


Figure 2. Clinical course under treatment



Abdominal pain is frequently the presenting symptom of lead poisoning, as was in our case. However, due to its broad differential diagnosis, lead intoxication is rarely considered, with 20% to 40% of all abdominal pain causes remaining undiagnosed at discharge [16]. A 2020 study on 125 patients called “Lead poisoning; a neglected potential diagnosis in abdominal pain” [17] stressed the importance of considering lead toxicity a potential differential

diagnosis in patients with severe and resistant abdominal pain when anaemia is associated. A positive correlation between lead toxicity and the consistency and intensity of abdominal pain was also highlighted [17], which explains why, when taken out of the toxic work environment, the patient’s symptoms ameliorated in absence of an etiological treatment.

The route of treatment recommended for lead

intoxication is chelation therapy. While EDTA is generally recommended, D-penicillamine (Cuprimine) can be given at lead levels of around 45 µg/dL, being an efficacious and safe option [18]. In our case, D-penicillamine was given orally at a dose of 1000 mg per day, for 9 days, in association with bilastine and i.v. perfusions with glucose, C vitamin, benfotiamine and pyridoxine hydrochloride. As shown in figure 2, after the commencement of chelation therapy, the patient's haemoglobin and blood lead levels improved,

the patient's prognosis at discharge was positive, given the absence of complication

In conclusion, the present case highlights both the importance of occupation-related questions in a thorough clinical examination, as well as the need for lead intoxication to be more broadly considered in the differential diagnosis of severe, unresponsive to treatment abdominal pain, especially when anaemia is associated.

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