Increased Urine Chromium Concentrations in a Worker Exposed to Lead Chromate due to the Intake of Medical Herbs

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ABSTRACT

We describe the case of a worker exposed to lead chromate who presented high concentrations of chromium in urine (until 62 µg/l before working day and 52 µg/l the end of the working day). The environmental chromium concentrations in the workplace were below 0.5 µg/ m^3. In view of the results, a full study was made of the patient's habits outside work. He reported having bought a kilo of a medicine herb infusion at a street market three weeks previously. The concentration of total chromium in a prepared infusion was 12000 µg/l. The patient stopped consuming medicinal herb. Subsequently, the urine chromium analysis were below 0.5 µg/l. It Is important to provide advice to workers and the investigate their habits outside work, especially when the environmental and biological values are discordant.

Keywords: lead chromate; occupational risks, occupational medicine; medicinal herbs.

1. INTRODUCTION

Chrome VI or Cr (VI) compounds include a large group of chemicals with varying chemical properties, uses, and workplace exposures. Their properties include corrosion-resistance, durability, and hardness.Workers may be exposed to airborne Cr(VI) when these compounds are manufactured from other forms of Cr (e.g., the production of chromates from chromite ore); when products containing Cr(VI) are used to manufacture other products (e.g., chromate-containing paints, electroplating); or when products containing other forms of Cr are used in processes that result in the formation of Cr(VI) as a by-product (e.g., welding). In the marketplace, the most prevalent materials that contain chromium are chromite ore, chromium chemicals, ferroalloys, and metal. Sodium dichromate is the most common chromium chemical from which other Cr(VI) compounds may be produced. Cr(VI) compounds commonly manufactured include sodium dichromate, sodium chromate, potassium dichromate, potassium chromate, ammonium dichromate, and Cr(VI) oxide. Other manufactured materials containing Cr(VI) include various paint and primer pigments, graphic arts supplies, fungicides, and corrosion inhibitors (CDC and NIOSH,2013).

Hexavalent chromium compounds are sensitizers of both the skin and the lung. They produce a generalized irritation of the conjunctiva and mucous membranes, nasal perforation (Sanz P et al, 1989; Barceloux DG, 1999), contact dermatitis (Barceloux DG, 1999; Hartwing A et al, 2017), and lung and Sinonasal cancer (Davies JM, 1984; Ambroise D et al, 2006; Sorensen AR et al, 2017; Commiati V et al, 2017).

Ingestion of hexavalent compounds usually leads to abdominal pains, vomiting, diarrhoea, and intestinal bleeding (Sanz P et al, 1991; Barceloux DG,1999). In many cases, death occurs during the circulatory collapse (Loubières Y et al, 1999).

We describe the case of a worker exposed to lead chromate who presented high concentrations of chromium in urine. It is important to study the occupational exposure and the non-occupational exposure.

2. MATERIALS AND METHODS

We describe the case report of a worker exposed to lead chromate who presented high concentrations of chromium in urine.

A study of chromium environmental concentration in the workplace was made. Also, an occupational medical examination with a collection of the activities inside and outside the workplace, inclusion of eating habit, and a blood lead, urine chromium at the beginning and end of the workday was performed.

3. RESULTS

A 56-year-old man with no history of medical interest, non-smoker, sporadic consumer of alcoholic beverages.

For 11 years, he had been working in a factory that manufactures pigments and additives for chemical industry (paints, textiles, leather, ceramics, dyes, agrochemicals, and others). Most of the components of these pigments are organic, but the factory also produces some inorganic pigments such as lead chromate. The patient spent 12 hours a week (six hours per day, two days a week) producing lead chromate.

An occupational medical examination detected a blood lead level of 6 µg/dL (Spanish biological limit value (BLV): 70 µg/dL of INSST,2019) and a urine chromium level at the end of the working day of 52 µg/L (BLV at the end of working week: 25 µg/ L of INSST,2019); blood and urine creatinine were in the normal range. Due to the high concentrations of chromium in urine, we reviewed the working conditions and individual protection equipment. The environmental chromium concentrations in the workplace were below

0.5 µg/m ^{3} (Environmental Limit Value in Spain for lead chromate:12 µg/m ^{3}).

A new analysis of chromium in urine was made before and after work (to determine the increase during the working day) found levels of 62 µg/L before and 6 µg/L after finishing work. The tests were repeated a week later, yielding results of 41 µg/L before and 37 µg/L after work.

In view of these results, a full study was made of the patient's habits outside work. He reported having bought a kilo of a medicinal herb infusion (Equisetum Arvense, also known in Spain as "horse's tail") at a street market three weeks previously. Since then, he had consumed 300-500 mL /day of this infusion. The concentration of total chromium in a prepared infusion was 12000 µg/L, while the concentration of total chromium in hot water before introducing the herb was 4 µg/L (in Spain, the reference value of chromium in drinking water is less than 50 µg/L).

The patient stopped consuming Equisetum Arvense. After this, the urine chromium analysis was repeated before and after work, and in both cases the results were below 0.5 µg/L

4. DISCUSSION

Soluble chromium compounds are absorbed via cutaneous, digestive and respiratory routes. Hexavalent chromium easily penetrates cell membranes, reducing to trivalent chromium. More than 80% is eliminated through the renal pathway. The urinary half-life of hexavalent chromium ranges from 15 to 41 hours (Tossavainen A et al, 1980).

For the biological control of exposed workers, urine chromium concentrations are determined at the end of the working week and also before and after the working day in order to determine the increase in chromium during the working day. The maximum acceptable urine value is 25 µg/L (at the end of the work day) and the difference between before and after work should not exceed 10 µg/L (INSST, 2019) .

The urine chromium values of several European countries are expressed in Table 1.

Table 1. Hexavalent chromium biomonitoring values according to country (adapted from: Hartwing A et al, 2017)

Term	Biomonitoring Values	Country
BLV[a]	End of week 2.5 µg/L	France
VBR[b]	0.65 µg/L	France
BAR[c]	0.6 µgL (total chromium)	Germany
BMGV[d]	10 µmol/ mol creatinine in urine (post shift)	UK
BAT[e]	11 µg/L	Switzerland
BLV[a]	Total chromium increase in urine during one shift 10 µg/L; at the end of the workweek 25 µg/L	Spain

[a]BLV (Biological Limit Value), [b]VBR (Valor Biologique de Reference) Biological Reference Value, [c]BAR (Biologischer-Arbeitsstoff Referenzwert)Biological Reference Value, [d]BAT (Biologische Arbeitsstofftoleranzwerte)biological occupational chemical tolerance level, [e]BMGV (Biological Monitoring Guidance Value).

Equisetum Arvense is a medicinal herb used mainly due to its diuretic properties.

In our case, this worker had high concentrations of chromium in the urine. As these concentrations were high before the working day, an investigation was conducted and a high consumption of Equisetum Arvense was detected. The chromium concentrations in the infusion were analyzed and found to be very high. Consumption was withdrawn and in the following analytical control the urine chromium concentrations were within the normal limits and were consistent with the environmental concentrations in the workplace.

The consumption of infusions as common as tea (Camellia Sinenses L) can increase chromium concentrations in biological liquids, (Barman T, 2019), provide extensive research on the detection of arsenic and chromium in this type of plant. The concentration of Chromium among some tested black tea samples varied from 0.62 to 36.76 µg/g with a mean and median of 10.33 µg g−1 and 8.33 µg g−1, respectively (Barman T et al, 2019).

This case is interesting because it demonstrates that the consumption of medicinal herbs can interfere with biological controls carried out in workers exposed to hexavalent chromium compounds. This may produce confusion and may also cause legal problems for companies and workers.

5. CONCLUSIONS

It is important to provide advice to workers and to investigate their habits outside work, especially when the environmental and biological values are discordant. It is also important to stress the risks involved in buying medicinal plants in street markets since there is no quality control of the products on sale there.

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