CASE REPORT

A case report of elevated blood cadmium

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Abstract A 45-year-old male paint technician was identified as having an elevated whole-blood cadmium of 5.9 μg/l (Occupational and Safety Health Administration reference range for workers: ≤5.0 μg/l) through a routine workplace biological monitoring programme. Other than smoking 1.5–2 packs of cigarettes daily for 23 years, no additional non-occupational exposures to cadmium were identified. Whole-blood cadmium results taken 5, 4 and 2 years earlier were 3.1, 4.0 and 4.3 μg/l, respectively. After reassignment to a position without cadmium exposure, his whole-blood cadmium level 7 weeks later was 6.1 μg/l. A careful exposure history revealed that he had recently changed the brand of cigarettes he smoked. When he switched back to his original brand and reduced his consumption to one pack per day, his cadmium level fell to 2.9 μg/l taken 12 weeks after the initial elevated result. Eight weeks after returning to his original position with cadmium exposure, the value was 3.4 μg/l. No elevation in urine cadmium was noted at any point. An analysis of the tobacco revealed that the cadmium content of the new brand was almost 1.5-fold greater than the original brand. These results suggest that the consumption of different brands of cigarettes can lead to marked variations in whole-blood cadmium levels.

Key words Blood sampling; cadmium; cigarette smoking; metal imbalance; tobacco constituents.

Introduction

Cadmium is present in the work environment from paints and metals. Cadmium is also present in cigarettes with a variation depending on the cadmium content of the soil where the tobacco was grown. We report a case of elevated whole-blood cadmium of a painter who is also a cigarette smoker.

Case report

This report describes a 45-year-old smoking male paint technician identified with an elevated whole-blood cadmium of 52.5 nmol/l (5.9 μg/l) [Occupational and Safety Health Administration (OSHA) biological limit for workers ≤44.5 nmol/l (5.0 μg/l)] through a routine workplace monitoring programme. His work involved spraying paint containing insoluble cadmium sulphide pigment onto jet aircraft. At all times during painting, he used a supplied air respirator using a hood.

From October 2000 through December 2003, the cadmium level in the technician’s blood ranged from 27.6 to 38.3 nmol/l (3.1–4.3 μg/l). In April 2005, the level rose to 52.5 nmol/l (5.9 μg/l), and because of potential work exposure, he was medically redeployed to another job without cadmium exposure. Despite this move, his blood cadmium remained elevated at 54.3 nmol/l (6.1 μg/l) 7 weeks later. Other than smoking 1.5–2 packs of cigarettes daily for 23 years, no additional non-occupational exposures to cadmium were identified. No elevation in urine cadmium, urine β-2 microglobulin, blood creatinine or urea levels was noted at any point.

A careful exposure history revealed that he had recently changed the brand of cigarettes he smoked. When he switched back to his original brand and reduced his consumption to one pack per day, his blood cadmium level fell to 25.8 nmol/l (2.9 μg/l) taken 12 weeks after the initial elevated result. Eight weeks after returning to his original position with cadmium exposure, the value was 30.2 nmol/l (3.4 μg/l). All blood cadmium levels are summarized in Figure 1.

Biological analysis was conducted for blood cadmium by inductively coupled plasma–mass spectrometry. The reference interval for blood cadmium for non-smokers is 2.7–10.7 nmol/l (0.3–1.2 μg/l), for smokers is 5.3–34.7 nmol/l (0.6–3.9 μg/l) and for occupational exposure the OSHA cadmium standard is 44.5 nmol/l (5.0 μg/l) cadmium in whole blood. Fractions of tobacco, paper and filter material for both old and new brands of cigarette samples were analysed for arsenic, cadmium, chromium, nickel, lead and selenium by inductively coupled plasma–atomic emission spectroscopy.

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When comparing the new brand with the old brand of cigarette, the only real difference was in the cadmium content of the tobacco. An average cadmium concentration of five samples each of the old brand [0.833 μg/g ± standard deviation (SD) 0.038] compared to the new brand of tobacco (1.22 μg/g ± SD 0.081) showed that the new brand had a greater cadmium concentration, on average, of 0.397 μg/g of sample. The new brand of cigarette was tested from the same pack that the paint technician had been smoking at the time of the elevation in blood cadmium, and the old brand of cigarette was purchased over the counter. These results suggest that the consumption of different brands of cigarettes can lead to marked variations in whole-blood cadmium levels.

Discussion

We conclude that the elevated blood cadmium levels were the result of switching brands of cigarettes to a brand with 0.397 μg/g greater cadmium levels in the tobacco because the technician’s blood cadmium level had been stable and below the OSHA limit for several years, because removal from the potential cadmium exposure did not reduce recently elevated levels and because return to the original brand of cigarettes and reduction in consumption did reduce the levels to the previous range.

The importance of cigarette smoking as a potential source of cadmium exposure was first recognized 37 years ago. It is now well established that smoking may represent the single greatest cadmium exposure source for the general population, with current smokers showing levels in blood, renal cortex and adipose tissue several times that of non-smokers [1,2]. The health effects of cadmium from smoking are not known. However, cadmium is a Group 1 carcinogen according to International Agency for Research on Cancer and a nephrotoxin [3].

While the concentration of cadmium in the tobacco from the new brand is within previously reported ranges, this is the first report to our knowledge implicating a specific brand as the potential cause of significant variation in blood cadmium levels of a smoker.

More recently, it has been observed that, unlike other metals, the cadmium content of cigarettes shows marked variations depending upon the geographical origin of the tobacco. One study reported >11-fold differences between brands of different countries (0.29–3.38 μg/g) [1]. To a greater extent than most other pollutants, cadmium is readily taken up from the soil by the tobacco plant. Our findings, in which there was little variation in the content of other measured elements, confirm this conclusion. Therefore, differences in cadmium concentrations in cigarettes are largely reflective of the cadmium content of the soil in which the tobacco is grown. Elevations have been attributed to generalized pollution and the use of municipal sewage as fertilizer [4]. Unfortunately, because cigarette manufacturers routinely blend tobacco from many different countries of origin, it is not possible to identify the region with an elevated level of cadmium in soil.

These results suggest that the consumption of different brands of cigarettes can lead to marked variations in whole-blood cadmium levels including elevation above OSHA biological limits. Occupational health professionals should inquire not only about the amount of tobacco consumption but also about the specific brand usage when taking an exposure history for cadmium. Since quitting is the only proven strategy to reduce the risk of smoking, all smokers should be advised to seek assistance in smoking cessation. Additionally, the levels of cadmium and other toxic compounds in cigarettes and other tobacco products should be minimized [5].

Disclaimer

The findings and conclusions of this paper are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

Key points

- Although smoking is well recognized as a potential cause of elevated blood cadmium levels, it is less widely known that the cadmium content in tobacco varies markedly.
- We report a case in which a worker’s blood cadmium rose above regulatory limits for medical removal, most likely as a result of a change in the brand of cigarettes smoked.
- Occupational health physicians should not only inquire about the amount of cigarettes smoked but also about the recent changes in cigarette brands during the exposure assessment for cadmium.
Conflicts of interest

None declared.

References