



Assessment of nickel and cobalt release from 200 unused hand-held work tools for sale in Denmark – Sources of occupational metal contact dermatitis?

Jacob P. Thyssen ^{a,*}, Peter Jensen ^a, Carola Lidén ^b, Anneli Julander ^b, Morten S. Jellesen ^c, Torkil Menné ^a, Jeanne D. Johansen ^a

^a National Allergy Research Centre, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, DK-2900 Hellerup, Denmark

^b Institute of Environmental Medicine, Karolinska Institutet, SE-171 77 Stockholm, Sweden

^c Department of Mechanical Engineering, Technical University of Denmark, Kgs. Lyngby, Denmark

ARTICLE INFO

Article history:

Received 7 June 2011

Received in revised form 11 July 2011

Accepted 25 July 2011

Available online 1 September 2011

Keywords:

Nickel allergy

Cobalt allergy

Allergic contact dermatitis

Public health

Work tools

ABSTRACT

Introduction: Nickel and cobalt allergy remain frequent in dermatitis patients. It is important to determine possible nickel and cobalt exposures at work as these may offer important information to regulators and physicians who perform patch testing. Clinical relevance of metal exposure is usually assessed by the treating physician via the medical history and by presentation of allergic contact dermatitis.

Objectives: To screen unused non-powered hand-held work tools for nickel and cobalt release by using colorimetric spot tests.

Materials & methods: A random selection of 200 non-powered hand-held work tools for sale in 2 retailers of home improvement and construction products were analyzed qualitatively for metal release using the colorimetric nickel and cobalt spot tests.

Results: Nickel release was identified from 5% of 200 work tools using the dimethylglyoxime (DMG) test. In 8 of 10, positive results were located to the metal ring that acts like a cuff and is located at the end of the grip. The positive DMG test results were not related to specific categories of work tools. The cobalt spot test gave no positive test reactions.

Conclusions: It appears that the proportion of work tools that release nickel, in amounts that may result in allergic nickel dermatitis, has decreased markedly, when results were compared with a Swedish study performed more than a decade ago. No cobalt release was detected but it should be underscored that hard-metal tools were not examined. Other sources of cobalt may explain the relatively high levels of cobalt allergy in dermatitis patients.

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1. Introduction

In Denmark, nickel allergy is common in women from the general population as well as in dermatitis patients (Thyssen et al., 2009a, 2009b). We have previously investigated consumer nickel exposure and shown that nickel is often released in high concentrations from jewellery, hair clasps and mobile phones (Thyssen et al., 2008, 2009c, 2010b). Also, 565 unused non-powered hand-held tools were investigated for nickel release in Sweden in the late 1990's by using the dimethyl glyoxime (DMG) test and it was found that 27% had metal parts that were positive (Lidén et al., 1998). These observations may partly explain the persistence of nickel allergy despite regulatory intervention (Thyssen et al., 2011). Patch test reactivity to cobalt is often observed in dermatitis patients and occasionally in the general

population (Thyssen et al., 2009a, 2009b). We recently showed that cobalt release was infrequently encountered when jewellery was examined with a novel cobalt spot test (Thyssen et al., 2010a). To explain the high prevalence of cobalt allergy in dermatitis patients, other sources of cobalt exposure should be identified.

Occupational exposure to nickel and cobalt has been investigated on several occasions. A visit to 3 different plating firms revealed that 30 cold impregnated aluminium plates gave positive DMG test reactions (Lidén, 1994). Staton et al., found high levels of nickel on the fingers in nickel platers and nickel refinery workers but low levels in cashiers, shop assistants, bar staff and hairdressers (Staton et al., 2006). A recent Danish study showed that 1 of 200 scissors and 7 of 13 crochet hooks were DMG test positive, when random hairdresser salons in Copenhagen were visited (Thyssen et al., 2009d). Also, the study showed that the prevalence of nickel allergy was high in hair dressers but it was concluded that was mainly caused by consumer nickel exposure. Using the acid wipe sampling technique (Lidén et al., 2006), deposition of nickel and cobalt on the hands was examined in carpenters, locksmiths, cashiers and secretaries after normal work

* Corresponding author at: National Allergy Research Centre, Department of Dermato-Allergology, Copenhagen University Hospital Gentofte, University of Copenhagen, Ledreborg Allé 40, 1. 2820 Gentofte, Denmark. Tel.: +45 3977 7307; fax: +45 3977 7118.
E-mail address: jacpth01@geh.regionh.dk (J.P. Thyssen).

routines (Lidén et al., 2008). Nickel deposition was highest in locksmiths followed by carpenters, cashiers, and secretaries while the amount of cobalt was much smaller in all groups. Another study, in a metal industry, found high nickel skin deposition in workers from the thermal application department whereas high deposition of cobalt was identified in workers performing dry sharpening of tools as they handled items made of tungsten carbides containing cobalt (Julander et al., 2010). Also, cobalt-containing hard metal alloys with different surface coatings released cobalt in chemical analysis and elicited allergic cobalt dermatitis in cobalt allergic patients (Julander et al., 2009). It has been shown that repeated daily exposure to low nickel concentrations on the hands of patients with hand eczema and nickel allergy result in inflammatory skin changes (Nielsen et al., 1999). The present study aimed to screen unused non-powered hand-held work tools for nickel and cobalt release by using two different colorimetric spot tests. No special tools were examined. The investigation was done to estimate the risk of developing nickel and cobalt dermatitis on the hands in workers and consumers frequently using ordinary work tools.

2. Materials and methods

2.1. Identification and test strategy

Two of the largest retailers of home improvement and construction products and services in Denmark (Bauhaus Danmark A/S, and Silvan A/S) were contacted and informed about the study purpose. A visit was arranged to big-box format stores of each retailer in the Copenhagen area on separate days. The investigator (P.J.) was granted access to the work tools sections and performed nickel and cobalt spot testing on selected work tools. Work tools were typically purchased by professional as well as non-professionals but none were special tools. The selection was made from non-powered hand-held tools with metallic parts that come into prolonged or repeated contact with the skin during normal use. Tools with metallic grips, handles or parts located where hands and fingers will touch during normal use were examined. No screwdrivers, garden tools or kitchen tools were examined. Also, we tried to include as many different categories of tools and brands as possible. Only one tool, from a series of identical tools in different sizes, was examined. Cutting tools made of hard-metals were not included. Nickel and cobalt spot testing was performed at separate spots close to each other, and never at the same spot to avoid false positive reactions. Overall, a wide selection of tools from different brands including Millarco, Toolmate, Black & Decker, Piranha, Stanley, Kaufmann, Hultafors, Matador, DBL, Craft, Kitline, Stannol, Nows, Irwin, Wisent, Stabila, Bessey, Craft, Rothenberger, Bahco, Stabila, Kirchen, Hawe, Alpha-tools, Knipex, Wera, Comfort, Jung, Henkelmann, Heka, Pariere, EDMA, Körner and Collomix were tested.

2.2. Nickel testing

The DMG nickel spot test was prepared by a hospital pharmacy in the Capital Region of Copenhagen. The test solutions were 1% DMG in alcohol, and 10% ammonium hydroxide in water. The test was administered by placing two drops of each solution in succession on a white cotton stick that was rubbed for up to 20 s against the test object. A positive reaction was indicated by pink coloration (indicating release of nickel ions) of the cotton stick, whereas a negative reaction was registered when no colour change was observed (Fig. 1). Doubtful reactions, defined as very weak pink reactions or discoloration possibly masking a pink colour, were retested and if the reaction remained doubtful it was not recorded as positive.

2.3. Cobalt testing

A cobalt test based on nitroso R salt was prepared by the Department of Mechanical Engineering, Technical University of Denmark, Lyngby (Thyssen et al., 2010a). A white cotton stick was dipped in the cobalt test solution, a clear yellow solution, and was then rubbed for 30 s against the test item. If the cotton stick changed color from yellow to red, it indicated that cobalt ions were released in concentrations that may elicit positive patch-test reactions in cobalt allergic patients (Thyssen et al., 2010a) (Fig. 1).

3. Results

A total of 140 and 60 non-powered hand-held work tools from Bauhaus and Silvan, respectively, were tested for nickel and cobalt release. DMG testing was positive in 10 (5%) of the tools (Table 1). These were all for sale in Bauhaus. In 8 of these, the DMG test positive spot was located to the metal ring that acts like a cuff and is located at the end of the grip (Fig. 2). Thus, a positive DMG test was not related to specific categories of work tools but to some of the metal rings. No association with price was identified. Also, no specific brands were associated with nickel release. No doubtful reactions were observed. The cobalt spot test gave no positive reactions.

4. Discussion

This study showed that nickel was released from 5% of 200 unused non-powered hand-held work tools examined with the DMG test (Table 1). This screening test becomes positive, as indicated by pink coloration of a white cotton stick (Fig. 1), when an item under investigation releases nickel in amounts that may result in allergic nickel dermatitis in sensitized individuals. A recent study showed that the specificity of the DMG test (98%) is high whereas the sensitivity is moderate (59%) (Thyssen et al., 2010b). When our finding is compared with a previous study investigating nickel release

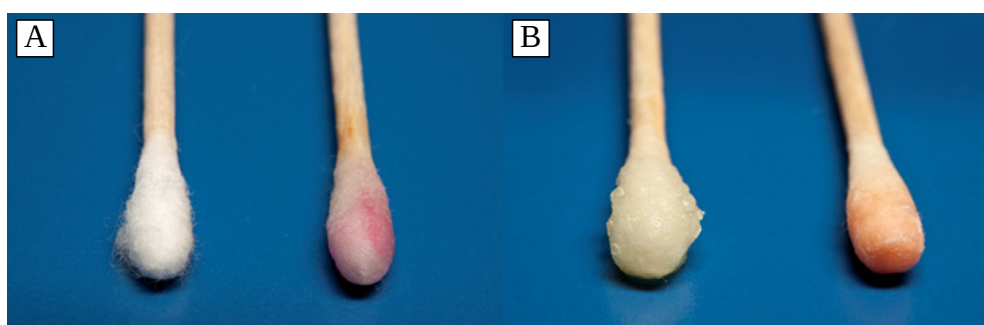


Fig. 1. A (Nickel test): A negative dimethylglyoxime (DMG) test reaction was registered when no colour change was observed after rubbing the stick for 20 s against the tool under investigation (left stick) whereas a positive reaction was indicated by pink coloration of the white cotton stick after rubbing indicating release of nickel ions (right stick). B (Cobalt test): The clear yellow cobalt-test solution was added on the tip of a white cotton stick, which was then rubbed for 30 s against the test item. If the cotton stick remained yellow (left stick), it indicated a negative reaction whereas a color change from yellow to red indicated release of cobalt ions (right stick).

Table 1

200 non-powered hand-held work tools were tested for nickel release using the dimethylglyoxime (DMG) test.

Tool category	Number of tested tools	DMG test-positive tools	
		No.	Type of tool
Cutting tools	27	2	Tile cutter Mitre saw
Pliers	26	5	Tile saw Hacksaws ($n = 2$) Marquetry saw Bow saw
Measuring tools	17		
Spanners	14		
Clamping tools	22		
Striking tools	24		
Hand saws	10		
Trowels	11	3	Paint scrapers Groove scraper
Files	8		
Scraping tools	12		
Other tools ^a	29	10	
All tools	200		

^a E.g. mixing cup, jointing gun, allen key sets.

from 565 work tools (27% were DMG test positive) (Lidén et al., 1998), it appears that the proportion of work tools that release nickel has decreased markedly. Therefore, workers and consumers who handle work tools seem to be at lower risk of developing hand eczema due to nickel exposure from tools. However, the study underscores that nickel is still released from this category of items. Dermatologists and occupational health personnel should therefore screen the tools of their patients when clinically relevant and possible (Thyssen et al., 2010b; Jensen et al., 2011). Clinical relevance of metal exposure is usually assessed by the treating physician via the medical history, the use of metal spot tests and by presentation of allergic contact dermatitis. A limitation of the study is the relatively modest sample size, the absence of more sophisticated metal release analysis offering quantitative measurements and the fact that we only examined unused work tools. It is possible that alloys, lacquers or other coatings may deteriorate following use and wear and result in increased nickel release. Also, professional special work tools were not investigated.

It remains unsettled whether work tools are covered by the former EU Nickel Directive which now is included in REACH, the EU chemicals regulation. The European Commission recently suggested that for the purpose of the implementation of the restriction on nickel for prevention of nickel allergy, the term *prolonged* should be understood as covering a daily overall contact with the skin of more than 30 min

continuously or 1 h discontinuously (<http://www.videncenterforallergi.dk/nikkel-paa-arbejdspladsen.html>). This definition would mean that many work tools would be covered by the limitations in nickel release, which is justified from a public health and a scientific point of view. The issue is currently being discussed with member states. Since quite few tools in the present study, and 27% in the former study (Lidén et al., 1998), released nickel it is obvious that nickel releasing materials are not necessary part of hand-held work tools and that they may be omitted.

Occupational cobalt allergy has traditionally been observed in metal workers (Fischer and Rystedt, 1983), tool makers (Kanerva et al., 2000) and cement workers (Wahlberg et al., 1977). Other occupations associated with occupational cobalt allergy include hair-dressers, construction workers, rail cash/checkout operators, tool sharpeners, machine operators and domestic cleaners (Athavale et al., 2007; Lidén et al., 2011). In the present study, no cobalt release from work tools was identified. The cobalt spot test is positive, as indicated by a red coloration of the normally yellow solution (Fig. 1). It was developed to detect approximately 8 ppm cobalt in a solution (Thyssen et al., 2010a). Based on clinical experiments (Fischer and Rystedt, 1983; Allenby and Basketter, 1989; Julander et al., 2009), the cobalt spot test is considered to detect cobalt around the lowest threshold level to which highly sensitive individuals may react (Thyssen et al., 2010a). Thus, it appears that exposure to ordinary work tools can not explain the high level of cobalt allergy among dermatitis patients but it should be acknowledged that historically, work tools might have been a source of cobalt release. In line with this observation, many work tools are made of chromium-vanadium alloys or stainless steel; alloys that do not pose clinical problems in cobalt allergic patients. Also, a recent study found cobalt deposited on the skin in locksmiths and carpenters (Lidén et al., 2008). Past studies have convincingly shown that cobalt-containing hard metal alloys or cemented tungsten carbides may result in deposition of high concentration of cobalt on the skin as well as allergic cobalt dermatitis (Linnainmaa and Kiilunen, 1997; Julander et al., 2009, 2010). Our findings suggest that cobalt release from ordinary hand held work tools is not a problem and that clinicians should look for other sources of cobalt release in patients with cobalt allergy and hand eczema (Stefaniak et al., 2010). Future studies should continue to identify sources of cobalt exposure.

In conclusion, non-powered hand-held work tools remain a source of nickel exposure, thus posing a risk for nickel allergy and dermatitis but, except hard metals tools, they do not seem to release cobalt in high concentrations.

Funding sources

Peter Jensens salary was supported by a grant from the Michaelsen Foundation.

Prior presentations

The content has not been published previously and is not otherwise submitted for publication.

Conflict of interest

Jacob P. Thyssen and Morten S. Jellesen sold the cobalt spot test to SmartHealth (Phoenix, Arizona) after its development. The company did not participate in its development and had no influence on the present study. Jacob P. Thyssen and Morten S. Jellesen will receive royalty fee from annual net sales of the spot test. Torkil Menné, Jeanne D. Johansen, Carola Lidén, Anneli Julander and Peter Jensen have no conflict of interest to disclose.



Fig. 2. A positive dimethylglyoxime (DMG) test result indicating nickel release from a metal ring located at the end of the grip, that may cause nickel allergy and dermatitis.

Ethical approval

Not required.

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