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CONTACT DERMATITIS

Low-cobalt diet for dyshidrotic eczema patients

Joseph Stuckert[1] and Susan Nedorost[2]
[1]Department of Medicine, University of Pittsburgh Medical Center, Pittsburgh, PA 15213, USA, and
[2]Department of Dermatology, University Hospitals Case Medical Center, Cleveland, OH 44106, USA

Background: Dyshidrotic eczema is a type of chronic intermittent dermatitis characterized by vesicles, dystrophic fingernail changes, and rarely bullae that affects the hands and feet. Many exogenous factors may trigger a flare including dermatophyte infections, contact irritants, and metal hypersensitivity. Although metal hypersensitivity does not play a role in all cases of dyshidrotic eczema, high oral ingestion of nickel and/or cobalt should be considered, regardless of patch test results.

Objective: We updated and simplified existing published guidelines for low-cobalt diets. A recent review of the literature showed that dietary cobalt restriction, a safe yet burdensome treatment option for dyshidrosis, is referenced to dated sources.

Methods: We have analysed current data for the cobalt content in common food items.

Conclusion: We propose a revised, point-based diet that will eliminate much of the dietary cobalt (and nickel) and reduce dyshidrotic eczema flares.

Key words: metals; systemic allergic dermatitis; treatment. © Blackwell Munksgaard, 2008.
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Cobalt exposure

Cobalt exposure, whether by inhalation, orally, or topically, occurs in a wide array of circumstances. Workers in many hard metal industries, such as coal and metal mining, tungsten carbide industry (where cobalt acts as a binder), smelting and refining, and chemical production industries, often have the highest exposure levels (1, 2). The level of cobalt in the air is higher in areas near factories and in heavily industrialized cities (3). Regardless of the circumstance, environmental exposure may result in systemic toxicity or allergy, as well as cutaneous irritancy or allergy.

Cobalt toxicity

Chronic cobalt ingestion, at levels above a normal dietary intake, may lead to organ toxicity. For example, in the 1960s, cobalt chloride was an additive in beer as a foam stabilizer. Cobalt cardiomyopathy occurred in many heavy beer consumers and resulted in up to a 50% mortality rate (3). An established allergen in the occupational setting, cobalt causes allergic contact dermatitis.

Cobalt allergy

Cobalt exposure via inhalation may lead to cobalt-related asthma. Hard metal workers may develop cough, wheezing, and dyspnoea that often improves during weekends and holidays. Multiple reports have recognized an immunological correlation with specific immunoglobulin IgE and IgG antibodies to cobalt (4, 5). Cobalt contact allergy may also lead to metal prosthesis failure and allergic vasculitis (2).

Cobalt and nickel

Allergic contact dermatitis from cobalt is a factor in hand dermatitis for sensitized patients handling hard metal tools. Nickel allergy and irritant hand dermatitis often precede allergic contact hand dermatitis due to cobalt. Of patients who developed an occupational dermatitis, roughly 90% had developed jewellery dermatitis prior to employment and/or the onset of dyshidrotic eczema (6). A detailed jewellery history is especially important as even very low concentrations of metals may precipitate a flare of allergic contact

dermatitis (7). Patients are frequently co-sensitized to nickel and cobalt; fortunately, the topical and systemic avoidance strategies are similar (8).

Dyshidrotic eczema and evidence for cobalt-induced systemic allergic dermatitis

Of particular interest is cobalt ingestion causing systemic allergic dermatitis in the form of dyshidrotic eczema. Dyshidrotic eczema is a type of chronic intermittent dermatitis that affects the hands and feet. Symptoms include pruritus and a burning sensation that may precede the development of vesicles, bullae, and dystrophic fingernail changes (9). Although the exact mechanism is not known, metal ions can likely function as both type I and type IV hypersensitivity allergens in the induction of systemic allergic dermatitis. Recent evidence even contends that metal ions act as an atypical hapten by activating T cells through human leucocyte antigen-independent pathways (10). In addition to antigen-presenting cells, antibodies may assist systemic allergic dermatitis in a manner similar to protein contact dermatitis (11).

Although not all dyshidrotic eczema is due to metal hypersensitivity, high oral ingestion of cobalt should be considered, regardless of patch test results. In 1979, Veien and Kaaber (12) first noted that oral challenge of nickel, cobalt, and chromium might result in a dyshidrotic flare even when the patch test results are negative. In fact, of 202 patients with patch test-negative dyshidrotic eczema, 25% flared after an oral ingestion of metal salts. The flare improved with a diet low in metal salts and recurred if the diet was stopped (8). Examining only patients with patch test-positive dyshidrotic eczema, over 50% flared after oral ingestion of metal salts (13). Although nickel sensitivity is more common than cobalt sensitivity, the two are quite linked. Rystedt and Fischer (6) reported that a quarter of nickel-sensitive patients developed a cobalt allergy and patients with simultaneous nickel and cobalt allergies have more severe dyshidrotic eczema. Of note, all discussed studies have used an oral 'challenge' of metal salts consisting of amounts in far excess of levels seen in a normal diet. However, multiple studies have demonstrated that even normal dietary levels of nickel and cobalt may cause a dyshidrotic eczema flare, especially among those patients who are patch test positive (14–16).

Other exogenous factors may serve as triggers of dyshidrotic eczema, such as dermatophyte infections (17). Therefore, a careful patient history should accompany any treatment plan of hand eczema. In particular, a history of jewellery intolerance and tinea pedis should be pursued.

Cobalt and vitamin B12

While hypersensitivity reactions have been related to cobalt exposure, there is no evidence linking these reactions to the vitamin B12 occurring naturally in foods: adenosylcobalamin and methylcobalamin. There are multiple reports detailing reactions to injections of the synthetically derived preparations of B12 including cyanocobalamin and hydroxocobalamin (18, 19). Regardless, the cobalt level contributed by vitamin B12 in foods is likely too insignificant an amount to be responsible for systemic allergic dermatitis (3, 20). Thus, the ingestion of foods high in cobalt causing systemic allergic dermatitis is due to cobalt not found in vitamin B12.

Role of disulfiram

If dietary and environmental avoidance fails, there is some evidence that disulfiram will reduce the frequency of flares in patients with dyshidrotic eczema and nickel allergy (21). Disulfiram is first metabolized (reduced) to diethyldithiocarbamate, which acts as a chelating agent for transition metal ions such as nickel and cobalt and results in the increased urinary excretion of the metals. However, there are considerable disadvantages associated with disulfiram treatment including dermatitis flares, hepatotoxicity, and dermatitis relapse after discontinuation of treatment (22). A low-metal diet is a safer, albeit more burdensome, alternative in the treatment of dyshidrotic eczema.

Objective

Published references regarding low-cobalt diets are antiquated and lack current data. For example, existing guidelines suggest an avoidance of beer. This recommendation reflects the use of cobalt chloride as a foam stabilizer during the 1960s. However, many international food safety administrations do not allow cobaltous salts to be used as foam stabilizers in beverages or in foods (1). Therefore, we have updated and simplified existing published guidelines for low-cobalt diets.

Methods

A list of the cobalt content of 237 food items, adjusted for serving size, was prepared from a 1987 United States Food and Drug Administration (FDA) study (23), follow-up FDA Total Diet Studies from the 1990s (24), and an additional recent study (25). We have based our cobalt intake guidelines to reduce flares from clinical experience as well as Jensen et al.'s (20) meta-analysis of oral

Table 1. Low cobalt point-based diet*

Points	Food	Serving size – American	Serving size – metric
Avoid	Brazil nuts	1 oz	28 g
	cow liver	4 oz	113 g
	Homeopathic/Herbal Remedies		
7	Flaxseeds	2 tablespoons	13 g or 30 ml
	Garbanzo beans/chick peas	Half of a cup	93 g or 112 ml
	Lamb liver	4 oz	113 g
5	Buckwheat	2 tablespoons	15 g or 30 ml
	Chilli with meat and beans	1 cup	240 g or 224 ml
	Chocolate cake	3 × 3 × 2 inch	95 g or 7.5 × 7.5 × 5 cm
	Chocolate milk	1 cup	240 g or 224 ml
	Chocolate milk shake	1 cup	240 g or 224 ml
	Chocolate powder drink mix	1 packet or 1.3 oz	36 g
	Clam chowder soup	1 cup	240 g or 224 ml
	Lamb kidney	4 oz	113 g
	Millet seeds	2 tablespoons	13 g or 30 ml
	Mixed nuts without peanuts	1 oz	28 g
	Pinto beans	Half of a cup	93 g or 112 ml
	Soy milk	1 cup	240 g or 224 ml
	Sunflower kernels	1 oz	28 g
3	Baked beans	Half of a cup	93 g or 112 ml
	Bean soup	1 cup	240 g or 224 ml
	Chocolate	1 oz	28 g
	Chocolate ice cream	Half of a cup	100 g or 112 ml
	French fries	1 small or 3 oz	84 g
	Kidney beans	Half of a cup	93 g or 112 ml
	Oat ring cereal	1 cup	30 g or 224 ml
	Pizza	Quarter of 12 inch pie	130 g or quarter of 30 cm pie
	Potato	Half of a cup	78 g or 112 ml
	Rice bran	2 tablespoons	15 g or 30 ml
	Soy nuts cereal	1 cup	40 g or 224 ml
	Tahini	2 tablespoons	32 g or 30 ml
	Tofu	4 oz	113 g
	Veal (cutlets)	4 oz	113 g
	Wheat bran cereal	Half of a cup	31 g or 112 ml
	Yeast products (pastes, brewers, vegemite, marmite)	1 teaspoon	5 g or 5 ml
2	Alfalfa	1 oz	28 g
	Almonds	1 oz	28 g
	Brownies	1 brownie or 3 × 1 × 1 inch	24 g or 7.5 × 2.5 × 2.5 cm
	Cantaloupe	Half of a cup	80 g or 112 g
	Chicken TV dinner	Half of a dinner or 5.5 oz	154 g
	Chocolate pudding	Quarter of a cup	70 g or 66 ml
	Chocolate syrup	1 tablespoon	16 g or 15 ml
	Crisped rice cereal	1 cup	33 g or 224 ml
	Fruit flavoured cereal	1 cup	30 g or 224 ml
	Ground beef (hamburger patty, Meatloaf)	4 oz	113 g
	Lentils	2 tablespoons	13 g or 30 ml
	Multivitamin	1 tablet	1.5 g
	Navy bean	Half of a cup	93 g or 112 ml
	Nutrigrain bar	1 bar or 1.3 oz	37 g
	Oysters	3 oz	84 g
	Peas	Half of a cup	73 g or 112 ml
	Pepitas	1 oz	28 g
	Prune juice	1 cup	240 g or 224 ml
	Pumpkin	Half of a cup	58 g or 112 ml
	Raisin bran cereal	Half of a cup	30 g or 112 ml
	Red wine	1 cup	240 g or 224 ml
	Shrimp	3 oz	84 g
	Strawberries	Half of a cup	72 g or 112 ml
	Tomato juice	1 cup	240 g or 224 ml
	Walnuts	1 oz	28 g

(Continued)

Table 1. Continued

Points	Food	Serving size – American	Serving size – metric
1	Apple juice	1 cup	240 g or 224 ml
	Apricots	1 fruit or 1.4 oz	38 g
	Asparagus	Half of a cup	67 g or 112 ml
	Avocado	Quarter of a fruit or 2.2 oz	60.5 g
	Bagel	1 bagel or 4.3 oz	120 g
	Beef (steak, rump, chuck, roast, sirloin, round)	4 oz	113 g
	Beef bouillon soup	1 cup	240 g or 224 ml
	Beef taco	1 taco or 3.6 oz	100 g
	Breakfast sandwich (egg, cheese, ham)	1 sandwich or 5 oz	139 g
	Broccoli	Half of a cup	44 g or 112 ml
	Cashews	1 oz	28 g
	Chicken noodle casserole	4 oz	113 g
	Chicken noodle soup	1 cup	240 g or 224 ml
	Chocolate chip cookies	1 cookie or 0.5 oz	14 g
	Cod/haddock fillet	4 oz	113 g
	English muffin	1 muffin or 2 oz	57 g
	Fish sticks and patties	4 oz	113 g
	Granola cereal	Half of a cup	30 g or 112 ml
	Grape juice	1 cup	240 g or 224 ml
	Green beans	Half of a cup	55 g or 112 ml
	Instant mashed potatoes	Half of a cup	105 g or 112 ml
	Lima beans	Half of a cup	55 g or 112 ml
	Multigrain/whole wheat/cracked wheat bread	1 slice or 1.5 oz	43 g
	Mushroom soup	1 cup	240 g or 224 ml
	Oat bran cereal	Half of a cup	35 g or 112 ml
	Onion rings	1 small or 3 oz	84 g
	Peanuts	1 oz	28 g
	Pears	Half of a fruit or 3.2 oz	90 g
	Pecans	1 oz	28 g
	Potato chips	1 oz	28 g
	Prunes	Half of a cup	85 g or 112 ml
	Rye bread	1 slice	37 g
	Salisbury steak TV dinner	Half of a dinner or 6.5 oz	182 g
	Soy sausage	2- to 4-inch links or 1.2 oz	2- to 10-cm links or 34 g
	Stuffed green peppers	Half of a stuffed pepper or 4 oz	110 g
	Sweet potato	Half of a cup	78 g or 112 ml
	Tempeh	4 oz	113 g
	Turkey TV dinner	Half of a dinner or 6 oz	165 g
	Wholemeal flour	Quarter of a cup	30 g or 66 ml
	Squash	Half of a cup	57 g or 112 ml

*Limit daily intake to no more than 12 points per day. Amount needed to induce flare may also depend on smoking status and environmental levels in air, soil, and water (i.e. living near industry) (3). A multivitamin counts as 2 points.

nickel exposure and systemic allergic dermatitis. From clinical experience, flares are sporadic and almost never continuously active. If dietary cobalt caused the flares in some of our patients, then the average dietary cobalt intake would be less than that needed to cause a flare. We have also seen patients report flares after ingesting a generous helping of chocolate-covered nuts. Using Jensen et al.'s meta-analysis of systemic allergic dermatitis as a reference for cobalt-induced flares, roughly 1% of patients will flare with cobalt exposure equal to the average daily intake. From two sources (3, 23), the average cobalt ingestion is 12 μg per day.

Results and Conclusions

We propose the following point-based diet to help patients limit their cobalt ingestion to a level below that which will cause a flare for most patients: <12 μg per day. After receiving patient feedback, we believe that patients are more likely to adhere to a point-based diet that permits ingestion of certain food items in moderation, as opposed to a diet that only lists food items that should be avoided. However, the best approach for each patient is the interventional diet that the individual patient will most likely adhere to while helping the patient to become aware of eating habits and portion sizes (26). We recommended that

patients avoid both Brazil nuts and cow liver (25) and homeopathic/herbal remedies (27) due to high metal content. All other food items are assigned a specific point value (the first column in Table 1): 7, 5, 3, 2, or 1 point. A patient should add up the assigned points every time he ingests a food that is on the list while limiting daily intake to no more than a total of 12 points per day. The patient should also pay close attention to the listed serving size for food items. It should be noted that the amount of cobalt intake needed to induce systemic allergic dermatitis also depends on smoking status and environmental levels of cobalt in air, soil, and water (i.e. living near industry) (3). Foods not listed in the table have a point value of 0. Multivitamins should conservatively be given a point value of 2. The cobalt content in a multivitamin exceeds the level that would be expected given the vitamin B12 content (3, 25). Therefore, cobalt is a likely metal contaminant in multivitamins in a manner similar to homeopathic/herbal remedies (27). The proposed point-based diet will eliminate much of dietary nickel too.

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References

1. Eleventh Report on Carcinogens. *Substances profile: Cobalt Sulfate*. *United States National Toxicology Program*, North Carolina, 2004.
2. Bradberry S M, Berry S T, Vale J A. *Cobalt Monograph. The International Programme on Chemical Safety INTOX Database*, National Poisons Information Service, Birmingham, 1996.
3. Expert Group on Vitamins and Minerals. *Review of Cobalt*. UK Food Standards Agency, 2002.
4. Cirla A M Cobalt-related asthma: clinical and immunological aspects. *Sci Total Environ* 1994: 150: 85–94.
5. Shirakawa T, Kusaka Y, Fujimura N, Goto S, Morimoto K. The existence of specific antibodies to cobalt in hard metal asthma. *Clin Allergy* 1988: 18: 451–460.
6. Rystedt I, Fischer T. Relationship between nickel and cobalt sensitization in hard metal workers. *Contact Dermatitis* 1983: 9: 195–200.
7. Nielsen N H, Menné T, Kristiansen J, Christensen J M, Borg L, Poulsen L K. Effects of repeated skin exposure to low nickel concentrations: a model for allergic contact dermatitis to nickel on the hands. *Br J Dermatol* 1999: 141: 676–682.
8. Veien N K, Hattel T, Justesen O, Norholm A. Oral challenge with metal salts (I). Vesicular path-test-negative hand eczema. *Contact Dermatitis* 1983: 9: 402–406.
9. Rietschel R L, Fowler J F. *Dyshidrotic Eczema. Fisher's Contact Dermatitis*, 4th edition. Baltimore, Williams and Wilkins, 1995: 332–345.
10. Thierse H R, Gamerdinger K, Junkes C et al. T cell receptors (TCR) interaction with haptens: metal ions as non-classical haptens. *Toxicology* 2005: 209: 101–107.
11. Tanaka Y, Tanaka M, Anan S, Yoshida H. Immunohistochemical studies on dust mite antigen in positive reaction site of patch test. *Acta Derm Venereol Suppl (Stockh)* 1989: 144: 93–96.
12. Veien N K, Kaaber K. Nickel, cobalt, and chromium sensitivity in patients with pompholyx (dyshidrotic eczema). *Contact Dermatitis* 1979: 5: 371–374.
13. Veien N K, Hattel T, Justesen O, Norholm A. Oral challenge with nickel and cobalt in patients with positive patch tests to nickel and/or cobalt. *Acta Derm Venereol* 1987: 67: 321–325.
14. Nielsen G D, Jepsen L V, Jorgensen P J, Grandjean P, Brandrup F. Nickel-sensitive patients with vesicular hand eczema: oral challenge with a diet naturally high in nickel. *Br J Dermatol* 1990: 122: 299–308.
15. Veien N K, Hattel T, Laurberg G. Placebo-controlled oral challenge with cobalt in patients with positive patch tests to cobalt. *Contact Dermatitis* 1995: 33: 54–55.
16. Jensen C S, Menné T, Lisby S, Kristiansen J, Veien N K. Experimental systemic contact dermatitis from nickel: a dose-response study. *Contact Dermatitis* 2003: 49: 124–132.
17. Peck S. Epidermophytosis of the feet and epidermophytids of the hands: clinical, histologic, cultural, and experimental studies. *Arch Dermatol Syph* 1930: 20: 44.
18. Moloney F J, Hughes R, O'Shea D, Kirby B. Type I immediate hypersensitivity reaction to cyanocobalamin but not hydroxycobalamin. *Clin Exp Dermatol* 2008: 33: 412–414.
19. Heyworth-Smith D, Hogan P G. Allergy to hydroxycobalamin, with tolerance of cyanocobalamin. *Med J Aust* 2002: 177: 162–163.
20. Jensen C S, Menné T, Johansen J D. Systemic contact dermatitis after oral exposure to nickel: a review with a modified meta-analysis. *Contact Dermatitis* 2006: 54: 79–86.
21. Kaaber K, Menné T, Veien N, Hougaard P. Treatment of nickel dermatitis with Antabuse; a double-blind study. *Contact Dermatitis* 1983: 9: 297–299.
22. Kaaber K, Menné T, Veien N K, Baadsgaard O. Some adverse effects of disulfiram in the treatment of nickel-allergic patients. *Derm Beruf Umwelt* 1987: 35: 209–211.
23. Pennington J A T, Jones J W. Molybdenum, nickel, cobalt, vanadium, and strontium in total diets. *J Am Diet Assoc* 1987: 87: 1644–1650.
24. Analyses performed by FDA's Center for Food Safety and Applied Nutrition's as part of an Independent Quality Assurance activity 1994–2001. Cobalt analytical results obtained by instrumental neutron activation of selected food items from the US Food and Drug Administration's Total Diet Study (available from http://www.cfsan.fda.gov/~comm/tds-toc.html) Accessed on 15 January 2008.
25. Hokin B, Adams M, Ashton J, Louie H. Analysis of the cobalt content in Australian foods. *Asia Pac J Clin Nutr* 2004: 13: 284–288.
26. Franz M, Boucher J, Green-Pastors J, Powers M. Evidence-based nutrition practice guidelines for diabetes and scope and standards of practice. *J Am Diet Assoc* 2008: 108 (Suppl. 1): S52–S58.
27. Medeiros L, Fransway A F, Taylor J, Wyman M, Janes J, Fowler J, Rietschel R. Complementary and alternative remedies: an additional source of potential systemic nickel exposure. Presented at American Contact Dermatitis Society Meeting, January 31, 2008, San Antonio, TX.

Address:
Dr Susan Nedorost
Department of Dermatology
University Hospitals Case Medical Center
11100 Euclid Ave
Cleveland, OH 44106
Tel: +1-216-844-8200
Fax: +1-440-250-2451
email: jjsst95@yahoo.com