

# Persistent Chlorotrichosis With Chronic Sun Exposure

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## PRACTICE POINTS

- Chlorotrichosis is the deposition of copper onto hair, which causes a green discoloration and most commonly occurs in blonde patients with excessive exposure to chlorinated water.
- Hair cuticle damage from hair care practices, such as use of heat or chemicals, can predispose patients to the development of chlorotrichosis.
- Although a number of treatments have been proposed, the use of penicillamine shampoo seems to be particularly effective and works via chelation of the adherent copper molecules.



**FIGURE 1.** A, Patient with green hair (chlorotrichosis) before treatment. B, Patient's hair after 2 treatments with penicillamine shampoo.

To the Editor:

Chlorotrichosis, or green hair discoloration, is a dermatologic condition secondary to copper deposition on the hair. It most often is seen among swimmers who have prolonged exposure to chlorinated pools. The classic patient has predisposing chemical, heat, or mechanical damage to the hair shaft and usually lighter-colored hair.<sup>1-3</sup> We present a case of chlorotrichosis in a young brunette patient who did not have predisposing factors except for chronic sun exposure.

A 13-year-old healthy adolescent girl with brown hair presented with persistent green hair for 2 years (Figure 1A). She had first noted hair discoloration after swimming in a neighbor's chlorinated outdoor pool during summertime but experienced year-round persistence even without swimming. She denied any history of typical risk factors for hair damage, including exposure to hair dye or bleach, styling products, heat, or mechanical

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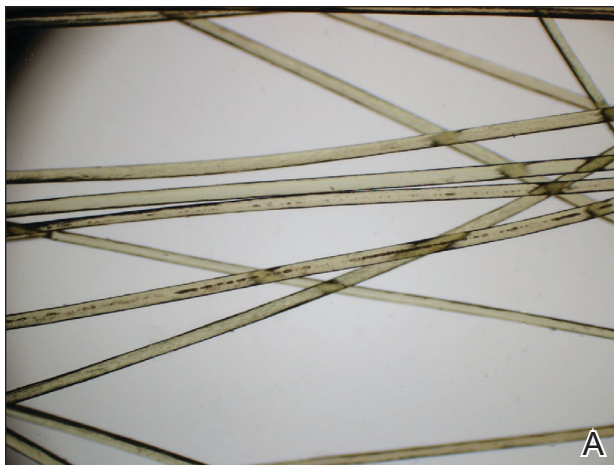
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damage from excessive brushing. Her sister had blonde hair with a history of similar activities and exposures, and although she did style her hair with heat, she did not develop hair discoloration. The patient lived in a newer home, and prior tap water testing did not show elevated levels of copper. She admitted to strictly wearing her hair down at all times, including during strenuous activity and swimming. Excessive teasing at school prompted her mother to seek advice from hair salons. Bleaching test strips of hair reportedly caused paradoxical intensification of green, and the patient declined recommendations for red hair dye. The patient also tried Internet-based suggestions such as topically applying crushed aspirin, lemon juice, tea tree oil, and clarifying shampoos, which all failed to result in notable improvement.

Physical examination revealed a sun-exposed distribution of ashy green hair that was worse at the distal hair ends and completely spared the roots. Trichoscopy of discolored hair (Figure 2A) revealed diffuse cuticle thinning, whereas unaffected hair appeared normal



**FIGURE 2.** A, Trichoscopy of chlorotrichosis-affected hair demonstrated diffuse cuticle thinning (original magnification  $\times 4$ ). B, Trichoscopy of unaffected hair showed a thicker healthier cuticle (original magnification  $\times 4$ ).

(Figure 2B). Because the patient reported slight improvement with tea tree oil, treatment was initiated with twice-weekly hot vegetable oil treatments applied for 20 minutes, which ultimately proved unsuccessful. Penicillamine shampoo (250-mg capsule of penicillamine into 5-mL purified water and 5-mL pH-balanced clear shampoo) was then recommended. At 3-month follow-up, the patient exhibited notable improvement of the hair discoloration, with only mild persistence at the distal ends of sun-damaged hair, visible only under fluorescent

### Treatment and Prevention of Chlorotrichosis

Treatment Options	Suspected Mechanism
EDTA shampoo <sup>4,6</sup>	Chelates copper molecules so they may be washed away, though less effective than penicillamine
Hot vegetable oil <sup>4,6</sup>	May increase porosity of outer hair sheath to allow for escape of copper molecules
Hydrogen peroxide <sup>4,6</sup>	Oxidation-reduction reaction may allow ionized copper to dissolve and/or dislodge
Lemon juice <sup>5</sup>	Possible binding effect of citric acid with copper
Penicillamine shampoo <sup>5,6</sup>	Chelates copper molecules so they may be washed away
Preventative measures: condition hair with quaternary ammonium compounds prior to swimming <sup>4,7</sup> ; shampoo hair while still wet following each swim <sup>4</sup> ; use pH-balanced clear shampoos (avoid alkaline shampoos); maintain pH of pool or tap water in range of 7.2–8.0 (more specifically 7.4–7.6) <sup>4</sup> ; minimize hair damage (eg, chronic sun exposure, hair bleaching, hair dye, waving, chlorinated water, mechanical damage); use sunscreen spray, hats; monitor pool water, maintaining under Environmental Protection Agency standard of 1 ppm of copper <sup>6</sup>	Avoidance of predisposing hair damage and notable environmental copper exposure

Abbreviation: EDTA, ethylenediaminetetraacetic acid.

lighting (Figure 1B). Our recommendations thereafter were focused on prevention (Table).

The source of exogenous copper in chlorotrichosis commonly is tap water flowing through copper pipes or swimming pools rich in chlorine and copper-containing algaecides.<sup>2,4,8</sup> The acidity of tap water is thought to cause the release of copper from the pipes.<sup>2,5</sup> Such acidity could result from the effects of acid rain on water reservoirs or from water additives such as fluoride<sup>2</sup> or those used in decalcification systems.<sup>5</sup> Additionally, the attachment of electrical grounds to copper piping can cause copper to solubilize through an electric current, increasing water levels of copper.<sup>3</sup> Although low pH facilitates copper solubility, high pH within the hair facilitates copper precipitation, which is quickly followed by adhesion to anionic molecules within hair shafts. Therefore, it is postulated that chlorotrichosis may persist in insufficiently rinsed hair with residual alkaline shampoo.<sup>6</sup>

Beyond pH flux in the induction of chlorotrichosis, other environmental agents have been suspected to play a role. A case report of green hair in a black patient following use of selenium sulfide 2.5% shampoo identified hair damage from tinea capitis infection as predisposing to chlorotrichosis.<sup>9</sup> Other reports have cited tar shampoo and industrial exposure to cobalt, nickel, brass, mercury, or chromium as causative factors.<sup>2,3,6,7</sup> Interestingly, green hair discoloration also has been observed in the metabolic disorder phenylketonuria.<sup>1</sup>

Few individuals exposed to elevated levels of copper will develop chlorotrichosis, which emphasizes the critical role of predisposing hair damage in its pathogenesis. With violation of the hair cuticle, chlorine can crystallize and copper can adhere to the hair shaft.<sup>10</sup> Bleaching and waving of the hair also appear to alter the composition of keratin by increasing the number of cysteic acid and similar anionic sulfonate groups, which can bind copper.<sup>8</sup>

Although not harmful, chlorotrichosis may be aesthetically undesirable and lead to considerable social ostracism.

Without intrinsic hair defects or obvious differences in predisposing factors, the question was raised as to why our patient, as a brunette, experienced dramatic hair discoloration while her blonde sister was entirely unaffected. We postulated that our patient's persistent green hair may have been due to her unique predisposition to extensive sun-induced and mechanical hair damage because of her unwavering tendency to wear her hair down at all times. A variety of treatments of variable reported efficacy have been proposed (Table); fortunately, if treatments fail, the discoloration resolves with hair growth.

This case is unique in that it presented in a brunette patient with seemingly minimal hair damage with an unaffected blonde-haired sibling and with persistence over years. Furthermore, it lends credence to the use of penicillamine shampoo in treating chlorotrichosis, even in particularly difficult cases in which other treatments have failed.

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