Lanolin: The 2023 American Contact Dermatitis Society Allergen of the Year

Hadley Johnson, BS; Thomas Norman, BA; Brandon L. Adler, MD; JiaDe Yu, MD

PRACTICE **POINTS**

- Lanolin is a common ingredient in personal care products (PCPs), cosmetics, topical medicaments, and industrial materials.
- Allergic contact dermatitis to lanolin appears to be most common in patients with stasis dermatitis, chronic leg ulcers, atopic dermatitis, and perianal/genital dermatitis.
- There is no single best lanolin patch test formulation. Patch testing and repeat open application testing to PCPs containing lanolin also may be of benefit.

In 2023, lanolin was named the American Contact Dermatitis Society Allergen of the Year. Despite its widespread use in personal care products and industrial goods, lanolin is thought to be a rare sensitizer in patients with healthy skin; however, those with chronic inflammatory skin conditions are at a higher risk for allergic contact dermatitis (ACD) to lanolin. The proper patch test formulation for lanolin is a source of contention. In this article, we discuss ACD to lanolin with a focus on its paradoxical nature and the subtleties to consider when patch testing to this controversial allergen.

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Lanolin was announced as the Allergen of the Year by the American Contact Dermatitis Society in March 2023.[1] However, allergic contact dermatitis (ACD) to lanolin remains a matter of fierce debate among dermatologists. Herein, we discuss this important contact allergen, emphasizing the controversy behind its allergenicity and nuances to consider when patch testing.

What is Lanolin?

Lanolin is a greasy, yellow, fatlike substance derived from the sebaceous glands of sheep. It is extracted from wool using an intricate process of scouring with dilute alkali, centrifuging, and refining with hot alkali and bleach.[2] It is comprised of a complex mixture of esters, alcohols, sterols, fatty acids, lactose, and hydrocarbons.[3]

The hydrophobic property of lanolin helps sheep shed water from their coats.[3] In humans, this hydrophobicity benefits the skin by retaining moisture already present in the epidermis. Lanolin can hold as much as twice its weight in water and may reduce transepidermal water loss by 20% to 30%.[4-6] In addition, lanolin maintains tissue breathability, which supports proper gas exchange, promoting wound healing and protecting against infection.[3,7]

Hadley Johnson is from the University of Minnesota Medical School, Minneapolis. Thomas Norman and Dr. Adler are from the Keck School of Medicine, University of Southern California, Los Angeles. Dr. Adler is from the Department of Dermatology. Dr. Yu is from the Department of Dermatology, Massachusetts General Hospital, Harvard Medical School, Boston.

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Correspondence: JiaDe Yu, MD, Department of Dermatology, Massachusetts General Hospital, 50 Staniford St, Ste 200, Boston, MA 02114 (Jiadeyu@mgh.harvard.edu).

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Many personal care products (PCPs), cosmetics, and topical medicaments contain lanolin, particularly products marketed to help restore dry cracked skin. The range of permitted concentrations of lanolin in over-the-counter products in the United States is 12.5% to 50%.[3] Lanolin also may be found in industrial goods. The Table provides a comprehensive list of common items that may contain lanolin.[1,3,8,9]

A Wolf in Sheep's Clothing?

Despite its benefits, lanolin is a potential source of ACD. The first reported positive patch test (PPT) to lanolin worldwide was in the late 1920s.[10] Subsequent cases of ACD to lanolin were described over the next 30 years, reaching a peak of recognition in the latter half of the 20th century with rates of PPT ranging from 0% to 7.4%, though the patient population and lanolin patch-test formulation used differed across studies.[9] The North American Contact Dermatitis Group observed that 3.3% (1431/43,691) of patients tested from 2001 to 2018 had a PPT to either lanolin alcohol 30% in petrolatum (pet) or Amerchol L101 (10% lanolin alcohol dissolved in mineral oil) 50% pet.[11] Compared to patients referred for patch testing, the prevalence of contact allergy to lanolin is lower in the general population; 0.4% of the general population in Europe (N=3119) tested positive to wool alcohols 1.0 mg/cm^2 on the thin-layer rapid use Epicutaneous (TRUE) test.[12]

Allergic contact dermatitis to lanolin is unrelated to an allergy to wool itself, which probably does not exist, though wool is well known to cause irritant contact dermatitis, particularly in atopic individuals.[13]

Who Is at Risk for Lanolin Allergy?

In a recent comprehensive review of lanolin allergy, Jenkins and Belsito[1] summarized 4 high-risk subgroups of patients for the development of lanolin contact allergy: stasis dermatitis, chronic leg ulcers, atopic dermatitis (AD), and perianal/genital dermatitis. These chronic inflammatory skin conditions may increase the risk for ACD to lanolin via increased exposure in topical therapies and/or increased allergen penetration through an impaired epidermal barrier.[14-16] Demographically, older adults and children are at-risk groups, likely secondary to the higher prevalence of stasis dermatitis/leg ulcers in the former group and AD in the latter.[1]

Lanolin Controversies

The allergenicity of lanolin is far from straightforward. In 1996, Wolf[17] first described the "lanolin paradox," modeled after the earlier "paraben paradox" described by Fisher.[18] There are 4 clinical phenomena of the lanolin paradox[17]:

- Lanolin generally does not cause contact allergy when found in PCPs but may cause ACD when found in topical medicaments.
- Some patients can use lanolin-containing PCPs on healthy skin without issue but will develop ACD when a lanolin-containing topical medicament is applied to inflamed skin. This is because inflamed skin is more easily sensitized.
- False-negative patch test reactions to pure lanolin may occur. Since Wolf's[17] initial description of the paradox, free alcohols of lanolin have been found to be its principal allergen, though it also is possible that oxidation of lanolin could generate additional allergenic substances.[1]
- Patch testing with wool alcohol 30% can generate both false-negative and false-positive results.

At one extreme, Kligman[19] also was concerned about false-positive reactions to lanolin, describing lanolin allergy as a myth attributed to overzealous patch testing and a failure to appreciate the limitations of this diagnostic modality. Indeed, just having a PPT to lanolin (ie, contact allergy) does not automatically translate to a relevant ACD,[1] and determining the clinical relevance of a PPT is of utmost importance. In 2001, Wakelin et al[20] reported that the majority (71% [92/130]) of positive reactions to Amerchol L101 50% or 100% pet showed current clinical relevance. Data from the North American Contact Dermatitis Group in 2009 and in 2022 were similar, with 83.4% (529/634) of positive reactions to lanolin alcohol 30% pet and 86.5% (1238/1431) of positive reactions to Amerchol L101 50% pet classified as current clinical relevance.[11,21] These findings demonstrate that although lanolin may be a weak sensitizer, a PPT usually represents a highly relevant cause of dermatitis.

Common Sources of Lanolin[1,3,8,9]

Cosmetics: blush, concealer, eye makeup (eyeliner, eye shadow, mascara), lip balm/lipstick, makeup remover wipes
Industrial goods: metalworking fluid, corrosion inhibitors, printing ink, leather, wax/polish, wire insulation
Personal care products: bar soaps, bodywashes, conditioners, depilatory creams, hairstyling products, moisturizers (lotions, creams), shampoos, shaving creams, sunscreens
Topical medicaments: anti-itch creams, diaper rash creams and ointments, wound healing ointments, hemorrhoid creams and ointments, nipple creams, topical corticosteroids

Considerations for Patch Testing

Considering Wolf's[17] claim that even pure lanolin is not an appropriate formulation to use for patch testing due to the risk for inaccurate results, you might now be wondering which preparation should be used. Mortensen[22] popularized another compound, Amerchol L101, in 1979. In this small study of 60 patients with a PPT to lanolin and/or its derivatives, the highest proportion (37% [22/60]) were positive to Amerchol L101 but negative to wool alcohol 30%, suggesting the need to test to more than one preparation simultaneously.[22] In a larger study by Miest et al,[23] 3.9% (11/268) of patients had a PPT to Amerchol L101 50% pet, whereas only 1.1% (3/268) had a PPT to lanolin alcohol 30% pet. This highlighted the importance of including Amerchol L101 when patch testing because it was thought to capture more positive results; however, some studies suggest that Amerchol L101 is not superior at predicting lanolin contact allergy vs lanolin alcohol 30% pet. The risk for an irritant reaction when patch testing with Amerchol L101 should be considered due to its mineral oil component.[24]

Although there is no universal consensus to date, some investigators suggest patch testing both lanolin alcohol 30% pet and Amerchol L101 50% pet simultaneously.[1] The TRUE test utilizes 1000 μg/cm^2 of wool alcohols, while the North American 80 Comprehensive Series and the American Contact Dermatitis Society Core 90 Series contain Amerchol L101 50% pet. Patch testing to the most allergenic component of lanolin—the free fatty alcohols (particularly alkane-α,β-diols and alkane-α,ω-diols)—has been suggested,[1] though these formulations are not yet commercially available.

When available, the patient's own lanolin-containing PCPs should be tested.[1] Performing a repeat open application test (ROAT) to a lanolin-containing product also may be highly useful to distinguish weak-positive from irritant patch test reactions and to determine if sensitized patients can tolerate lanolin-containing products on intact skin. To complete a ROAT, a patient should apply the suspected leave-on product to a patch of unaffected skin (classically the volar forearm) twice daily for at least 10 days.[25] If the application site is clear after 10 days, the patient is unlikely to have ACD to the product in question. Compared to patch testing, ROAT more accurately mimics a true use situation, which is particularly important for lanolin given its tendency to preferentially impact damaged or inflamed skin while sparing healthy skin.

Alternatives to Lanolin

Patients with confirmed ACD to lanolin may use plain petrolatum, a safe and inexpensive substitute with equivalent moisturizing efficacy. It can reduce transepidermal water loss by more than 98%,[4] with essentially no risk for ACD. Humectants such as glycerin, sorbitol, and α-hydroxy acids also have moisturizing properties akin to those of lanolin. In addition, some oils may provide benefit to patients with chronic skin conditions. Sunflower seed oil and extra virgin coconut oil have anti-inflammatory, antibacterial, and barrier repair properties.[26,27] Allergic contact dermatitis to these oils rarely, if ever, occurs.[28]

Final Interpretation

Lanolin is a well-known yet controversial contact allergen that is widely used in PCPs, cosmetics, topical medicaments, and industrial goods. Lanolin ACD preferentially impacts patients with stasis dermatitis, chronic leg ulcers, AD, and perianal/genital dermatitis. Patch testing with more than one lanolin formulation, including lanolin alcohol 30% pet and/or Amerchol L101 50% pet, as well as testing the patient's own products may be necessary to confirm the diagnosis. In cases of ACD to lanolin, an alternative agent, such as plain petrolatum, may be used.

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