

Contact Dermatitis: From Basics to Allergodromes

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Parents frequently bring their infants, toddlers, children and adolescents to see their pediatricians for various dermatologic concerns. Primary care providers are the pivotal physicians who determine which patients can be managed in their offices and which

patients need a referral to the dermatologist. Unfortunately, the burden of dermatitis can be overwhelming for all involved including the patient, family, pediatrician, and dermatologist. Although some dermatologic conditions (eg, atopic eczema) are more easily diagnosed, allergic

CME EDUCATIONAL OBJECTIVES

1. Outline the clinical presentations and pathophysiology of both allergic contact dermatitis (ACD) and irritant contact dermatitis (ICD).
2. Review the most common allergens and products responsible for allergic contact dermatitis in children.
3. Discuss the recommendations for management of children with suspected contact dermatitis including guidelines for referral for patch testing.

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SIDEBAR.

Clinical Clues that Heighten Index of Suspicion for Allergic Contact Dermatitis

- New-onset dermatitis
- Progressing or deteriorating dermatitis (atopic dermatitis/psoriasis) such as increasing total body surface area (TBSA) involvement or involvement of specific body sites (ie, face/eyelids/hands/neck folds)
- Recalcitrant dermatitis by standard therapies (clearing only with suprapotent topical steroids or oral steroids)
- Clinical presentation of dyshidrosis

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contact dermatitis (ACD) is commonly under-recognized and overlooked, especially if it is a contributing factor to worsening atopic dermatitis (AD). Segurado Rodriguez et al linked ACD to a family history of AD (85%), female sex (74%), and 11 to 16 years (63%).¹

Because ACD in children is an under-recognized entity, the true prevalence of childhood ACD remains largely unknown. However, the Society of Investigative Dermatology and American Academy of Dermatology have estimated that 72.3 million individuals in the United States of America suffered from contact dermatitis (CD) in 2004 with a \$1.6 billion burden of cost.² Therefore, when a child is afflicted, the burden on the family is unquantifiable as a pediatric patient's undiagnosed ACD can be devastating to both the child and the caretakers.

Extrapolating the adult data to children suggests that ACD is prevalent in the pediatric population, as it has been estimated that ACD may account for approximately 20% of all childhood dermatitis.^{3,4} We believe this estimate may be low, however, as the diagnosis may be overlooked in very young pediatric patients. In fact, Bruckner et al reported that children as young as 6 months of age may react to common allergens,⁵ and there are documented cases of ACD as young as 1 week of age.^{6,7} Recent studies have provided evidence to support a growing

awareness of ACD in children. These studies indicate high percentages of positive patch test reactions in tested pediatric populations. International positive patch test prevalence in pediatric patients ranges from 14% to 70%, with a 65.7% to 83% clinical relevance.⁸ Positive patch test prevalence in the United States ranges from 65.7% to 83%, with about a 51.2% to 77% clinical relevance.⁹⁻¹¹ Thus, patch testing can play a critical role in managing patients with allergic contact dermatitis.

Because it can be difficult to determine when ACD is contributing to another underlying eczematous dermatitis, The Sidebar lists some clinical clues to consider. Persistent, well-demarcated, linear, and geometric skin findings may be the first indication of ACD. The patch testing tool (described later) is critical in the elucidation of the allergens that may be the causative agents of the patient's dermatitis. For this reason, it becomes extremely important for both the pediatrician and dermatologist to consider ACD as a component for all patients with recalcitrant dermatitis.

Because the diagnosis of ACD requires a high index of suspicion clinically, we present diagnostic clues and detail common allergens that will help pediatricians recognize ACD in addition to recommending pearls for its appropriate management, which includes referral for patch testing.

IRRITANT CONTACT DERMATITIS VERSUS ALLERGIC CONTACT DERMATITIS

The three major contact dermatitides include allergic contact dermatitis (ACD), irritant contact dermatitis (ICD), and contact urticaria. Understanding the difference between the two major types (ACD and ICD) will help to avoid unnecessary workup and inadequate management. Irritant contact dermatitis (ICD) is the most common form, seen in approximately 80% of cases of contact dermatitis. ICD is characterized by a non-immunologic skin reaction secondary to exposure to any substance which is irritating to the skin. The severity of the reaction is directly proportional to the concentration and the time of exposure to the irritating agent. In children, common irritants include saliva, urine, feces, intestinal secretions, certain foods, harsh detergents, soaps, wipes, and bubble baths.^{12,13}

Allergic contact dermatitis (ACD), on the other hand, is a delayed type T-cell mediated hypersensitivity reaction (type IV). Initially, sensitization occurs when a small hapten penetrates the skin, becomes processed by Langerhans cells or dermal dendritic-antigen presenting cells (of the immune system), and then is later presented to a naïve T-cell in the lymph node. Presentation to the T-cell results in subsequent clonal expansion of memory T-cells. Upon re-challenge, the primed T-cells (clones) mount an immunologic response to a subsequent exposure to the same allergen (or cross-reacting substance), and thus elicit the clinical picture of ACD.¹⁴ This delayed-type reaction induces an inflammatory skin reaction with edema, erythema, and vesiculation that can either be localized to or distant from the site exposed to the allergen. It is important to note that the thresholds for sensitization vary among all individuals, and various factors may contribute to one's susceptibility including age and frequency, type, and duration of allergen exposure.¹¹ Some patients do

TABLE.

Common Allergens and Where to Find Them

Nickel	Jean snaps, buckles, orthodontics, eye glasses, school chair screws/nails, vitamins, dark chocolate, and some foods
Cobalt	Button snaps, zippers, braces, amalgams, vitamins (metals)
Neomycin and bacitracin	Neosporin, triple ointment, polysporin
Fragrance mix (geraniol, cinnamaldehyde, hydroxycitronellal, eugenol, cinnamol alcohol, and oak moss)	Baby lotions, soaps, deodorants, toothpaste, cosmetics, perfumes, colognes, scented candles
Quaternium 15	Shampoo, liquid soaps, preservative in cosmetics (formaldehyde releasing preservative [FRP])
Propylene glycol	Lubrication in moisturizers, hand sanitizers, antibacterial lotions, deodorants, snack foods, dessert mix packs, salad dressings, ibuprofen
Colophony	Sport racket handles, postage stamp, adhesives, tiles, shoes and shoe polishes, glues
Lanolin	Metal lubricants, rust preventers, and fiber treatments, skincare products and emollients, including Aquaphor, Eucerin
Balsam of Peru (Myroxylon pereirae)	Fragrance, flavor agent, tomato, sunscreen, toothpaste
Formaldehyde	Plywood, plastics, cosmetics, aspartame, instant coffee, personal hygiene products
Cocamidopropyl betaine	No tear shampoos, liquid soaps, toothpaste, contact lens solutions, hair conditioners.
Carbamates	Diapers, toys, rubber, balloons, elastic, shoes
Disperse blue	Blue dye, clothing, spandex, and Lycra, fabrics
Cinnamic aldehyde	Flavorant in toothpaste, chewing gum, ice cream, spices, soft drinks
Sorbitan sesquileate	Emulsifier in topical medicaments and cosmetics.
Potassium dichromate	Multivitamins, chrome-tanned leather, anti-rust paint, mascara, bleach
Para-phenylenediamine (PPD)	Hair dye, printing ink, temporary tattoos
Bronopol	Shampoos, diaper wipes, hair conditioners
Corticosteroids	Topical corticosteroid creams/ointments/lotions
Paraben mix	Preservative in cosmetics, creams, lotions, mustard.

Data from Militello et al.¹⁴ Skin and aging. Focus on T.R.U.E. test allergens.

*FRP: formaldehyde release preservatives

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not develop an allergy until after multiple repeated exposures to the allergen, while other more potent allergens elicit earlier and more intense reactions. For example, one of the best studied allergens known to elicit ACD is the oleoresin present in the *Toxicodendron* genus of plants such as poison ivy, sumac, and oak. Because of the marked temporal association with exposure to this allergen, many patients are able to diagnose themselves. When allergens are ubiquitous or found in low concentrations in, for example, personal

hygiene products or medicaments, the temporal association may not be so apparent. Three studies on patch tested North American pediatric populations were recently published, which demonstrated a significant overlap in allergen frequencies and clinical relevance with each other and adult data.^{10,11,15} The top allergens identified in these studies are common allergens in many of products available for use in the United States.

It is important to recognize the clinical relevance of positive patch test reac-

tions to the patient's current dermatitis. For example, patch test reactions to thimerosal, a mercuric derivative of thiosalicylic acid, have been shown to be of little clinical relevance in active dermatitis in both adults and children. Although a recent, 15-year meta-analysis found thimerosal, which is commonly used as a preservative in vaccines, to be the second most common allergen,¹⁶ the North American Contact Dermatitis Group (NACDG) and some tertiary centers, however, have determined this chemical



Figure 1. Perioral dermatitis in a patient with ACD to fragrance and flavor agents. (Picture by Dr. Sheila F. Friedlander.)

to be very unlikely to cause contact allergy. So these groups removed it from their standard screening panels.^{10,17} Regardless of this, manufacturers have begun using alternative preservatives in vaccines and other products.¹⁸ In fact, thimerosal is no longer found in any vaccines recommended for children under 7 years except for the inactivated influenza vaccine.¹⁹

Recognizing the top allergens is important if we are to exert a paradigm shift in this field and work towards regulating and removing common allergens from use.²⁰ Finally, we need to recognize that the potential exists for pediatric exposures to be quite different from adult exposures as products marketed for children may be unique to them.⁹ The composite data of the top 20 allergens from the three North American studies are compiled in the Table (see page 101).

CLINICAL PRESENTATION

ICD usually appears as a large erythematous patch in a discrete geometric pattern that is identical to the distribution of the offending-irritating chemical agent. ACD, however, may similarly appear in the same locations, but morphologically may appear erythematous and edematous with small coalescing eczematous vesicles and papules.²¹ The area of greatest allergen exposure will most likely have the most severe eczematous dermatitis, but occasionally, the site of exposure does not correspond to the location of active lesions. Also, distant or more generalized

eruptions may be associated with local allergen exposures and are commonly referred to as 'id' reactions.¹⁴

The location of dermatitis on the body also presents clues for diagnosis. Allergens found in clothing may cause worse dermatitis in locations where the clothing rubs against the skin such as flexural areas of the extremities.¹⁴ Conversely, cosmetic allergens such as fragrances may induce lesions on the face and neck where clothing is not covering the skin.

A THOROUGH PATIENT HISTORY

A thorough history is often beneficial in determining the causative allergens in patients' dermatitis, especially one that considers the time course necessary for an ACD reaction to develop. It is important to ask the patients or their parents/caretakers about hygiene products, clothing, footwear, jewelry, cosmetics, recent travel, new products, medicaments, herbal supplements, hobbies, extracurricular activities, and environments. Often, it also becomes useful to ask about parents' or siblings' products because of the potential indirect or even direct exposure from their products, often referred to as 'connubial' dermatitis.²²

Gender differences should also be taken into consideration in history taking because of a general higher risk for ACD in females,²³ which may potentially be caused by the increased use of cosmetics and jewelry. However, a high percentage of positive reactions to potassium dichromate (common in leather materials) and carba mix (common in rubber materials) may be due to exposure to athletic gear and equipment.²⁴ These considerations should be assessed during the initial consultation.

ALLERGODROMES

Following are common presenting pictures and allergens in children, which we call "allergodromes." These are common causative agents for pediatric dermatitis frequently seen in pediatricians' offices.

Diaper Dermatitis: Irritant versus Allergic

A common dermatologic reason parents bring their infants and toddlers to their pediatricians' and pediatric dermatologists' offices is diaper dermatitis.²⁵ One large prospective study reported 16% of children with a skin complaint as having diaper dermatitis, with the highest prevalence among infants between 9 to 12 months of age.²⁶

Diaper dermatitis may be secondary to either irritants or allergens, or both, and geographic clues may be helpful in discerning between the two. For example, if a patient presents with diaper dermatitis that affects the perineum with sparing of the intertriginous creases, the first suspected causative agent is usually an irritant in nature.²¹ This primary irritation is thought to occur secondary to the diaper's environment of moisture from urine and feces and fecal proteases that lead to low pH to further harm the skin. Irritation can also occur secondary to friction from the diaper itself as well as from any topical agents applied to the affected area.^{4,27} Glue used in the fabrication of diapers has also been implicated as an irritant in diaper dermatitis.²⁸ If the diaper dermatitis appears to be recalcitrant to common therapies including frequent diaper changes and the use of non- or less irritating barrier agents to protect the affected area, ACD should be suspected. Some chemicals used in the production of diapers have been reported to cause skin sensitization; for example dyes and fragrances used in the manufacturing of the diaper.^{21,29} Additionally, mercaptobenzothiazole (a rubber accelerator in the vulcanization process), p-tert-butyl-phenol-formaldehyde resin (a glue), and cyclohexyl thiophthalimide (a vulcanization retardant) have also been implicated.³⁰

It is important to note that baby wipes or moist towelettes can also cause a contact dermatitis in both the caregiver (presenting as hand dermatitis) and the patient.³¹⁻³³ These products often contain a

lotion component with various preservatives and fragrances.³¹ Common allergens in these products include fragrance and formaldehyde-releasing preservatives (FRP) such as quaternium-15, DMDM hydantoin, and bronopol, in addition to non-formaldehyde-releasing preservatives such as iodopropynyl butylcarbamate and methylchloroisothiazolinone (MCI)/ methylisothiazolinone (MI).^{31,33}

If ACD is suspected, one of the first recommendations a pediatrician can make is for dye-free and fragrance-free diapers and removal of baby wipes, which may result in significant improvement of the dermatitis.

Lip-licking Dermatitis

Lip-licking can lead to an irritant dermatitis that presents in a perioral distribution secondary to the repeated wet and dry cycles from saliva and subsequent air drying that disrupts the epithelial barrier and causes fissuring.³⁴⁻³⁶ Behavioral modification may be effective; however, behavioral changes may be difficult to achieve in small children, so emollients in the areas may provide additional barrier protection and should be recommended.³⁷

Cheilitis can also be caused by ACD to various products of daily use such as toothpaste, cosmetics, medications, and nickel.³⁸ Cocamidopropylbetaine has been implicated in one case as the cause of allergic contact cheilitis. This chemical is commonly found in rinse off products, cosmetics, acne treatments and skin care products.³⁹

Foot Dermatitis

When patients present for evaluation of atopic dermatitis, with eczematous plaques on unusual locations such as the feet, it is important to consider the role of chemicals in the footwear (socks and shoes) that may have come into contact with the affected skin as causative agents for the dermatitis.^{40,41} Components of the socks and shoes may provide useful information in assigning clinical rele-

vance to positive reactions to shoe-based chemicals. The most common allergens in footwear are mercaptobenzothiazole (a rubber accelerator),⁴² mercapto mix (a rubber accelerator chemical mix), thiuram mix (a rubber accelerator), and black rubber mix (a rubber antidegradant).⁴⁰

We advise always wearing socks with shoes, especially in today's milieu of foreign outsourcing and the difficulty in obtaining information regarding manufacturing ingredients from companies.⁴¹ Furthermore, because socks may contain elastic-based chemicals (which are highly prevalent in shoe-associated dermatitis), we recommend wearing 100% cotton socks, and even then changing them regularly (new socks every 3 months) because socks have been shown to absorb chemicals from shoes permanently.

Head (ear), Neck, and/or Wrist Dermatitis

Nickel

The distribution of eczematous reactions is critically important in diagnosing allergic contact dermatitis, especially when nickel or fragrance contact allergy is suspected.^{11,14} The exact prevalence of pediatric contact allergy is difficult to determine because of limited data and the fact that many patients are treated by pediatricians instead of dermatologists. When nickel is involved, classic sites of dermatitis distribution can be the earlobes (from earrings) and/or necks and wrists (from other jewelry), and infra-umbilical (from jean snaps).⁴³ In 1985, a study reported nickel allergy in 13% of those with pierced ears compared to 1% without piercings.⁴⁴ At that time nickel prevalence in U.S.-based patch test populations was reported to be 9.7%.⁴⁵ This year, Zug et al reported that the incidence of nickel allergy was 26%, which represents an alarming upward trend.¹¹

Pediatricians can recommend patients with known nickel allergy to obtain a confirmatory nickel detection testing kit,

several of which are commercially available. The easy-to-use nickel test kit consists of adding a drop of 1% dimethylglyoxime-ammonia (DMG-A) to a cotton tip applicator and rubbing the applicator against the suspected metal. The applicator turns pink when in contact with an object that contains nickel in a concentration of at least 1:10,000.

Nickel is one of the top allergens that induces systemic contact dermatitis.⁴⁶ In these cases, the dermatitis may be far more widespread. These patients may be incredibly difficult to treat due to the ubiquitous nature of nickel. For example, nickel is found in certain foods, so in patients exquisitely sensitized to nickel, dietary exposure can cause a dermatitis exacerbation or a more generalized response. Improvement with dietary restriction has been reported.^{47,48}

Fragrance

Fragrance allergy is not only common in the general adult population but also in the pediatric populations, especially in adolescent females.¹⁰ Potential sensitizers include perfumed products (scented sprays/candles, deodorants, shampoos, lotions, etc.). Often, the dermatitis is distributed in the head and neck areas, associated with the point of contact with the source. A pediatrician may initiate a fragrance-free regimen and find some immediate symptomatic relief.¹⁶ It is important for all clinical practitioners to be aware and emphasize that "unscented" and "scent-free" may actually denote the presence of masking fragrances/scents, and are not necessarily fragrance-free.¹⁴ It is imperative that patients are meticulous in reading the ingredient labels of all products to make sure fragrance/masking fragrance is not listed and that practitioners provide patients/families with safer alternative options.⁴⁹

Cocamidopropyl betaine, a quaternary ammonium detergent found in most "no-tears" shampoos, has also been found to be a potential allergen in pedi-

atric patients and may cosensitize with fragrances because of their frequent concomitant use.⁵⁰

Hobbies

It is also important to consider a patient's hobbies in evaluation of his/her dermatitis. For example, there is a report of a youngster who was an avid skateboarder and carried his skateboard by its metallic wheels; he had a positive patch test reaction to cobalt.⁵¹ Thiuram, which is a common allergen seen in footwear, is also found in toys, pacifiers, and sporting gear.¹⁴

Black Henna, Temporary Tattoos (fashion-culture dermatitis)

Children and adolescents frequently get temporary tattoos on vacations or on special occasions in certain cultures. Although allergy to natural henna dye that leaves a red to auburn color has been reported very rarely,⁵² there is increasing concern of ACD and hypersensitivity reactions to henna-based tattoos adulterated with hair dye [eg, p-phenylenediamine (PPD)].²⁰ PPD is frequently added to henna to deepen the intensity of the color and to accelerate its drying time.⁵³ PPD has proven to cause not only localized bullous and blistering reactions, but also anaphylactic-like responses in patients exposed to this chemical.^{54,55} Furthermore, even once the active dermatitis has resolved, residual pigment changes may remain, and sensitization to PPD may be permanent.^{20,54}

It is important to recognize that PPD can also cross-react with a number of para-amino benzoic acid-based chemicals, such as sulfonamides (antibiotics and diabetic medications), hydrochlorothiazides (anti-hypertensives), ester anesthetics, and disperse dyes (such as diaminobenzenes and diaminotoluenes).^{20,54,56} What is remarkable about this practice is that PPD has been banned from skin application in the United States since 1938.²⁰ We recommend that

pediatricians encourage their patients and parents to avoid black henna temporary tattoos. The use of natural henna without black dye additives for cultural celebrations (eg, mehndi tattooing) carries significantly less risk of reactions.

Cosmetics

Pediatricians must consider the use of cosmetics as possible culprits in patients' dermatitis, especially because "child cosmetics are marketed down to 3 years. Although prevalence studies have not been determined in the pediatric population, it was estimated in 1988 that 1% to 3% of the population was sensitive to a cosmetic product or related ingredient.⁵⁷ These data, however, are most likely significantly underestimated as cosmetic users often just switch to a different product instead of visiting a physician for treatment.⁵⁸

Increasingly, children are using various forms of cosmetics, including products for their nails.¹³ Most allergic reactions to nail polish and related nail products are to tosylamide/formaldehyde resin found in nail polish enamel, nail hardeners, and setting lacquers, and used to aid in nail polish flow, adhesion, shine, and durability.⁵⁸ Clinically, the symptomatic dermatitis can be distant from the applied sites, representing areas where the fingernails may frequently come in contact from itching or rubbing, such as the neck, face, lips, and eyelids,⁵⁸ which may baffle both the primary care provider and dermatologist. Additionally, this allergen may contribute to the flaring of a child's atopic dermatitis because of scratching.⁵⁹

Preservatives also are used commonly in cosmetics, and because they are commonly low-molecular weight compounds, they are common sensitizers for contact allergy.⁵⁸ Quaternium-15 and imidazolidinyl urea (formaldehyde-releasing preservatives) and the isothiazolinones have been reported to be the most common.⁶⁰

Ingested Substances that Can Cause ACD

Besides the association of nickel and fragrance-flavorants with systemic contact dermatitis (SCD) noted above, several other allergens have also been implicated in SCD. Because it is beyond the scope of this article, we direct the reader to key resources.^{61,62} Nevertheless, we want to highlight three other allergens reported to be associated with systemic contact dermatitis, not to suggest their greater importance but to demonstrate the importance of expanding the differential to include SCD in widespread dermatitis (eg, formaldehyde, propylene glycol and propolis).

Formaldehyde

Formaldehyde and the formaldehyde-releasing preservatives are substances that have been identified recently as important allergens in children with contact dermatitis.^{10,15} Of note, formaldehyde has been implicated in systemic reactions that include migraine headaches, asthma and generalized eczema.⁶³ In 2003, Hill and Belsito noted that aspartame, a synthetic sweetener that is metabolized to methanol and later into formic acid, was associated with SCD.⁶⁴ This association also has been noted to occur in children.⁶³ Aspartame may be found in children's chewable vitamins, gelatin, soft drinks, etc. For this reason, especially in exquisitely sensitized persons, we recommend avoidance of products and foods that contain aspartame.

Propylene Glycol

Propylene glycol also has been implicated in systemic reactions in previously sensitized individuals. The reaction can occur secondary to ingestion of certain foods that contain propylene glycol like salad dressings, desserts, and snack foods, as well as medicaments such as ibuprofen.⁶⁵ Its wide use is secondary to its multiple chemical characteristics, which include its preservative, humec-

tant, softener, and solvent properties. It is also found in topical medicines (eg, corticosteroids), cosmetics, and fragrances. It is important to note that external exposure to propylene glycol can also trigger a systemic reaction.⁶⁵

Propolis

When considering which materials and chemicals have come in contact with the symptomatic patient, it is just as important to consider also orally ingested items, as these have also been shown to exacerbate dermatitis. Sensitization to propolis is common, with approximately 1.2% to 6.6% of tested pediatric patients reacting.⁶⁶ Propolis, a wax-like substance made by honey bees (*Apis mellifera*), is often found in orally ingested substances such as cough syrups, oral pills, lozenges, toothpastes, lotions, ointments, cosmetics, and vitamins.⁶⁶ A case of a pediatric patient developing ACD from ingesting vitamins has been reported,⁶⁷ suggesting the importance of considering ingestible items as a potential cause of ACD.

ACD in Atopic Dermatitis (AD) Patients

It is also important to consider previously diagnosed atopic dermatitis patients as being susceptible to ACD because of their already altered barrier and their frequent use of the various topical steroids and antibiotics for their atopic management.^{23,42} Recent data from the University of Miami and the University of Pennsylvania found a high prevalence of clinically relevant patch test reactions in pediatric patients who also had AD.¹⁰ Likewise, NACDG substantiated these findings and showed that children with AD, unlike adults, had an increased risk for ACD; however, they were not more likely to have a positive patch test reaction than children without AD.¹¹

When clinically suspected, it is important to refer children with chronic dermatitis for patch-testing, because

determination of relevant allergens is imperative for the improvement or resolution of symptoms. Studies have shown significant improvement or resolution of recalcitrant dermatitis when avoidance has been instituted.^{42,68}

MEDICAMENTS

Neomycin, gentamicin, and bacitracin are all topical antibiotics with high rates of allergic contact sensitization,^{5,69,70} with neomycin being the second-most common allergen in North America and bacitracin the seventh most common.⁷¹ Many dermatologists recommend against the use of these common allergens whenever possible. Patients with AD are commonly treated with topical antibiotics for infected wounds or recalcitrant, eczematous, impetiginized plaques. Such chronic use may be responsible for elevated levels of sensitization to neomycin and bacitracin found in these patients and can also be a trigger for their flare-ups.⁷²

Topical corticosteroids, commonly used both over-the-counter and by prescription from dermatologists and primary care physicians for symptomatic treatment of dermatitis, can also induce contact allergy.⁷³ This form of ACD can be noted in atopic dermatitis patients whose primary lesions fail to resolve despite treatment with high potency corticosteroids.⁴² These patients could be sensitive to either the active ingredient in the topical steroid or to preservative in the topical medicament.¹⁴ Regardless, patients with recalcitrant atopic dermatitis who fail to improve, or even exacerbate, with topical steroid therapy should be referred for patch testing with a panel that includes screening agents for steroid and medicament allergy.

ACD to emulsifiers is considered uncommon; however, a series of pediatric patients has been reported to be allergic to sorbitan sesquioleate (SS), an emulsifier commonly found in products formulated for pediatric consumers (eg,



Figure 2. Geometric eczematous plaques on a patient with foot ACD to his tennis shoes components. (Photography by Dr. Lawrence Eichenfield, MD.)

diaper creams and moisturizers, in addition to topical steroid preparations used to treat dermatitis).⁷⁴ In addition, lanolin and wool alcohol are also used for their emulsifying and hydrating effects, which has been noted in ACD.⁷⁵

Treatment for children with recalcitrant dermatitis should also include anti-histamines. In children exquisitely sensitive to ethylenediamine, however, the avoidance of may be necessary. Hydroxyzine is part of the piperazine class of antihistamines (notably cross-sensitizing structurally with ethylenediamine-based topical products) used in the treatment of pruritus in children with eczema. Patch testing can identify these patients. There have been several case reports of systemic contact dermatitis, which is a delayed-type hypersensitivity reaction caused by a systemically administered substance, secondary to sensitization after chronic use of hydroxyzine.^{76,77}

WHAT IS PATCH TESTING?

The gold standard for diagnosis of ACD is epicutaneous patch testing. This diagnostic procedure involves the placement of individual chemicals constructed into panels of chambers that contain the suspected allergens under occlusion to unaffected areas on the back and inner arms of the patient affected with recalcitrant dermatitis. The first reading, along with the removal of the patches,

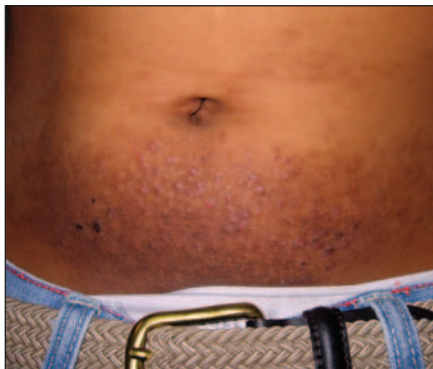


Figure 3. Patient with ACD to nickel. Jean snap/belt buckle sign. (Photograph by Dr. Bari Cunningham, MD.)

is usually performed 48 hours after initial placement; however, new evidence from the German group suggests that application time of 24 hours may be sufficient.⁷⁸ Subsequently, a delayed read is performed usually between 72 hours and 7 days (168 hrs), as a 48-hour read alone may miss 33% or more reactions.⁷⁹

Irritant reactions may be observed within the first 48 hours, but typically these resolve by the time of the delayed reading. It is important to assess the reactions based on the severity of erythema, induration, or blistering that occurs at the specific chamber site.⁸⁰ Once reactions are observed, it is then necessary, through history and investigation into environmental exposures and inspection of the patient's personal effects, to assign clinical relevance and direct avoidance measures for the patient and family to follow.

WHO TO PATCH TEST?

The Food and Drug Administration (FDA) approved a commercially available screening tool for ACD, the Thin-layer Rapid-Use Epicutaneous (T.R.U.E.) test, in 1997 for use in individuals older than 18 years. To date, the FDA has not formally approved patch testing in pediatric patients, despite many international studies demonstrating patch test utility in children and U.S.-based data demonstrating patch test clinical safety and efficacy.^{10,81} In general, experts suggest that in children

with chronic, recalcitrant, or progressing dermatitis or dermatitis involving the hands and face, patch test evaluations may be indicated.⁶⁸

Parents might be hesitant to have children undergo this epicutaneous diagnostic procedure, especially if they have had to endure prick testing (for evaluation of IgE-mediated type I hypersensitivity reactions) in the past, so it becomes the clinician's role to explain properly the differences and the potential clinical utility of the results.

Patch testing can also be cumbersome to perform, and a detailed history is especially important to determine which allergens to select in pediatric patients with smaller body surface area available for the application of chambers. Furthermore, certain distraction techniques in clinic such as videos and drawing materials may be invaluable in completing the examination, patch testing, and post-patch test education session.^{9,82} Psychosocial aspects of the child must be considered before engaging in this week-long evaluation tool.

TREATMENT

The basis of contact dermatitis treatment is appropriate irritant and allergen avoidance. Although topical emollients, corticosteroids, and calcineurin inhibitors as well as occasional and judicious use of oral corticosteroids may provide symptomatic relief, especially with antihistamines, recognition of the etiologic agent and subsequent avoidance is critical for sustained relief. We present this information to aid pediatricians in recognizing common patterns associated with specific high yield allergens (allergodromes) and to suggest some parameters for when a referral for patch testing is necessary for allergen detection and appropriate avoidance that can be clinically and economically effective.^{68,83} Education on avoidance subsequently becomes the mainstay of treatment for the parents and patients, and we also recommend that detailed

instructions also be sent to teachers and healthcare providers.⁹

RECOMMENDATIONS

The value of patch testing has become recognized increasingly in pediatric populations as the incidence and prevalence of ACD in these patients is remarkable. It is always important to consider contact dermatitis as the cause or potential contributor of a child's dermatitis, especially when the cutaneous lesions are in a discrete geometric pattern. Irritant contact dermatitis (ICD) is the more common form, while ACD is less common and immune-mediated. A thorough history is imperative to help delineate the causative irritants or allergens in these patients' dermatitis. To help treat these patients appropriately, we detail multiple 'allergodromes' that are important for both dermatologists and pediatricians to recognize.

Often, patients suffer from dermatitis caused by a variety of everyday sources, from hygiene products to cosmetics to hobbies to prescribed medications. Minor adjustments that promote allergen avoidance often can resolve the dermatitis, such as using only dye-free and fragrance-free diapers, promoting ways to break the habit of lip licking, using an emollient to increase the barrier protection around the lips, and always wearing 100% cotton socks with shoes. We also remind the reader to remember the known top allergens and to keep them in mind when observing the distribution of eczematous reactions, especially when they are suspicious for nickel or fragrance allergies. Fashion trends such as black henna tattooing and cosmetics are additional significant culprits of ACD. Affected patients may also have eczematous reactions distant from the site where the product is originally applied, related to rubbing or itching [eg, with the use of nail polishes due to tosylamide/formaldehyde resin (TSFR)].

Ingested substance, including nickel, fragrance-flavorants, formaldehyde, propylene glycol, and propolis can also induce systemic contact dermatitis. Pediatricians frequently care for children with atopic dermatitis, so in these patients, it is important to recognize how commonly ACD, secondary to contact allergy from topical medications such as antibiotics and corticosteroids, coexists with the primary dermatologic condition.

Determining which patients need to be referred for patch testing can be very difficult for both the dermatologist and the pediatrician. In general, we recommend that patch testing should be considered in children with chronic, recalcitrant, or progressing dermatitis, or dermatitis involving the hands and face. Patch testing will help to determine the agents responsible for inducing the cutaneous reactions; however, it will be up to the family and patient to adhere to a strict allergen avoidance regimen. In affected patients, topical emollients, corticosteroids, and calcineurin inhibitors and judicious use of systemic corticosteroids can be considered in conjunction with antihistamines for symptomatic relief as the avoidance regimen is instituted.

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