



Allergic contact dermatitis: Kids are not just little people



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Abstract Over the last ten years, there has been an increased awareness of allergic contact dermatitis (ACD) in children, in addition to adults. Historically, ACD was not considered a significant disease in the pediatric population. This may have been due to failure to employ patch testing, which is the gold standard for establishing a diagnosis of ACD. A number of epidemiologic studies now reflect upon the significance of positive patch tests in children and its utility in diagnosing ACD. While there is significant overlap among the most common allergens in children and adults, the patterns of exposure and sources of allergens can significantly differ, because children have distinct experiences related to their exposure to personal care products, articles of clothing, and time spent in play as opposed to work. Evaluation of the pediatric patient with dermatitis involves specialized knowledge in taking the pediatric history and specific techniques employed for successful patch test application.

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How does taking a history help uncover a culprit allergen?

When assessing children for potential contact dermatitis, practitioners should be aware that children might have different risk factors and presentations when compared to adults. Atopic dermatitis (AD) is more common in childhood, and the defect in the skin barrier in these patients may lead to a higher risk of contact sensitization.¹ Children with AD are often exposed to many different topical

medicines, moisturizers, soaps, bath additives, and dressings, serving to create their risk of sensitization through increased exposure in combination with skin barrier dysfunction.² Secondary ACD, as a consequence of an impaired skin barrier, is also observed in adults with lifelong or new onset AD, irritant dermatitis from wet-work occupations and hobbies, chronic leg ulcers, and genital dermatoses. Just as the history for an adult with suspected ACD includes questions regarding exposures related to occupation, hobbies, and personal care, a pediatric history for possible contact dermatitis should include assessment of the child's hobbies, sports, music, art, and other activities. It may be necessary to extend the history taking to include all caregiver contact, e.g: parents, grandparents, day care workers,

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neighbors, teachers, and coaches. For younger children, it can be useful to obtain a list of school activities to assess the potential allergens used in school projects such as glues, plants and flowers, rubber products and inquire about after school activities.

The age of the child may also affect the types of exposures, as well as the best strategies for eliciting a history. Infants and toddlers are often exposed to allergens applied by caregivers and may be inadvertently exposed to contactants on their caretakers (e.g. perfumes, hair dyes). For instance, if parents sprays cologne on themselves and then hold a child who is allergic to the fragrance, the pattern of contact dermatitis would differ from what would be seen in patients who spray the fragrance directly on themselves. Infants and toddlers may chew or drool on blankets or urinate in diapers, allowing allergens to leach out more readily. Children are shorter and more likely to play closer to the ground, and thus their rhus and other plant exposures can present on the face. Peri-orbital edema from contact dermatitis in children may be mistaken for cellulitis.³ Young children who are toilet training will use toilets seats many more times per day than an adult and can get irritant or allergic contact dermatitis from the seat itself or cleaning agents.⁴ For older children, goggles used in swimming or headsets used in multiplayer video games may contain potential allergens. Adolescents may not readily disclose their exposures. For instance, an adolescent who uses cologne for the first time or secretly goes to a bonfire, where rhus is accidentally burned, may not readily admit it.

An advantage of evaluating potential contact dermatitis in children is that parents are typically very motivated to find the cause for their children's often exuberant and recalcitrant eruptions. Parents will readily keep journals to track exposures and can help their children to comply with avoidance and therapy.

From an epidemiologic standpoint, many companies are shifting pediatric products to be more "natural," and thus we may see an increase in exposure and resultant allergy to botanical ingredients. Notably, these natural products may still contain allergenic preservatives, such as methylchloroisothiazolinone (MCI) and formaldehyde releasing preservatives FRPs.

How does the patch testing technique differ in children compared to adults?

Patch testing is not FDA indicated in children, although it has been shown in clinical trials to be safe and effective in a trial of children from 6-17 years of age,⁵ and of note there are reports of using patch testing in children as young as 6 months of age.⁶ Even though it is deemed safe and effective, the theoretical risk of sensitization through allergen application should be explained to parents during the informed consent for patch testing. Children also have less body surface area on which to apply patches, and the patches to be applied need to be chosen judiciously.

The "gold standard" for the diagnosis of allergic contact dermatitis in children, as in adults, is the epicutaneous patch test. At the present time, the commercially available patch test device approved for adults by the Food and Drug Administration (FDA) in 1994 does not carry an indication for children, even though it has been shown to be both clinically sound in the diagnosis of contact allergy in the pediatric population and safe.⁴ In addition, a larger scale Pediatric Research Equity Act (PREA) trial has been conducted to evaluate the safety and efficacy of this device [The Thin-layer Rapid Use Epicutaneous (T.R.U.E.) Test (Mekos Laboratories A/S, Hillerød, Denmark)] with all 3 pre-made panels in subjects aged 6 to 18 years, which confirmed the prior observations.⁴

One issue with this pre-made device is that it is a screening agent with a set number of specific allergens, and there is no allowance for interchanging allergens, based on relevant exposure history. This is important, because a significant number of centers select allergens and patch test children, based on specific exposure history and the regional distribution of dermatitis (eg: quaternium 15 in hand dermatitis, para-phenylene diamine in patients with reactions to black henna tattoos). By selecting exposure-history based allergens, the clinician is better able to hone in on the probable causative agent, maximize the probability of finding a relevant true positive, and work with the limited space that a child's back affords. In addition, allergens deemed to have low clinical relevance (eg: gold and thimerosal) may be eliminated and exposure to irrelevant allergens reduced.

Allergen concentrations and other technical aspects of patch testing have been reviewed for pediatric patch testing.⁷⁻¹¹ The general consensus for adolescents aged 13 years or older is that they can be tested by the standard method performed in adults, with allergen removal at 48 hours and delayed readings at 96 and 120 hours.^{10,12-16}

In addition, the T.R.U.E.TM test and American Contact Dermatitis Society Core 80 series are thought to be appropriate screening tools in adolescents. For children 6-12, most contact dermatitis clinics use the standard allergen concentrations. Experience varies, and some centers conform to a 24-hour application period^{15,17} especially in children with AD or generalized dermatitis, to reduce irritant reactions.

In children less than 6 years of age, patch testing is usually reserved for cases with high indices of suspicion. Of note, several studies have noted a peak prevalence in patients 3 years and younger,¹⁰ and thus the diagnosis of ACD should not be overlooked in this population.¹⁸ In the non-atopic 3-6 year old age group, some providers use the standard concentrations of allergens with a 24-48 hour application and standardized screening trays^{10,19}, while others select allergens by history and perform a 24 hour application time, a 72, 96 and 120 hour read.⁸ One must also consider that in young children there may be a greater level of activity, both during application of the patch test and while the patches are in

Table 1 Important Allergens to consider in Children ^{^^}

Allergen	Description
Nickel [^]	Metal - alloys (naturally in chocolate, peanut butter, pinto beans, and oats)
Cobalt [^]	Metal - often alloy with nickel
Potassium dichromate	Metal - derived from chromium
Gold ^{* #}	Metal - precious
Budesonide	Corticosteroid [triamcinolone group] (Group 2)
Tixocortol pivalate	Corticosteroid [hydrocortisone group] (Group 1)
Propylene glycol [^]	Preservative, solvent/moistening agent
Lanolin	Emollient
Neomycin sulfate	Topical antibiotic
Bacitracin	Topical antibiotic
Colophony	Fragrance/Adhesive – distillation product of conifers
<i>Myroxylon pereirae</i> (balsam of Peru)	Fragrance/flavorant – tree resin (naturally cross reacts with chemicals in tomatoes/ketchup)
Fragrance mix 1	Mix of 8 fragrances: <i>cinnamic alcohol, cinnamic aldehyde, a-amylcinnamic alcohol, geraniol, hydroxycitronellal, eugenol, isoeugenol, and oak moss absolute</i>
Fragrance mix 2	Insert ingredients
Formaldehyde [^]	Preservative
Quaternium-15 [^]	Preservative- formaldehyde releaser
Bronopol [^]	Preservative- formaldehyde releaser
Imid Urea [^]	Preservative- formaldehyde releaser
Diad Urea [^]	Preservative- formaldehyde releaser
Thimerosal ^{* #}	Mercuric preservative, vaccine related source
p-tert butyl formaldehyde resin [#]	Adhesive and neoprene cement allergen
Carbamates	Rubber accelerator
Thiuram [^]	Rubber accelerator
Para-phenylenediamine [#]	Hair dye chemical, black henna tattoos
Disperse dyes (blue 106/124; yellow 3/9)	Aniline dye
Compositae mix/ parthenolide	Ragweed family plant allergens (Daisy, Dandelion)

* contact sensitization seen, low relevance

[^] irritant reactions may be seen, especially in patients with AD and the very young

[#] test when history directs potential clinical relevance

^{^^} based on the Textbook of Clinical Pediatrics chapter defining the 20 pediatric allergens reported ubiquitously by multiple authors in the U.S.A, Canada, Europe (Germany, Italy, U.K., France, Spain, Belgium), and Brazil

place. A significant amount of time may be necessarily spent in physically reinforcing the patches with medical tape (Hypafix™) and emotionally reinforcing the need to keep the patches secure and in place for a minimum of 24 hours. Discussion with the child and family around a motivational incentive (rewards system), for cooperating with the patch test procedure (special lunch, toy, book etc.) may be necessary.²⁰ Distraction tools, such as games, drawing, and videos, may need to be incorporated to assist during the patch application.²¹

While children under 1 year of age have been patch tested and found to have clinically relevant allergens,²⁰ patch testing in the under 3 years of age population can be a challenge. A greater number of irritant reactions may be seen, compliance with patch application may be reduced (young children are less likely to leave the patches in place), and distraction tools may not suffice.²² Reduced concentra-

tions may be necessary, especially in patients who meet the Hanifin and Rajka criteria for AD. Note, if irritation is not seen and there is substantial reason to believe a false negative reaction has occurred, then the patch tests would need to be repeated. In the higher (standardized) concentrations for the allergens. USA most children with contact dermatitis will not be patch tested. In a recent report analyzing the first three North American published studies (over a two to ten year period) in pediatric contact dermatitis, the summation was that a total 592 affected children were tested by a total of 19 patch testers over an average of 5.3 years (an average of six patients per year).²³ While these numbers are staggeringly small, the data are useful and indicate that patch testing is needed. Given the growing body of knowledge at US centers regarding patch testing children, it is probably prudent to state that children under 2 years of age may best be served by testing with the comprehensive technique, which means

Table 2 Regional Dermatitis More Prevalent in Children

Region	Product/Allergen
Eyelids	Shampoos, cleansers – cocamidopropyl betaine; Metals e.g. nickel from hands to face – toys, coins, keys
Face	Cell phones – nickel and chromate; connubial –PPD, fragrance
Perioral	Musical instruments – nickel; flavored lip balms; chewing gum – flavorings; pacifiers - rubber
Neck	Cell phones – nickel; atomizer sign - fragrance
Ears	Costume jewelry, wireless headsets – nickel
Diaper	Baby wipes – preservatives; diapers – mercaptobenzothiazole, para-tertiarybutyl-phenol-formaldehyde resin
Thighs	Toilet seat – wood, plastic, cleaners (irritant); chairs – nickel bolts
Extremities	Shin guards, splints – urea formaldehyde resin, thioureas
Scalp	Car seats
Trunk	Nickel clothing snaps on infant clothing ⁶⁸
	Breast and nipple dermatitis from PTBFR in padded training bras ⁵²
Feet	Shoes- PTBFR, rubber accelerants in children's shoes e.g. Crocs TM ⁶⁹

allergen selection based primarily on exposure history so as to minimize unnecessary exposure and to adjust for the limited surface area for patch placement.¹¹

What are the most common culprit allergens in different age groups?

In a recent report from a USA referral center, the top culprit allergens were analyzed and compared against those from other North American Contact Dermatitis Clinics, where children had been evaluated, namely: Mayo Clinic (pediatric, 2000-2006 data),²⁴ Ottawa Clinic (pediatric data, 1996-2006),²⁵ and the North American Contact Dermatitis Group (pediatric data, 2001-2004).²⁶ There are a number of allergens that were found ubiquitously across nearly all pediatric age groups, namely: *Myroxylon pereirae*, cobalt chloride, neomycin sulfate, fragrance mix, gold sodium thiosulfate, thimerosal, and formaldehyde.²⁷ See Table 1. Notably, in this recent report, patients aged 10 months to 16 years were patch test evaluated, and 76.7% of the patients were found to have positive patch tests (PPTs) that were of definite or probable clinical relevance. Probably due to referral bias, many of the patients also carried a diagnosis of AD.²¹

It has been suggested that due to immunosenescence that elderly patients should be less vulnerable to ACD; however, retrospective analysis of patch test data from the North American Contact Dermatitis Group (1994-2008) showed that adults 65 years and older had similar rates of positive patch test reactions similar to younger adults and higher rates than children. Allergens for which reaction rates were statistically higher in older adults than both younger adults and children included *Myroxylon pereirae*, fragrance mix I, neomycin, bacitracin, carba mix, formaldehyde, and FRPs. Reaction rates to p-phenylenediamine and thiuram mix were higher in older adults than in children, but not higher than in younger adults. Reaction rates to nickel, thimerosal, and cobalt were lower in older adults than in younger adults and

children. Reactions to gold were significantly lower for older adults and children than for younger adults.²⁸

Which allergens are associated with regional contact dermatitis in children and adults?

Similar to adults, children are most commonly sensitized to allergens that are ubiquitous in the environment. As chronic ACD may be difficult to distinguish clinically and histopathologically from other spongiotic forms of dermatitis with chronicity (such as AD or nummular dermatitis), there needs to be a high index of suspicion prompting evaluation for this diagnosis. While the common allergens in adults and children may be somewhat similar, there are some differences in prevalence rates, and there can be quite a bit of variability in the mode of exposure to these allergens. The distribution of allergen specific ACD may differ between adults and children due to the variation in behavior and activities. The legs, feet, hands, and face are the areas most frequently affected in the pediatric population.²⁹ This is primarily due to exposure to metals, footwear, topical medications, and cosmetics. Knowledge of the unique regional presentations of contact dermatitis in the pediatric population and understanding the age dependent changes in lifestyle may provide significant clues to the cause of ACD. See Table 2.

Facial

The face has been shown to be the most common location for ACD in children and adolescents.³⁰ In both adults and children, the eyelids and periorbital skin are particularly prone to ACD due the increased permeability of the eyelid skin and the fact that it is almost always exposed to the external environment.³¹ Sources of eyelid ACD common to both children and adults include aerosolized products, nail products, metal particles from hands to face, and medications and preservatives in ophthalmic preparations.³² Cocamidopropyl

betaine is a highly relevant allergen in the pediatric population and a common source of eyelid ACD.²⁵ Other potential sources more prevalent in children include allergens in sports gear from swimming goggles.³³ In adults, fragrances are a significant cause of eyelid ACD.³⁴

Unilateral facial dermatitis in a preauricular or lateral facial distribution should raise suspicion of cellular phone dermatitis. This is an emerging condition, and the responsible allergen is usually nickel and much less commonly chromate.³⁵ Out of 26 cases of cellular phone dermatitis most of the cases involve young adults between ages 18 – 35 with five patients younger than 18.³⁶ One study looking for the presence of free nickel in wireless communication devices determined that the presence of nickel is usually on the menu buttons and sometimes on the liquid crystal display frames.³⁷ When unilateral facial dermatitis presents in the infant and toddler age group, it is important to consider connubial contact dermatitis from para-phenylenediamine in hair dye, usually from recently dyed hair in the mother or from fragranced products used by the mother.^{20,38}

Perioral

Cheilitis in both children and adults can be either irritant or allergic in nature. The most common irritant dermatitis cause is from lip-licking, which presents in a perioral distribution secondary to repetitive wet and dry cycles. While uncommon, metal orthodontic devices made of stainless steels, chrome-cobalt, and nickel-titanium can cause perioral dermatitis. This can be angular or circumoral in distribution.³⁹ Another potential source includes nickel in the mouthpiece of musical instruments, as children are more likely to be playing instruments with worn coating and exposed nickel.⁴⁰ There are also both common and unique potential sources of ACD in a circumoral distribution, including rubber allergens from pacifiers in the infant and flavorings in chewing gum.^{29,41} Adults have greater exposure to lip cosmetics, dental hygiene products including toothpastes and whiteners, and a wider range of potential dietary culprits.

Axillary

Axillary contact dermatitis is more common in adults than in children, because adults use products to minimize perspiration and mask its odor. In addition, perspiration in adults can result in leaching of textile dyes from garments and lead to axillary ACD.

Hands

An analysis of hand dermatitis due to ACD identified preservatives, metals, fragrances, topical antibiotics, and rubber additives as the most common causative allergens.⁴² Although these allergens are found on screening standard

allergen patch test series, more specialized testing with allergens specific to a patient's occupation or testing to dilutions of the patient's specific exposures (such as cutting oils) may be warranted in adults with hand dermatitis. Certain patterns of hand dermatitis are more common with different allergens: dyshidrosiform dermatitis from metals; fingertip dermatitis in florists and dental and professionals from Alstroemeria and acrylics, respectively; dorsal hand and circumferential wrist dermatitis from accelerators in rubber gloves.

Feet

Perspiration from feet can promote shoe/textile dermatitis in both adults and children. A recent publication of positive relevant patch tests in patients with juvenile plantar dermatides underscores the importance of considering secondary ACD in patients with primary dermatides.⁴³

Legs

ACD affecting the legs in adults is commonly seen as a complication of stasis dermatitis, especially when a leg ulcer is present. Leg ulcer patients have been found to be sensitized to a variety of allergens including lanolin, balsam of Peru and fragrance mix, rubber allergens, topical antibiotics, and preservatives including FRPs.⁴⁴ In children, ACD affecting the legs is most likely a reaction to a garment, athletic guard, or brace worn for sports related activities/injuries or prosthetic devices.

Bathing Trunk/Diaper/Genital

Children seem uniquely susceptible to contact dermatitis in this area, largely due to dependency on diapers and the prolonged contact with toilet seats in the training period and beyond. Potential sources of toilet-seat dermatitis include exotic wooden toilet seats and associated paints, varnishes and lacquers.^{45,46} More recently, there have been cases of ACD to polypropylene in plastic toilet seats and school chairs.⁴⁷ The typical distribution involves the buttocks and posterior aspects of the thighs. In a related scenario, nickel screws and legs in a school chair can affect this same distribution.⁴⁸ Notably, irritant contact dermatitis can also manifest in the "toilet seat" distribution from strong irritants in harsh detergents used to disinfect toilet seats both in the home and in public restrooms.³

Because the diaper area is usually spared in childhood AD, there should be a high clinical suspicion of ACD, when a well-demarcated dermatitis is present in this distribution. This can be difficult to distinguish from infantile psoriasis in this distribution; however, psoriasis is usually more elevated and may have silvery scale and more scalloped borders to the plaques.⁴⁹ This area is uniquely susceptible to ACD, as the allergens are held in contact with the skin for prolonged

periods under moist, humid conditions. ACD to diaper-associated chemicals is seen in children. The most common allergens include mercaptobenzothiazole, fragrance mix, cyclohexylthiophthalimide, p-tert-butylphenol resin, sorbitan sesquioleate and historically disperse dyes.⁵⁰ Disposable diapers have been associated with a number of cases of ACD due to a variety of allergens. The initial disposable diapers were coated with rubber material to prevent leakage giving rise to a “gun holster” distribution of dermatitis in these infants and children. The allergens included mercaptobenzothiazole and para-tertiarybutyl-phenol-formaldehyde resin (PTBFR).⁵¹ As the diapers evolved, reports began to surface of the dyes portion of the diapers causing an ACD at the diaper margins including the inner thighs, hips, and waist-band region. In these cases, the culprit was various disperse dyes used in the colored portion of the disposable diapers.⁵² In another report, the prominent portion of the genital region and areas just inferior were affected from an allergen in a specific brand of diapers.⁵³

Adults can also show reactions in these locations from components of pads for incontinence and menstruation, wet wipes for cleansing, fragrances, rubber allergens, and topical medicaments. Corticosteroids are often implicated, when ACD complicates genital dermatides.

Systemic Contact Dermatitis

There are increasing reports of systemic allergic contact dermatitis in children. *Myroxylon pereirae* or Balsam of Peru is one of the more common systemic allergens and has been reported in foods and other edible items more frequently consumed by children. One such report demonstrated a systemic contact dermatitis to *Myroxylon* with ketchup and pizza sauce as the main source of the allergen.⁵⁴ Carnauba wax and propolis, which can cross react with a component of *Myroxylon*, were shown to cause both a systemic contact and a local reaction with the source being children’s vitamins and a cherry flavored lip balm respectively.⁵⁵ A series of papers in *Dermatitis*, the journal of the American Contact Dermatitis Society, identify dietary strategies to minimize systemic contact dermatitis for patients allergic to common food ingredients including nickel, balsam of Peru, benzoic acid, and propylene glycol.^{56–58}

Emerging patterns of pediatric ACD

Arms and legs – Shin guards used in soccer have been reported in children who play soccer, basketball, rollerblading, and field hockey. The causative allergens are thought to be a para-tert-butyl-formaldehyde resin^{25,59} or dialkyl-thiourea accelerators.⁶⁰ These same allergens are responsible for reactions underlying splints so frequently worn by children after the classic presentation for this association is involvement of the child’s contact points including the sports-related injuries and bras.⁶¹

Car seat dermatitis-occipital scalp, elbows, thighs, calves with the nylon covering on car seats⁶²

Prominentia laryngea (Adam’s apple) – This is coined the atomizer sign and occurs in fragrance-sensitized women and girls with repeated open application of fragrances to the anterior part of the neck.⁶³

Face, diaper, hands – Reports are emerging in children secondary to preservatives including MCI, iodopropynyl butylcarbamate, and other black preservatives.^{64,65}

Tattoo distribution – Temporary henna tattoos are increasingly popular among children. Sensitization to (PPD) followed by severe allergic reactions at the site of the tattoo have been reported when the temporary natural henna is adulterated with PPD.⁶⁶ In children with glucose-6-phosphate deficiency, topical application of henna may cause life-threatening hemolysis.⁶⁷

What is the best approach to allergen avoidance in children?

Although the allergen sensitization profile of children and adults may be similar, the education and counseling after patch testing in the pediatric population is distinctly different from the adult patient. The first goal of treatment of allergic contact dermatitis (ACD) is identification of the offending allergens followed by stopping the culprit allergen.⁷⁰ Children have less control over their environment than adults. For example, there have been several reports of connubial contact dermatitis in children from their parents. These children presented with facial dermatitis proven to be associated with paraphenylenediamine in the mother’s freshly dyed hair or fragrance from the mother’s perfume.^{71,34}

When the child is found to have possible or definite allergens, it is important to educate all of the individuals involved in their care. This often includes family members e.g. grandparents, hired caretakers, teachers, school nurses, day care personnel, coaches, friends and their parents, neighbors, and many other individuals involved in the daily life of the child. It is of utmost importance to educate the parents, as they will ultimately need to implement the avoidance plan with everyone who interacts with the child. Carving out appropriate time to educate the parents in person needs to be a priority, as they need to understand the allergen and expect potential relapses. When possible, the child needs to be engaged in the education. When this is not practical in a very young child, it may be necessary to employ child distraction tools.

Part of this process of education also involves establishing relevance for a positive patch test. There is only a partial concordance between a positive patch test and ACD.¹⁵ Just because a child is allergic to fragrance does not mean he or she has to avoid all fragranced products.⁷² Determining relevance usually involves a subsequent follow up visit with the patient and parents to assess the level of improvement. It

is often helpful for parents to bring objects including toys and costume jewelry frequently played with to the clinic at these visits, as this will often elucidate relevance.⁷³ Electronic gaming toys e.g. the Xbox or computers are often potential sources of nickel exposure.⁷⁴ First generation iPads®⁷⁵ may contain nickel and lead to a generalized dermatitis in nickel allergic children. Provocative use testing is another way to determine relevance. This involves applying a small amount of the product to the area of typical use and observing for a reaction. Similarly, a repeat open application test (ROAT) can be used. This involves applying a small amount of the leave-on product to the antecubital fossae twice a day for seven to ten days and observing for an eczematous reaction on a daily basis.

Children and their parents have unique requirements before and after patch testing is performed. Children are often bored and impatient during the rather complex pre- and post-procedure counseling session. Strategies to relieve some of this include the use of videotapes to distract the children and/or role playing games.²² In addition, many children have pre-conceived fears about patch testing, as they have already undergone prick testing by an allergist. One suggested measure is to demonstrate the procedure on the parent in clear view of the child. In addition, children can draw a picture of their experience, which can be shared with other children.⁷⁶

It is also necessary to educate the parents about contact dermatitis. They need to understand that patch testing is only one aspect of the overall evaluation and management plan and that patch testing could potentially provide a negative result which would still be of clinical value. They also need education in the logistics, including how to keep the patches dry by avoiding submersion bathing of the children and keeping them away from activities that cause excessive perspiration. This can be challenging in many normally active children. Parents also need counseling on stopping topical medications and creams prior to patch testing, if they are being applied to areas where the patches will be applied, and to continue to apply them to 'flare' areas during patch testing. Lastly, the parents need to understand that multiple visits will be required for patch test placement and reading so that they can coordinate their schedules and the child being away from school.⁷⁷

Conclusions

To encourage adherence to medical advice on contact allergies, parents and other caretakers need to be provided with alternative products without the allergens. The American Contact Dermatitis Society (info@contactderm.org) has developed a database of personal care topical products, called the Contact Allergen Management Program (CAMP). Clinicians can provide caretakers with an alternative products list free of allergens by using this database.

References

- Seidenari S, Giusti F, Pepe P, Mantovani L. Contact sensitization in 1094 children undergoing patch testing over a 7-year period. *Pediatr Dermatol*. 2005;22:1-5.
- Thyssen JP, McFadden JP, Kimber I. The multiple factors affecting the association between atopic dermatitis and contact sensitization. *Allergy*. 2014;69:28-36.
- Canan H, Altan-Yaycioglu R, Durdu M. Periocular Paederus dermatitis mimicking preseptal cellulitis. *Can J Ophthalmol*. 2013;48:121-125.
- Litvinov IV, Sugathan P, Cohen BA. Recognizing and treating toilet seat contact dermatitis in children. *Pediatrics*. 2010;125:e419-e422.
- Jacob SE, Herro EM, Sullivan K, Matiz C, Eichenfield L, Hamann C. Safety and efficacy evaluation of TRUE TEST panels 1.1, 2.1, and 3.1 in children and adolescents. *Dermatitis*. 2011;22:204-210.
- Manzini B, Ferdani G, Simonetti V, et al. Contact sensitization in children. *Pediatr Dermatol*. 1998;15:12-17.
- Weston WL, Weston JA, Kinoshita J, et al. Prevalence of positive epicutaneous tests among infants, children, and adolescents. *Pediatrics*. 1986;78:1070-1074.
- Hogan PA, Weston WL. Allergic contact dermatitis in children. *Pediatr Rev*. 1993;14:240-243.
- Jacob SE, Burk CJ, Connelly EA. Patch testing: Another steroid-sparing agent to consider in children. *Pediatr Dermatol*. 2008;25:81-87.
- Roul S, Ducombs G, Taieb A. Usefulness of the European standard series for patch testing in children. A 3-year single-centre study of 337 patients. *Contact Dermatitis*. 1999;40:232-235.
- Worm M, Aberer W, Agathos M, Becker D, Brasch J, Fuchs T, Hillen U, Hoyer P, Mahler V, Schnuch A, Szliska C, German Contact Dermatitis Research Group (DKG). Patch testing in children-Recommendations of the German Contact Dermatitis Research Group (DKG). *J Dtsch Dermatol Ges*. 2007;5:107-109.
- Mortz CG, Lauritsen JM, Binslev-Jensen C, Andersen KE. Contact allergy and allergic contact dermatitis in adolescents: prevalence measures and associations. The Odense adolescence cohort study on atopic dermatitis and dermatitis (TOACS). *Acta Derm Venereol*. 2002;82:352-358.
- Lacahapelle JM, Maibach HI. Patch testing, prick testing – A practical guide. Berlin: Springer. 2003.
- Rietschel RL, Rosenthal LE, NACDG. Standard patch test screening series used diagnostically in young and elderly patients. *Am J Contact Dermat*. 1990;1:53-55.
- Camarasa JMG, Aspiolea F, Alomar A. Patch tests to metals in childhood. *Contact Dermatitis*. 1983;9:157-158.
- Mortz C, Andersen KE. Allergic contact dermatitis in children and adolescents. *Contact Dermatitis*. 1999;41:121-130.
- Admani S and Jacob SE. Allergic Contact Dermatitis in Children: Review of the Past Decade. *Curr Allergy Asthma Rep*, <http://dx.doi.org/10.1007/s11882-014-0421-0>.
- Jacob SE, Herro EM. Patch testing in young children should not be overlooked. *Dermatitis*. 2013;24:258-259.
- Belloni Fortina A, Romano I, Peserico A, Eichenfield LF. Contact sensitization in very young children. *J Am Acad Dermatol*. 2011;65:772-779.
- Beattie PE, Green C, Lowe G, Lewis-Jones MS. Which children should we patch test? *Clin Exp Dermatol*. 2006;32:6-11.
- Jacob SE. Avoid the shriek with shrek: Video-distraction assist for pediatric patch testing. *Dermatitis*. 2007;18:179-180.
- Fisher AA. Childhood allergic contact dermatitis. *Cutis*. 1975;15:635-642.
- Jacob SE, Breithaupt A. Environmental Exposures – A Pediatric Perspective on Allergic Contact Dermatitis. *Skin Aging*. 2009:28-36.
- Wetter DA, Davis MDP, Yiannias JA, Cheng JF, Connolly SM, el-Azhary RA, et al. Patch test results from the Mayo Clinic Contact Dermatitis Group, 1998–2000. *J Am Acad Dermatol*. 2005;53:416-421.

25. Hogeling M, Pratt M. Allergic contact dermatitis in children: the Ottawa Hospital patch testing clinic experience, 1996-2006. *Dermatitis*. 2008;19:86-89.
26. Zug KA, McGinley-Smith D, Warshaw EM, Taylor JS, Rietschel RL, Maibach HI, Belsito DV, DeLeo VA, Marks JG, Mathias CG, Sasseville D. Contact allergy in children referred for patch testing: North American Contact Dermatitis Group data, 2001-2004. *Arch Dermatol*. 2008;144:1329-1336.
27. Jacob SE, Yang A, Herro EM, Zhang C. Contact Allergens in a Pediatric Population: association with atopic dermatitis and comparison with other North American referral centers. *J Clin Aesthet Dermatol*. 2010;3:29-35.
28. Warshaw EM, Raju SI, Fowler JF, Maibach HI, Belsito DV, Zug KA, et al. Positive patch test reactions in older individuals: retrospective analysis from the North American Contact Dermatitis Group 2004-2008. *J Am Acad Dermatol*. 2012;66:229-240.
29. Pigatta P, Martelli M, Marsili C, Fiocchi A. Contact dermatitis in children. *Ital J Pediatr*. 2010;36:2. <http://dx.doi.org/10.1186/1824-7288-36-2>.
30. Duarte I, Lazzarini R, Kobata CM. Contact Dermatitis in Adolescents. *Am J Contact Dermat*. 2003;14:200-204.
31. Rougier A, Dupuis D, Lotte C, Wester RC, Maibach HI. Regional variation in percutaneous absorption in man: measurement by the stripping method. *Arch Dermatol Res*. 1986;278:465-469.
32. Lee PW, Elsie ML, Jacob SE. Allergic contact dermatitis in children: common allergens and treatment: a review. *Curr Opin Pediatr*. 2009;21:491-498.
33. Vaswani SK, Collins DD, Pass CJ. Severe allergic contact eyelid dermatitis caused by swimming goggles. *Ann Allergy Immunol*. 2003;90:672-673.
34. Wenk KS, Ehrlich A. Fragrance series testing in eyelid dermatitis. *Dermatitis*. 2012;23:22-26.
35. Rajpara A, Feldman SR. Cell phone allergic contact dermatitis: case report and review. *Dermatol Online J*. 2010;16:9.
36. Berk DR, Bayliss SJ. Cellular phone and cellular phone accessory dermatitis due to nickel allergy: report of five cases. *Pediatr Dermatol*. 2011;28:327-331.
37. Luo J, Bercovitch L. Cellphone contact dermatitis with nickel allergy. *CMAJ*. 2008;178:23-24.
38. Nijhawan RI, Jacob SE. Connubial dermatitis revisited: mother-to-child contact dermatitis. *Dermatitis*. 2009;20:55-56.
39. Leenen RL, Kuijpers-Jagtman AM, Jagtman BA, Katsaros C. Nickel allergy and orthodontics. *Ned Tijdschr Tandheelkd*. 2009;116:171-178.
40. Jacob SE, Herro EM. School-issued musical instruments: a significant source of nickel exposure. *Dermatitis*. 2010;21:332-333.
41. Militello G, Jacob SE, Crawford GH. Allergic contact dermatitis in children. *Curr Opin Pediatr*. 2006;18:385-390.
42. Warshaw EM, Ahmed RL, Belsito DV, DeLeo VA, et al. Contact dermatitis of the hands: cross-sectional analyses of North American Contact Dermatitis Group Data, 1994-2004. *J Am Acad Dermatol*. 2007;57:301-314.
43. Darling MI, Horn HM, McCormack SK, Schofield OM. Sole dermatitis in children: patch testing revisited. *Pediatr Dermatol*. 2012;29:254-257.
44. Balato A, Balato N. Contact Sensitization in the elderly. *Clin Dermatol*. 2011;29:24-30.
45. Holme SA, Stone NM, Mills CM. Toilet seat contact dermatitis. *Pediatr Dermatol*. 2005;22:344-345.
46. Exxedine K, Rafli N, Heenen M. Lymphomatoid contact dermatitis to an exotic wood: a very harmful toilet seat. *Contact Dermatitis*. 2007;57:128-130.
47. Heilig S, Adams DR, Zaenglein AL. Persistent allergic contact dermatitis to plastic toilet seats. *Pediatr Dermatol*. 2011;28:587-590.
48. Samimi SS, Siegfried E, Belsito DV. A diagnostic pearl: the school chair sign. *Cutis*. 2004;74:27-28.
49. Silverberg NB. Update on pediatric psoriasis, part 1: clinical features and demographics. *Cutis*. 2010;86:118-124.
50. Smith WJ, Jacob SE. The role of allergic contact dermatitis in diaper dermatitis. *Pediatr Dermatol*. 2009;26:369-370.
51. Roul S, Ducombs G, Leaute-Labreze C, Taieb A. 'Luck Luke' contact dermatitis due to rubber components of diapers. *Contact Dermatitis*. 1998;38:363-364.
52. Lauren A, Sweeney SM, Wiss K. Diaper dye dermatitis. *Pediatrics*. 2005;116:e450-e452.
53. Jacob SE, Herro EM, Guide S, Cunningham B, Connelly EA. Allergic contact dermatitis to Pampers Drymax. *Pediatr Dermatol*. 2012;29:672-674.
54. Herro EM, Jacob SE. Systemic contact dermatitis – kids and ketchup. *Pediatr Dermatol*. 2013;30:e32-e33.
55. Jacob SE, Chimento S, Castaneda-Tardran MP. Allergic contact dermatitis to propolis and carnauba wax from lip balm and chewable vitamins in a child. *Contact Dermatitis*. 2008;58:242-243.
56. Scheman A, Cha C, Jacob SE, Nedorost S. Food avoidance diets for systemic, lip, and oral contact allergy: an American contact alternatives group article. *Dermatitis*. 2012;23:248-257.
57. Scheman A, Rakowski EM, Chou V, et al. Balsam of Peru: past and future. *Dermatitis*. 2013;23:153-160.
58. Mislankar M, Zirwas MJ. Low-nickel diet scoring system for systemic nickel allergy. *Dermatitis*. 2013;24:190-195.
59. Brooks C, Kujajawska A, Patel D. Cutaneous allergic reactions induced by sporting activities. *Sports Med*. 2003;33:699-708.
60. Ghali FE, Agim N. Emerging Patterns of Contact Dermatitis. *Skin Aging*. 2008;16(8). [Available at: <http://www.skinandaging.com/article/9041>, Accessed April 1, 2010].
61. Herro EM, Friedlander SF, Jacob SE. Bra-associated allergic contact dermatitis: p-tert-butylphenol formaldehyde resin as the culprit. *Pediatr Dermatol*. 2012;29:540-541.
62. Ghali FE. "Car seat dermatitis": a newly described form of contact dermatitis. *Pediatr Dermatol*. 2011;28:321-326.
63. Jacob SE, Castaneda-Tardan MP. A diagnostic pearl in allergic contact dermatitis: the atomizer sign. *Cutis*. 2008;82:317-318.
64. Chang MW, Nakrani R. Six children with allergic contact dermatitis to methylisothiazolinone in wet wipes (baby wipes). *Pediatrics*. 2014;133:e34-e38. [Epub ahead of print].
65. Gardner KH, Davis MD, Richardson DM, Pittelkow MR. The hazards of moist toilet paper: allergy to the preservative methylchloroisothiazolinone/methylisothiazolinone. *Arch Dermatol*. 2010;146:886-890.
66. Jacob SE, Brod BA. Paraphenylenediamine in black henna tattoos. *J Clin Aesthet Dermatol*. 2011;4:46-47.
67. deGroot AC. Side-effects of henna and semi-permanent 'black henna' tattoos: a full review. *Contact Dermatitis*. 2013;69:1-25.
68. Jacob SE, Matiz C. Infant clothing snaps as a potential source of nickel exposure. *Pediatr Dermatol*. 2011;28:338-339.
69. Castaneda-Tardran MP, Gelpi C, Jacob SE. Allergic contact dermatitis to Crocs™. *Contact Dermatitis*. 2008;58:248-249.
70. Fonacier LS, Aquino MR, Mucci T. Current strategies in treating severe contact dermatitis in pediatric patients. *Curr Allergy Asthma*. 2012;12:599-606.
71. Fortina BA, Romano I, Peserico A, Eichenfield LF. Contact sensitization in very young children. *J Am Acad Dermatol*. 2010;65:772-779.
72. Storrs FJ. Fragrance. *Dermatitis*. 2007;18:3-7.
73. Hsu JW, Jacob SE. Children's toys as potential sources of nickel exposure. *Dermatitis*. 2009;20:349-350.
74. Jacob SE. Xbox-a source of nickel exposure in children. *Pediatr Dermatol*. 2014;31:115-116.
75. Jacob SE, Admani S. Allergic contact dermatitis to a laptop computer in a child. *Pediatr Dermatol*. 2014;31:345-346.
76. Jacob SE, Steele T, Brod B, Crawford GH. Dispelling the myths behind pediatric patch testing – experience from our tertiary care centers. *Pediatr Dermatol*. 2008;25:296-300.
77. Castaneda-Tardran MP, Matiz C, Jacob SE. allergic contact dermatitis. *Actas Dermosifiliogr*. 2011;102:8-18.