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Original Research

Art of prevention: The importance of bath time and avoiding extended exposure to irritating and allergenic chemicals☆

Tracy Novosel, MD [a], Chandler W. Rundle, BS [b], Jiade D. Yu, MD [c], Sharon E. Jacob, MD [d,*]

[a] Department of Dermatology, Atlantic Dermatology Associates, Virginia Beach, Virginia
[b] School of Medicine, Loma Linda University, Loma Linda, California
[c] Department of Dermatology, Massachusetts General Hospital, Boston, Massachusetts
[d] Department of Dermatology, Loma Linda University, Loma Linda, California

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Contact dermatitis (CD) is an umbrella term for a group of inflammatory skin conditions that result from contact between a chemical substance and the skin. Irritant CD (ICD) is by far the most prevalent and can occur in anyone (no prior sensitization is necessary). ICD can be thought of as the effect observed when a sensitive area of skin is exposed to too strong a chemical, such as detergents. Allergic CD (ACD), on the other hand, represents the clinical disease state that results from exposure to an allergenic chemical in a person who is already sensitized to that chemical, such as that in poison ivy. ACD is a delayed-type hypersensitivity reaction that is diagnosed through the application of a closed (under occlusion) patch test, in which the suspected allergen is placed on intact skin (on the back or inner arm) for 24 to 48 hours (Lazzarini et al., 2013). These patches are evaluated at removal and again at a later period (72-120 hours; Lazzarini et al., 2013).

Children represent a unique group in terms of ACD, despite the condition being quite prevalent in the pediatric population (20%-25% of all childhood dermatitis; Bruckner and Weston, 2002; Militello et al., 2006; Seidenari et al., 2005). Notably, patch testing in children with recalcitrant dermatitis is often delayed (Jacob et al., 2008; McGowan et al., 2018). This is unfortunate given that there is both an increase in the reported number of children with ACD and the need for patch testing in children with dermatitis (Jacob et al., 2008). Recent studies demonstrate that allergens in personal hygiene products contribute significantly to pediatric CD (Berne et al., 1996; Goon and Goh, 2006; Jacob et al., 2005; Pratt et al., 2004)—hence the role of the Pediatric Contact Dermatitis Registry, which is a collaborative, multidisciplinary registry consisting of >250 health care providers that provide data from >1000 patch-tested children in the United States (Jacob et al., 2017).

Bathing practice–associated exposures are important sources of these allergens (Table 1). In addition, several allergens can be in one product and can range from preservatives to fragrances to emulsifiers and detergents (Smaoui and Hlima, 2012; Timmermans et al., 2007). It is also important to recognize that these chemicals may serve as a source of ICD (especially in children with eczema who demonstrate lower thresholds for irritation; Fernandez Vozmediano and Armario Hita, 2005; Lammintausta et al., 1992; Lugovic and Lipozencic, 1997; Oranje and Wolkerstorfer, 1999) and may predispose children to ACD (Marty and Cheng, 2005). Therefore, it stands to reason that if the skin has already been damaged by endogenous dermatosis (e.g., atopic dermatitis) or external trauma, skin penetration by allergens may be enhanced. Skin barrier function is often genetically predetermined at birth; however, even healthy skin is more

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* Corresponding Author.
E-mail address: sjacob@contactderm.net. (S.E. Jacob).

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Table 1
Children product types used in bathing routines

Baby wipes
Lotion
Shampoo
Baby powder
Diaper cream
Conditioner
Bubble bath
Soap-cleansers

delicate in children (compared with adults) and consequently more prone to irritant and allergic contact dermatitis (Gelmetti, 2001).

The development of CD (both irritant and allergic types) requires contact with the eliciting chemicals; thus, decreasing the time of exposure may have a clinically relevant impact (Beattie et al., 2007). Furthermore, ICD, but not the elicitation of ACD, depends on the time of exposure. ICD is dependent on the concentration and duration of exposure. Allergic sensitization is a rate-limited phenomenon of a breached threshold in relation to hapten concentration per unit area of the skin and the immune state of the skin. In addition, inflammation is thought to predispose the epidermal layer to penetration by certain allergens. Thus, decreasing the time of exposure to surfactants may decrease ICD and only indirectly ACD.

Practical intervention

We made a concerted effort to change our approach and purposefully recommended that children be allowed to have bath time first and then be washed at the end of a bath, followed by immediate rinsing to minimize exposure duration to potentially irritating and allergenic chemicals in bathing and personal hygiene products. Hot water should be avoided because excess heat can induce proprioceptors with subsequent itching. With an acidified bath with moderately warm water, a child can play up to 15 minutes. The aforementioned are hypotheses based on observations from practice.

Water can be an irritant, and parents should be sure to acidify the water to a pH of 4.5 with vinegar to reduce skin pH and improve barrier function. Three to four cups of apple cider vinegar added to a half bath (approximately 20 gallons) is sufficient to achieve these results. Alternatively, pool salts (i.e., sodium chloride formulary designed to keep pools clean) can be added as a soothing agent (2 cups per 20-gallon tub) because salts are recognized to increase tolerability, reduce skin inflammation, and decrease transepidermal water loss (Bak et al., 2012; Yoshizawa et al., 2003). Notably, pool salts added to bath water would not have the same acidifying effect as salts in a pool, largely because the electrolysis component in a pool is absent from baths. Double-blind, placebo-controlled trials for bath additives would be helpful to further support this hypothesis.

The cutaneous acid mantle is a complex and highly regulated environment that provides antimicrobial activity, epidermal structural integrity, and barrier function (Rundle et al., 2017). This milieu is maintained by several mechanisms; however, the role of the acid mantle is most highlighted when it is aberrant. Dysregulation of the acid mantle results in the activation of serine proteases, which allows for the breakdown of essential barrier proteins and enzymes, abnormal lipid organization/metabolism, and irregular desquamation of the stratum corneum. Increased desquamation further compromises the epidermis, thus perpetuating decreased barrier integrity and protective function (Rundle et al., 2017).

Preservation of the skin barrier is the most effective way to prevent the elicitation of contact dermatitis. Avoidance of irritating compounds is the first step to restore the skin barrier. Optimization of the skin pH (between 4.6 and 5.6) allows for improved activity of the enzymes (e.g., B-glucocerebrosidase and acid sphingomyelinases) responsible for ceramide and lipid production, a necessary component for the maintenance of a healthy biome (Eberting, 2014). Furthermore, studies have demonstrated that hyperacidification of the epidermal layer improves stratum corneum desquamation and barrier homeostasis while simultaneously preventing skin irritation (Berardesca et al., 1997).

In our society, bathing children and then allowing them to play in the bath water is common practice. By instituting this change in the timing of bathing and play time practice, we observed a significant improvement in clinical manageability of patients with atopic dermatitis. However, the question of whether there was enough contact with sensitizing chemicals during bathing to have a clinical impact remains. We believe that, for exquisitely sensitized individuals, even prolonged contact with very small amounts of allergens can trigger a response (Jacob and Steele, 2007; Larsen, 1989; Ringborg et al., 2016), especially in neonates and infants (Bruckner et al., 2000; Fisher, 1994a, 1994b). Notably, these interventions are based on pathophysiology rather than clinical trials.

Conclusions

Our observation remains largely anecdotal, but we also realize that a sensitization induction study in bathing practices on children is unlikely to be performed. Furthermore, additional studies on acidification of the skin in children and its effect on the barrier are necessary. Therefore, based on our experience and the fundamental principles behind the development of both irritant and allergic CD, we recommend changing the general bathing practices of children so that we may ultimately decrease contact sensitization rates in this underserved population.

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