



Art of prevention: The importance of proper diapering practices[☆]

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Contact dermatitis (CD) is an inflammatory skin condition resulting from cutaneous exposure to a topical agent. Allergic CD (ACD), which accounts for 20% of CD cases, occurs after sensitization and subsequent exposure to a specific allergen through a type IV delayed hypersensitivity reaction (Tan et al., 2014). ACD is considered less common in toddlers and infants because of their immature immune systems (Tüzün et al., 2015). In contrast, irritant CD (ICD), which accounts for 80% of all CD cases, is caused by impairment of the skin's barrier function, leading to inflammation and erythema, and occurs quite frequently in young children (Klunk et al., 2014; Merrill, 2015; Tan et al., 2014; Tüzün et al., 2015).

ICD is commonly associated with rapid and repeated wet-to-dry cycles but can be compounded by irritation from substances such as saliva, urine and fecal enzymes, soap, and wipes (Klunk et al., 2014; Merrill, 2015). Diaper dermatitis (DD) is one of the most common forms of ICD and represents 20% of pediatric dermatology visits (Klunk et al., 2014). Although the exact prevalence is difficult to determine, studies have estimated DD to affect 7% to 35% of the general population, with the greatest incidence between the ages of 9 to 12 months (Klunk et al., 2014; Merrill, 2015; Tüzün et al., 2015). DD often presents as erythema and mild maceration of the buttocks, perianal area, genitals, inner thighs, or waistline with sparing of the skin folds (Merrill, 2015; Stamatas and Tierney, 2014; Tüzün et al., 2015). Most cases of DD are self-limited and resolve in 2 to 3 days with home management. Medical evaluation is sought for more persistent or robust cases (Shin,

2014; Stamatas and Tierney, 2014). More severe presentations include vesiculobullous (Harfmann et al., 2014), granuloma gluteale infantum (a rare but re-emerging condition with the use of non-disposable diapers; Ramos Pinheiro et al., 2018), Jacquet's erosive DD (Klunk et al., 2014), and DD complicated by secondary infection (most often *Candida albicans* or *Staphylococcus aureus*; Stamatas and Tierney, 2014).

A number of factors contribute to the development of DD in children, ultimately culminating in injury to the integrity of the stratum corneum and epidermis with increased skin permeability. The initiating event is overhydration of the diaper area resulting from prolonged exposure to urine and feces, as well as physical occlusion by the diaper (Klunk et al., 2014).

The increase in moisture causes breakdown and maceration of the skin, making the skin more susceptible to frictional damage from the diaper, which further potentiates injury to the stratum corneum and epidermis (Merrill, 2015). These events increase skin permeability to irritants that are present in the diaper area, namely components of urine and fecal enzymes (Merrill, 2015). Fecal ureases catalyze the production of ammonia from urinary urea, leading to an increase in the skin's pH (Stamatas and Tierney, 2014). In turn, the elevated pH activates fecal proteases and lipases, which are considered the most significant irritating agents involved in the development of DD (Tüzün et al., 2015). This is demonstrated by the positive correlation between the frequency of DD and the number of bowel movements per day (Shin, 2014). In addition, diarrhea is considered a risk factor for DD because of the faster stool passage through the gastrointestinal tract and therefore greater enzyme concentration (Stamatas and Tierney, 2014; Tüzün et al., 2015). The vicious cycle continues as fecal enzymes further increase the skin's permeability to other irritating agents,

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such as bile salts, which in turn also potentiate fecal enzyme activity (Stamatas and Tierney, 2014). The resultant effect is a perpetual breakdown of the skin barrier with subsequent inflammation and activation of the skin's repair response (Merrill, 2015).

Certain individuals may be at higher risk for DD based on diapering and feeding practices and underlying medical conditions. For example, infrequent diaper changes or inadequate cleansing can lead to prolonged exposure to urine and feces (Shin, 2014; Stamatas and Tierney, 2014). Although cleansing of the skin with diaper wipes has been shown to be as effective and safe as use of water and a washcloth, some wipes may contain alcohol or fragrances that can lead to irritation or ACD (Merrill, 2015; Stamatas and Tierney, 2014). Mild cleansers with a slightly acidic pH can be safely used to clean the diaper area, but traditional soaps should be avoided because of their more alkaline pH (Stamatas and Tierney, 2014).

Breastfed infants are less likely to develop severe DD in comparison with those who are fed formula (Merrill, 2015; Stamatas and Tierney, 2014). Stools from breastfed individuals have been shown to have a lower pH and may therefore be less irritating to the skin (Stamatas and Tierney, 2014). Zinc and biotin deficiency are also known to predispose to DD (Tüzün et al., 2015). Premature babies may be more prone to DD because the skin takes several weeks after gestation to develop the proper pH and full barrier function to defend against repeated irritant exposure (Shin, 2014).

Practical intervention

The most important aspect in managing DD is prevention. The first-line solution for both the treatment and prevention of DD is the ABCDE approach: air, barrier, cleansing, dry diaper, and education (Merrill, 2015).

Air

The diaper area should be exposed to air as often as possible (Merrill, 2015). Removing the diaper for extended periods of time minimizes friction as well as contact with moisture and irritants.

Barrier

Barrier creams that contain zinc oxide and/or petroleum provide a protective layer over the skin to reduce contact with urine and stool and allow the underlying skin to heal (Merrill, 2015). These creams can also be used to prevent or treat DD. A thick coat should be applied at each diaper change after gently removing stool or other contaminants. Noncontaminated residual barrier cream does not have to be completely removed at each change (Merrill, 2015).

Cornstarch may be used to reduce moisture and friction in the diaper area but should be used with care to prevent inhalation. Baby powders that contain talcum should be avoided due to concerns of asbestos contamination and increased risk of ovarian cancer (Whysner and Mohan, 2000).

Cleansing

The skin should be cleansed with water and/or gentle cleansers. Products with a more acidic pH similar to the skin (pH of 5–5.5) may help combat alkalization from fecal enzymes, which predisposes infants to DD (Merrill, 2015). The goal of cleansing is to completely remove urine and stool while minimizing frictional damage (Merrill, 2015). To this end, gentle cleansers may be a more efficient choice over water alone, but this is ultimately a matter of personal preference.

Dry diaper

Diaper changes should be done as soon as the diaper is soiled (Merrill, 2015; Stamatas and Tierney, 2014). Therefore, newborns should be changed approximately every 2 hours during the day, but older infants may only need a diaper change every 3 to 4 hours (Stamatas and Tierney, 2014). Super absorbable, breathable, and disposable diapers minimize overhydration and decrease contact with irritants compared with reusable cloth diapers and have been shown to decrease the incidence and severity of DD (Klunk et al., 2014; Odio and Thaman, 2014; Stamatas and Tierney, 2014; Tüzün et al., 2015).

Education

DD is a preventable condition, and caretakers should be instructed on proper diaper hygiene techniques. In addition to the guidelines outlined herein, caretakers should wash their hands before and after each diaper change to prevent contamination. When cleaning the diaper area, wiping should be done from the front to the back, and abrasive scrubbing of the skin should be avoided. If DD worsens or does not respond to the aforementioned techniques in a few days, the child should be evaluated by a health care professional.

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