Diaper Dermatitis in Infant Skin: Causes and Mitigation

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### SUMMARY

**What is diaper dermatitis (rash)?**
- Diaper dermatitis or diaper rash is a general term to describe skin inflammation in the diapered area.
- Healthy infants 9-12 months of age have a higher risk of developing rash. Pre-term newborns also have a higher risk of developing rash because their skin barrier is not fully-formed.

**Primary causes of diaper rash**
- **Skin wetness** – Humidity in the diaper increases skin wetness which compromises skin barrier and allows irritants to penetrate into deeper skin layers. Skin wetness also leads to increased pH which is harmful to skin.
- **Prolonged skin contact with feces** – Feces contains enzymes that degrade skin, triggering inflammation and redness. Urine combined with feces raises skin pH making fecal enzymes even more irritating to baby’s skin.

**Clean, dry skin helps prevent rash**
- Frequent diaper changes, airing out diapered skin, and cleaning the skin of irritants like feces and urine help maintain clean, dry skin. Creams and lotions provide a barrier between skin and diaper contents to further protect skin.

**Modern disposable diapers are designed to promote skin health**
- Enhanced, breathable outer cover materials allow air to pass through diapers to minimize moisture trapped inside. Advanced absorbent systems and materials are used to quickly take in fluid, channel it away from the skin, and retain more liquid.
Introduction

Infants under the age of two, especially pre-term neonates, are vulnerable to developing skin irritation in the diapered region. Over-hydration or prolonged skin contact with urine and feces can result in breakdown of the skin barrier (the protective outer layer of the skin) leading to irritation and the appearance of rash. This event is known as diaper rash or diaper dermatitis, a general term to describe skin inflammation in the diaper region.

Diaper dermatitis is among the most common skin disorders of infancy. It accounts for 10-20% of all skin disorders treated by pediatricians and the highest incidence occurs in children between 9 and 12 months of age.\(^1\) If left untreated, progressive skin irritation in the diapered region can lead to secondary infections including *Candida albicans* (candida dermatosis) and bacterial infections. Secondary infections require additional treatment provided by physician care.

Types of Diaper Dermatitis

Although there are many types of diaper dermatoses (Table 1), most incidences arise from a non-allergic rash resulting from chemical, physical or mechanical irritation called irritant contact dermatitis.

Table 1: Loosely defined categories of dermatitis occurring in the diaper area.\(^3\)

<table>
<thead>
<tr>
<th>Type of Rash</th>
<th>This category includes</th>
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<tr>
<td>Rashes that are directly or indirectly caused by the wearing of diapers.</td>
<td>Dermatoses: such as irritant contact dermatitis, miliaria, intertrigo, candidal diaper dermatitis, and granuloma gluteal infantum</td>
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<td>Rashes that appear elsewhere but can be exaggerated in the groin area due to the irritating effects of wearing a diaper.</td>
<td>Atopic dermatitis, seborrheic dermatitis, and psoriasis</td>
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<td>Rashes that appear in the diaper area irrespective of diaper use.</td>
<td>Rashes associated with bullous impetigo; Langerhans cell histiocytosis, acrodermatitis enteropathica (zinc deficiency); congenital syphilis; scabies; and HIV</td>
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Classifications of Diaper Dermatitis

Diaper dermatitis can be classified as mild, moderate, or severe, and is dependent on skin involvement and the degree of inflammation (Figure 1). Characteristics of mild diaper dermatitis include shiny erythema with or without scales whereas more severe cases have intense erythema, ulcerations, and pustule and vesicle eruptions.

![Representative images of diaper dermatitis severity range: (A) healthy skin, (B) slight, (C) mild, (D) severe.](image)

**Figure 1.** Representative images of diaper dermatitis severity range: (A) healthy skin, (B) slight, (C) mild, (D) severe.

Causes and Risk Factors

The exact cause or etiology of diaper dermatitis is not fully understood. However, we know that many factors within the diapered environment contribute to the manifestation of diaper dermatitis. Extensive research into this field has demonstrated that factors including chemical and mechanical irritants, skin pH, diet, skin over-hydration, skin occlusiveness, diarrhea, gestational age and medication contribute to the occurrence and severity of diaper dermatitis.\(^5\textbf{-7}\)

Factors contributing to diaper dermatitis:

- skin over-hydration
- skin occlusiveness
- feces and fecal enzymes
- infrequent diaper changes
- incomplete cleaning and drying of the skin in the diaper area
- infant's diet
Additionally, caretaker behavior and practices also influence the occurrences of diaper dermatitis such as infrequent diaper changes, incomplete cleaning and drying of the skin in the diaper area, diet (breast fed babies have been shown to have lower incidences of diaper dermatitis), and lack of or infrequent use of skin protectants. Conceptually, diaper dermatitis is believed to develop from fecal irritants left on the skin which can mix with urine to increase the pH on the skin. This also results in skin breakdown and infiltration of the irritants into the skin. Combined with increased skin hydration or wetness, mechanical rubbing of the diaper further weakens the skin barrier allowing additional irritants, bacteria, or fungi to enter the skin. Prolonged wetness can lead to infiltration and infection of the fungus *Candida albicans* leading to yeast infections. An illustration of diaper dermatitis induction is depicted in Figure 2.

**Figure 2:** Factors involved in the initiation and elicitation of diaper dermatitis disrupt the stratum corneum (SC), resulting in activation of immune responses in skin.
Pre-term Infants

It is also known that pre-term infants are at an increased risk of developing diaper dermatitis as their skin barrier (stratum corneum) is not fully formed yet. In fact, infants born at gestational age less than 25 weeks only have ½ the thickness of both the stratum corneum and the underlying epidermis as full term neonates do (Figure 3). Moreover, pre-mature infants skin is very permeable to both water and irritants. Additionally, infants born at less than 28 gestational weeks lack an outer protective layer called the vernix caseosa and suffer from increased water evaporation from their skin. It is estimated to take 2-9 weeks after birth for the skin to fully form in these pre-term babies.

Figure 3: Stratum corneum and epidermis are incomplete in 25 week gestational age pre-term (left) compared to full-term neonates (right).

Mitigation

Although diaper dermatitis has not been shown to be completely avoidable there is plenty of evidence that preventative care can be effectively implemented to reduce the incidence and severity of diaper dermatitis. Maintenance of dry skin in the diapered area can effectively reduce skin damage due to over-hydration. Strategies implementing frequent
diaper changes, airing out the skin in between diaper changes and use of diapers with increased wicking and superabsorbent materials help in keeping the skin dry. Additionally, the use of creams and ointments which provide barrier protection between the skin and the external environment can help mitigate diaper dermatitis by preventing direct skin contact. Mechanical irritation due to over-wiping can also lead to compromised skin and should be avoided. It is important to note that clinical studies have demonstrated the use of disposable wipes that contain emollient cleansers to be less irritating on infant skin than water and cloth.\textsuperscript{12-13}

Moreover, advances in diaper technology have helped mitigate the effects of elevated moisture retention and occlusion and helped address some of the moisture-induced skin irritation to keep baby comfortable.\textsuperscript{14-16} Enhanced breathable outer cover materials allow air to pass into the diaper and minimize the moisture trapped inside. More hydrophilic and sophisticated materials are used to quickly take fluid in and channel it away from skin into moisture trapping regions. Advanced absorbent systems are now designed to be more thin and flexible yet also retain more liquid and lock moisture away from the skin-diaper interface.\textsuperscript{14-16} A general diagram highlighting the interacting forces between healthy and irritated diapered skin balance is shown in Figure 5.

\begin{figure}
\centering
\includegraphics[width=\textwidth]{diaperSkinBalance.png}
\caption{Intricate balance between healthy and compromised diapered skin. Environmental and caretaker practices heavily influence incidence of diaper dermatitis.}
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References