

DIAPERS AND INFANT SKIN HEALTH

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ABSTRACT

Diaper dermatitis, or commonly called "diaper rash", is among the most prevalent cutaneous disorders of infancy and early childhood and important issue in nursing. The term itself is not diagnostic since it encompasses a variety of acute inflammatory reactions which are best regarded as a family of disorders arising from a combination of factors specifically attributable to the use of diapers.

Intensive study of the rash process has shown that skin wetness and fecal enzyme activity are damaging to skin and lead to the development of diaper rash. This suggests that it is important to keep urine away from babies' skin, so that the skin remains as dry as possible and maintains its barrier function abilities. Controlling the urine will also minimize the mixing of urine and feces within the diaper, which helps prevent the increased activity of enzymes that attack the skin and cause irritation.

Therefore, a diaper that keeps the skin drier and limits the mixing of urine and feces will help prevent the conditions that lead to diaper rash.

Since their introduction about 35 years ago, disposable baby diapers have undergone many design and performance changes. In particular, the performance of diapers was advanced by the introduction of absorbent gel materials (AGMs) to provide advantages in skin care, dryness, and leakage protection. Especially, important was the introduction of AGM which increased the absorbent capacity of the diaper several fold and yielded marked reductions in the degree of skin hydration occurring under the diaper. Studies show not only drier skin but more stable skin pH and less dermatitis with AGM diapers than with home-laundered cloth diapers or single-use diapers without AGM. Minimizing diaper area skin wetness is important for managing and preventing diaper rash. To minimize wetness, parents should use super absorbent diapers.

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change them frequently, and gently clean the perineal area with each diaper change.

In addition to the skin care benefits, disposable diapers are also better than cloth diapers in minimizing the risk of diarrhea outbreaks among infants and toddlers in day-care environments by reducing fecal contamination and minimizing the potential for transmission of gastro-intestinal tract disease in day-care settings. Furthermore, disposable diapers in the hospital provide nursing, health care, and other advantages over cloth diapers: convenience for nurses and parents, and better containment than cloth with less handling, decreasing the chance of spreading infections. These benefits extend from the care of infants in hospitals to children at home or in day care centers.

I. INTRODUCTION

1. Significance of the study

One of the most common dermatoses in infant is one of several acute inflammatory skin disorders caused either directly or indirectly by the wearing of diapers. (Whaley & Wong, 1997) Since their introduction about 35 years ago, the performance of single-use disposable diapers was advanced by the introduction of absorbent gelling materials (AGM) to provide advantages in skin care, dryness, and leakage protection. Historically, single use diapers used fluff cellulose pulp as the sole absorbent material. Today, AGM technology is used in most single-use diapers sold throughout the world. Further improvements of the various chassis components, absorption layers, and high emphasis on raw material technology innovation have ensured progress in performance of modern diapering.

These innovations in diaper design have been

focused on improving the product's ability to contain bodily waste and to reduce contact of the skin with these materials (Betz, Hunsberger, Wright, 1996). This dual design focus is supported by the well substantiated premise that overhydration from contact with urine and exposure to irritants in feces, contribute to the etiology of diaper dermatitis and other disorders characteristic of diapered skin. In addition, an approach to prevention and nursing care of common types of diaper rash will be discussed.

This is a descriptive study on diaper dermatitis to improve the skin health of the babies by literature review.

2. Purpose of the Study

This study would contribute to keep and promote healthy skin of the infant and enhance nursing care of the babies with diaper dermatitis.

II. LITERATURE REVIEW

1. Basic Concept of the Diaper rash

Diaper dermatitis, or diaper rash, as it is more commonly known, is an acute, inflammatory reaction of diapered skin. Descriptions of diaper rash are found in the medical literature as early as 1877 (Parrot, 1877). Although usually not a condition with a lasting effect, diaper dermatitis has a clear impact on the quality of the infant's life and is also a cause of frequent concern to mothers. Since almost every infant has several episodes of rash during his/her time in diapers, diaper dermatitis has significant implications on health care systems. These include the high costs derived from frequent medical examinations as well as treatment of secondary infections requiring the

use of antibiotics and/or antimycotics.

The results of extensive laboratory and clinical studies in the last 15 years have helped define the primary causes of diaper dermatitis (Berg, 1988; Hansen, 1998). This research has resulted in the development of a detailed model for identifying the causes and course of diaper rash and has guided the development of better disposable diapers.

The Diaper Dermatitis Model (Figure 1) identifies skin wetness, skin pH and fecal enzyme activity as key factors in the development of diaper dermatitis (Anderson, 1994; Berg, 1986; Berg, 1994; Buckingham, 1986; Zimmerman, 1986).

1) Skin Wetness

The skin in the diaper area is frequently overhydrated because of the presence of urine and the occlusive nature of the diaper itself. Hydrated skin has a higher coefficient of friction than dry skin and is thus more susceptible to abrasion damage than dry skin. Excess skin hydration also leaves the skin in a compromised state (i.e., reduced barrier function). Compromised skin is more permeable to irritants in the diaper environment (e.g., fecal enzymes) and more prone to infection by microbes like *Candida Albicans* as well as other yeasts which are not able to infect intact healthy skin.

2) Skin pH

Occlusion of the skin by moist diapers leads to an increase in the normal skin pH (5 to 6). The pH can also increase if feces and urine are allowed to interact for an extended period of time. The enzyme urease which is produced by intestinal microflora and found in feces can degrade the urea found in urine to ammonia. An elevation of the skin pH increases the permeability of the skin to irritants in the diaper environment. In addition, as the pH of

skin approaches neutrality, lipases and proteases found in the feces become more active.

3) Fecal Enzymes

Feces introduces some potentially damaging enzymes and bacteria into the diaper environment. Fecal bacteria produce urease which cleaves the urea in urine to produce ammonia. The resultant higher pH increases the activity of fecal enzymes which can attack the skin to produce irritation and further weaken the barrier function of the skin.

Other factors influencing diaper rash and its duration include: medications, diet/nutrition, diarrhea and the frequency of bowel movements and diaper changes.

In modern single-use diapers AGM is used in the diaper core to help hold urine away from the skin and fecal enzymes. This helps prevent the conditions that lead to diaper rash. The AGM technology provides advances in skin care benefits over previously available single-use and cloth diapers.

2. Diaper Dermatitis Model

Intensive study of the rash process has shown that skin wetness and fecal enzyme activity are damaging to skin and lead to the development of diaper rash. Healthy skin becomes compromised by (a) wetness - wet skin is more permeable, easily penetrated by irritant, and vulnerable to abrasion, (b) fecal enzymes - lipase and protease attack the skin and break down lipids and proteins, (c) mixing of urine and feces - urine/feces interaction results in production of ammonia from urine, which raises stool pH. Other factors that affect compromised skin are (a) friction - mechanical irritation caused by rubbing or chafing, (b) chemical irritation - irritating substances found in urine and feces, and (c) microbial infection - wet skin

is more susceptible to infection from micro-organisms in stool, especially yeast such as *Candida Albicans*.

3. Improvement of Diaper Technology

Disposable diaper technology has improved dramatically over the last several decades. With the evolution of diaper types from the traditional reusable cloth diaper to the more advanced disposable technologies containing absorbent gelling materials (AGM), babies' skin condition have significantly improved as well.

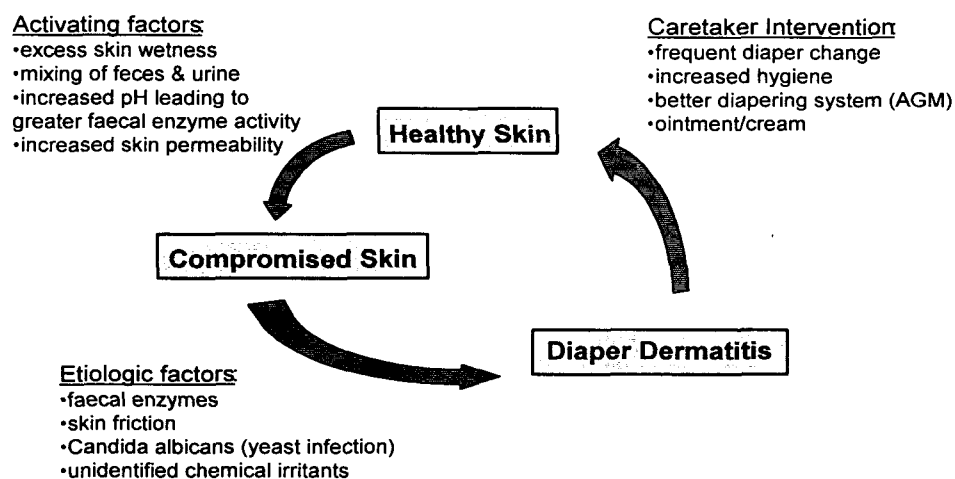
The introduction of absorbent gelling materials (AGM), more breathable materials and designs and other advances in the last 10-15 years have produced diapers which offer distinct benefits over cloth and fluff cellulose disposables. Of all the technology advances, the worldwide acceptance of AGM may have been the biggest contributor. The AGM used in diapers is a high molecular weight polyacrylate polymer that is capable of absorbing upto 50 times its weight in urine. As a result, modern disposable diaper cores containing AGM are capable of absorbing more than 7 times the

urine of traditional cloth diapers or cellulose fluff cores.

AGM is particularly effective in diapers because it absorbs urine to form a homogenous gel that keeps moisture away from the skin and does not allow the urine to interact with fecal enzymes. In contrast, cloth diapers can easily release urine onto the skin when pressure is applied, such as when a child sits.

A number of technical measurements can be made to assess a diaper's performance. Perhaps the most important parameter is rewet, which measures how much liquid can be released from the absorbent core. This is an indicator of how much wetness a baby's skin can be exposed to when pressure is applied. A lower rewet value means drier skin.

When it comes to keeping the babies' skin dry, the most important element in a diaper's design is its core structure and efficiency. Most modern super absorbent diaper core incorporates acquisition and distribution technologies which draw liquid away from the topsheet and distribute it throughout the 3-dimensional core space more efficiently. The homogeneous mix of absorbent gelling materials and cellulose in the



(Fig. 1) Diaper Dermatitis Model

core maximizes the total absorption capacity, preventing residual wetness from coming in contact with the skin.

4. Skin Care Benefits

Diaper rash is the most common skin disorders in infants, and peaks between 9 and 12 months of age (Jordan, 1986). In a Japanese study 41% of infants develop a diaper-related skin problem at least once per month. According to US study, the average child was found to experience about 18 diaper-related skin problems during their life; approximately 1 episode every 2 months (Data on file, Procter & Gamble, 1998).

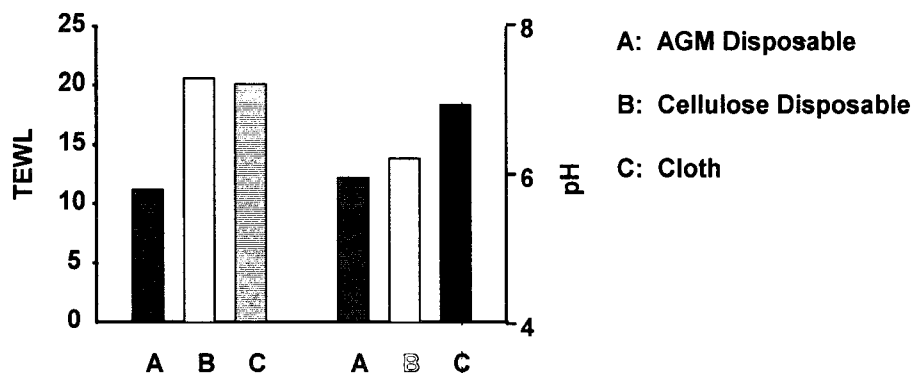
The scientific evidence is definitive in describing skin care benefits of AGM diapers. Infants diapered in AGM diapers have a lower incidence of diaper rash than infants diapered with home laundered cloth diapers.

Scientific safety testing and a long market history on these materials support the conclusion that they are non-irritating and non-allergenic, and safe for consumers.

In a series of clinical studies, Campbell et al., 1987 demonstrated the ability of AGM

diapers to keep skin drier (Campbell, 1987). In addition, the AGM-controlled isolation of urine from fecal material in disposable diapers helps minimize the formation of ammonia from urea. This prevents the skin pH from increasing and the subsequent increase in fecal enzyme activity that can further damage skin. The work by Campbell et al., 1987 showed not only drier skin but more stable skin pH and less dermatitis with AGM diapers than with home-laundered cloth diapers or disposable diapers without AGM (Figure 2). AGM technology has also been tested in other clinical studies using infants with atopic dermatitis (naturally dry and sensitive skin) and in children in day care to further verify the skin care benefits (Campbell, 1988; Seymour, 1987).

Lane, et. al., 1990 conducted another study that demonstrated the efficacy of AGM diapers (Lane 1990). This study included neonates from ages of 1 day to 14 weeks to examine both the safety and efficacy of AGM diapers. In addition to confirming the safety of AGM diapers, this study noted that there was a low incidence of diaper dermatitis throughout the period, and that infants in diapers with AGM had significantly less diaper dermatitis at the end of



(Fig. 2) Skin Hydration and pH. The use of AGM diapers lead to lower TEWL (transdermal water loss) values which are associated with drier skin and a diaper skin pH which is closer to normal.

the study than those in cloth diapers. Observations made by pediatricians during market use of single-use/AGM diapers have further demonstrated their benefit for reducing the chance of diaper dermatitis in comparison to cloth diapers(Austin, 1988).

Extensive studies conducted by Procter & Gamble and others, and consumer experience have collectively shown that the current super absorbent diapers provide good skin care and reduce the chance of diaper rash relative to cloth diapers or earlier single-use diaper. However, clinical studies have also found that most babies will experience rash occasionally, regardless of the type of diaper used. When the rash coincides with the use of a new type of diaper, the mothers may blame the diaper. However, most pediatricians agree the cause of rash in virtually all such cases is due to factors like diet and increased BM frequency.

III. NURSING CONSIDERATION IN DIAPER RASH MANAGEMENT

The most significant factor amenable to intervention is the moist environment created in the diaper are. So nurse or parent should change the diaper as soon as it becomes wet eliminates. Because the primary goal in managing diaper rash is to minimize wettness, parents should also use super absorbent diapers, and apply a barrier ointment. Zinc oxide or petrolatum as well as change diaper frequently.

1. Infection Control

The placement of children in group care facilities (day care and home care) is an increasing trend in many countries around the world. Whenever diaper-age children play together, the potential for transmission of

infectious illness increases, since young children have not yet developed good personal hygiene practices and have not developed full immunity to common ailments. The transmission of gastrointestinal illness in group care settings of diaper aged children has been extensively studied(Hillis, 1992). The high incidence of age-specific enteric infections is regarded as an important issue affecting the health of diapered infants and toddlers in such facilities. The contamination of hands, toys, and other surfaces with fecal-derived enteropathogens with subsequent oral contact has been recognized as a vector for disease transmission. Ekanem, et al., 1983 published a study of five day care centers and showed fecal contamination of child care surroundings (floors, diaper changing surfaces, toys) is significantly greater during infectious diarrhea outbreaks than non-outbreak periods (Ekanem, 1983). Morrow, et al., 1991 noted that approximately one half of the diarrhea illness in children younger than 3 years of age who attend day care can be attributed to the acquisition of the infection at a day care facility (Morrow 1991). The fecal-oral route of infection is not limited to "minor" illness such as diarrhea but may include more severe problems like hepatitis (Shapiro 1991).

A number of nursing strategies are recommended to reduce the transmission of enteric illness in group care facilities. These include hand-washing, good personal hygiene, the use of gloves, regular hard surface cleaning, care-giver and parent education, and segregation of ill children (Pass, 1991). Current scientific data also indicate that diaper type is an important preventive measure. Several studies have provided clear evidence of the benefits of single-use diapers. In a day care study designed to quantify the distribution of fecal coliforms (a measure of fecal contamination and disease transmission risk), Van, et al., 1991 reported

that the number of contaminated objects (hands, toys, inanimate surfaces) was significantly less ($p=0.017$) in rooms where single-use diapers were worn, compared to very similar settings where children wore double cloth diapers and plastic overpants(Van, 1991). Even where clothing was worn over diapers, there was still directionally less contamination with single-use diapers than with cloth diaper use.

The leakage prevention aspect of single-use diapers is very important to reducing the risk of fecal contamination of the day care play area and thus the potential for illness transmission. Modern single-use diapers are designed for maximal leakage prevention. The polyethylene backsheet, AGM/cellulose core, elasticized leg openings and waistbands, and interior leg cuffs all work to provide good fit and leakage protection. In addition to Van's publication, two clinical studies that examined diaper leakage during general diaper wearing (not just in day care settings) show that AGM diapers are better able to contain urine and synthetic diarrhea feces than cloth diapers with plastic overpants or other over covers, or single unit cloth products(Berg, 1993).

2. Diaper Rash Management

The primary goal in managing diaper rash is to minimize wetness. So nurses or parents should use super absorbent diapers, change them frequently, and apply a barrier ointment - zinc oxide or petrolatum.

There is no simple rule on how often the baby's diaper should be changed. Diapers should be changed whenever they become wet or soiled. With a super absorbent diaper, we can tell if it's wet by feeling for beads or lumps in the absorbent material. Some of simple guidelines for when to change baby diaper are: [1] right before or right after every feeding, [2] after

every bowel movement, [3] before bedtime, [4] when the baby wakes up, and [5] when going out with the baby. When changing the diaper, it is important to make sure the fastening tabs stick to the diaper. An extra care should be taken when baby care products (e.g., oils, powders, or lotions) are used as these can get on the tabs and cause them to be less sticky; make sure your fingers are completely clean and dry when fastening the diaper.

If using cloth diaper, use only overwraps that allow air to circulate and avoid rubber pants.

Barrier ointments should be applied after each diaper change. Nurses or Parents ought to clean off only visible contamination before reapplying each new layer. Using a spray bottle of clean water encourages gentle cleaning. Cleaning after urination is not necessary, but following bowel movements the parent can wash the genital area with warm water and a small amount of mild soap. Avoid overwashing the skin, especially, with perfumed soaps or commercial wipes that may be irritating. Commercially available diaper wipes are generally well tolerated by most infants. Parents need to know that vigorous cleansing perpetuates the irritation and retards healing. A small amount of hydrocortisone cream (1% or 0.5%) should be used twice a day for three to a maximum of five days, in the most advanced cases of diaper rash.

In case of diaper rash associated with candidal infection, parents or care-takers need to treat the infected area with the antibiotic nystatin. A corticosteroid cream can be applied to highly inflamed skin lesions on diaper areas. Prior to the application on this medication, the barrier ointment needs to be stripped - gently - from the diapered skin. Since the ointment is a barrier between the baby's skin and the diaper, any medication applied over the barrier would be prevented from contacting the skin. After

application of the medication, the barrier ointment can be reapplied on top of the medication.

IV. CONCLUSION AND SUGGESTIONS

In nursing aspects, nursing interventions are aimed at altering the key factors considered to produce dermatitis. Skin wetness, skin pH and fecal enzymes and bacteria. Diaper construction has a significant impact on the incidence and severity of diaper dermatitis. AGM disposable diapers have been shown to reduce diaper dermatitis and keep babies' skin drier than cloth or cellulose disposable diapers, and keep the skin pH in the diaper area closer to the normal pH of babies' skin Consistently.

Modern AGM disposable diaper has been continuously improving diaper to provide superior skin dryness and a healthier environment for the skin in the diaper area. AGM disposable diapers are an important physical barrier between the child, fecal material, and the environment so they can be an important tool in keeping the environment hygienic. Future progress in innovative diaper technology is expected to provide additional reductions in the prevalence of skin problems such as diaper dermatitis and irritation. These facts suggests significant meaning to nurses and parents in caring the skin care of the babies and choice of the diapers.

REFERENCES

- Anderson, P. H., Bucher, A. P., Saeed, I., Lee, P. C., Davis, J. A., & Maibach, H. I. (1994). Faecal enzymes : in vivo human skin irritation. Contact Dermatitis, 30(3), 152-158.
- Austin, A. P., Milligan, M. C., Pennington, K., & Tweitto, D. H. (1988). A survey of factors associated with diaper dermatitis in thirty-six pediatric practices. Journal of Pediatric Health Care, 6, 295-299.
- Berg, R. W. (1988). Etiology and pathophysiology of diaper dermatitis. Adv. Dermatol., 3, 75-98.
- Berg, R. W. (1993). Containment performance : A comparison of cloth and paper diapers. Tappi Journal, 76, 142-146.
- Berg, R. W., Buckingham, K. W., & Stewart R. L. (1986). Etiologic Factors in diaper dermatitis : The role of urine. Pediatric Dermatology, 3(2), 102-106.
- Berg, R. W., Milligan, M. C., & Sarbaugh, F. C. (1994). Association of skin wetness and pH with diaper dermatitis. Pediatric Dermatology, 11(1), 18-20.
- Betz, C., & M. Hunsberger, Wright. S. (1996). Nursing Care of Children, W. B. Saunders Co.
- Buckingham, K. W., & Berg, R. W. (1986). Etiologic factors in diaper dermatitis : The role of feces. Pediatric Dermatology, 3(2), 107-112.
- Campbell, R. L., Bartlett, A. V., Sarbaugh, F. C., & Pickering L. K. (1988). Effects of diaper types on diaper dermatitis associated with diarrhea and antibiotic use in children in day-care centers. Pediatric Dermatology, 5(2), 83-87.
- Campbell, R. L., Seymour, J. L., Stone, L. C., & Milligan, M. C. (1987). Clinical studies with disposable diapers containing absorbent gelling materials : Evaluation of effects on infant skin condition. Journal of the American Academy of Dermatology, 17(6), 978-987.
- Ekanem, E. E., DuPont H. L., Pickering, L. K., Selwyn, B. J., & Hawkins, M. (1983).

- Transmission dynamics of enteric bacteria in day-care centers. American Journal of Epidemiology 118(4), 562-572.
- Hansen, R. C., Krafchik, B. R., Lane A. T., Odio, M. R., & Schachner, L. A. (1998). Dealing with diaper dermatitis. Contemporary Pediatrics, Supplement, 5-14.
- Hillis, S. D., Miranda C. M., McCann, M., Bender, D., & Weigle, K. (1992). Day care center attendance and diarrheal morbidity in Columbia. Pediatrics, 90(4), 582-588.
- Jordan, W. E., Lawson, K. D., Berg, R. W., Franxman, A. B., & Marrer, A. M. (1986). Diaper dermatitis : Frequency and severity among a general infant population. Pediatric Dermatology, 3(3), 198-207.
- Lane, A. T., Rehder, P. A., & Helm, K. (1990). Evaluations of diapers containing absorbent gelling material with conventional disposable diapers in newborn infants. American Journal of Diseases of Children, 144(3), 315-318.
- Malrow
- Morrow, A. L., Townsend, I. T., & Pickering L. K. (1991). Risk of enteric infection associated with child day care. Pediatric Annals, 20(8), 427-433.
- Parrot, J. (1877). Clinique des Nouveau-Nes L'Athrepsie. Paris, Masson & Cie, 199-231.
- Pass, R. F. (1991). Day-care centers and the spread of Cytomegalovirus and Parvovirus B19. Pediatric Annals 20(8), 419-426.
- Seymour, J. L., Keswick B. H., Hanifin, J. M., Jordan, W. P., & Milligan, M. C. (1987). Clinical effects of diaper types on the skin of normal infants and infants with atopic dermatitis. Journal of the American Academy of Dermatology, 17(6), 988-997.
- Shapiro, C. N., & Hadler, S. C. (1991). Hepatitis A and Hepatitis B virus infections in day-care settings. Pediatric Annals, 20(8), 435-441.
- Van, R., Wun, C. C., Morrow, A. L., & Pickering L. K. (1991). The effect of diaper type and overclothing on fecal contamination in day-care centers. Journal of the American Medical Association, 265(14), 1840-1844.
- Whaley & Wong (1997). Essentials of Pediatric Nursing. Mosby, Fifth Edition 1093-1096.
- Zimmerer, R. E., Lawson, K. D., & Calvert C. J. (1986). The effects of wearing diapers on skin. Pediatric Dermatology, 3(2), 95-101.