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REVIEW ARTICLE

DIAPER DERMATITIS IN CHILDREN

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ABSTRACT

Use of diaper among infants and children is essential and universally accepted. However, many children face difficult condition by developing diaper dermatitis. Development of technology helps substantially lessen the severity of diaper dermatitis, but additional care and improvements are essential. Etiology includes overhydration, irritants, friction, diarrhoea, antibiotic use, increased skin pH, and increase duration of use of diaper. Early identification and treatment decreases associated morbidity and mortality. The important factor is awareness of parents and care takers regarding etiology and management of this condition. A literature search was conducted using key words diaper rash, diaper dermatitis, nappy rash, irritant contact dermatitis, perineal skin breakdown, zinc oxide, baby powder, and cornstarch through Google Scholar, Pubmed, CINAHL, Ovid and other relevant sites. Similarly, different relevant literature published in English language were also reviewed. The literature search yielded numerous articles dating from 1985 to 2015 of which we evaluated the refined ones. This review provides the scientific basis of etiology, contributing factors, comparison of diaper types and recent developments of diaper types and management.

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INTRODUCTION

Diaper dermatitis is among the most common skin disorders encountered during infancy period. Diaper rash is also known as diaper dermatitis, and is a general term describing any of a number of inflammatory skin conditions that can occur in the diaper area (Visscher, 2005). In this condition, rashes that are directly or indirectly caused by the wearing of diapers that includes dermatoses, such as irritant contact dermatitis, miliaria, intertrigo, candidal diaper dermatitis, and granuloma gluteal infantum (Visscher, 2009), are observed.

Etiology

The exact etiology of most diaper rashes is not clearly defined, however, they are likely to result from a combination of factors that includes wetness, friction, urine, faeces and the presence of microorganisms (Visscher, 2009). The use of diapers result in significant increase in skin wetness and pH (Visscher, 2009). Prolonged wetness may lead to softening of the stratum corneum, the outer protective layer of the skin, which is associated with extensive disruption of intercellular lipid lamellae (Boulais and Misery, 2008). The main irritants in this situation are fecal proteases and lipases, whose activity is markedly increased by the elevation of pH. Some studies pointed out the weakening of physical integrity of skin making the stratum corneum more vulnerable for damage due to friction from the surface of diaper and local irritants such as stool and urine (Boulias and Misery, 2008; Denda *et al*., 2007; Elias, 2007). High incidence of irritant diaper dermatitis has been observed in children who had history of diarrhoea in the previous 48 hours because of increased activity of fecal lipase and protease due to acceleration of gastrointestinal transit (Visscher, 2009).

Miliaria is a common presentation of diaper dermatitis which is due to obstruction of eccrine sweat glands when the stratum corneum becomes excessively hydrated and edematous (visscher, 2009; Boulais and Misery, 2008). On the other hand, intertrigo occurs when wet skin, which is more fragile and has a higher coefficient of friction, the damage may result from maceration and chafing (Visscher, 2009). Irritant contact dermatitis is most likely due to combination of intertrigo and miliaria, and has been shown to result from the irritating effects of mixing urine with faeces (Visscher, 2009). Urine in the presence of faecal urease becomes more alkaline due to the production of ammonia that causes activation of faecal lipases, ureases, and proteases which in turn irritate the skin directly and increase its permeability to other low molecular weight irritants (Boulias and Misery, 2008; Denda *et al*., 2007). Secondary bacterial and fungal infections are also commonly seen in diaper dermatitis. Bacteria may play a role in diaper

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dermatitis by the reduction of faecal pH and the resultant activation of enzymes (Visscher, 2009). Disruption of the skin barrier from any cause increases colonization and subsequent infection with potentially pathogenic skin flora, particularly Staphylococcus aureus, and irritant dermatitis is usually seen prior to these secondary infections (Steele, 2014). Polymicrobial growth is documented in at least half of diaper rash cultures in which Staphylococcus species are the most commonly grown organisms, followed by Streptococcus species and organisms from the family Enterobacteriaceae. Moreover, approximately, 50% of isolates also contain anaerobes (Visscher, 2009). It is well documented that if irritant dermatitis persists for more than 3 days and once the skin is compromised, risk of Candida infection increases (Levy, 2001). The range of secondary fungal infection is between 40% and 75% of diaper rashes. Child who has taken amoxicillin was found to have increased colonization by Candida and worsening of diaper dermatitis (Visscher, 2009).

Epidemiology

Diaper dermatitis is a common condition reported worldwide common among both sexes. The incidence and age of onset vary worldwide, related to differences in diaper use, toilet training, hygiene and child-rearing practices in different countries (Levy, 2001; Ward *et al*, 2000; Scheinfeld, 2005). Diaper rashes can start appearing during the neonatal period as soon as the child begins to wear diapers. The incidence peaks during 7-12 months, then decreases with age (Nield and Kamat, 2007). It stops being a problem once the child is toilet trained, usually around age 2 years (Scheinfeld, 2005). It occurs in both sexes and no sex differences on occurrence of rash exist. Prevalence of diaper rash in United states has been variably reported from 4-35% in the first 2 years of life. Diaper dermatitis represents 10 to 20 percent of all skin disorders evaluated by the general paediatrician (Levy, 2001; Ward *et al*, 2000). Incidence found to have tripled in babies with diarrhoea. A survey done among 1089 infants revealed that diaper dermatitis occurred in 50%; however, only 5% had severe rash (Steele, 2014).

Very few prevalence studies on diaper dermatitis is done outside the USA. A study done in Italy showed a prevalence of 15.2%, and a peak incidence of 19.4% in those aged 3-6 months (Longhi *et al*., 1992). Another study done in UK reported diaper dermatitis in 25% of children aged 1 month (Visscher, 2009). Majority of child develop at least 1 episode of diaper rash by the time he/she is toilet-trained. The incidence is found lower among breastfed infants most probably due to the less acidic nature of their urine and stool (Visscher, 2009). A severity scale reflecting the etiology of diaper rash was developed that revealed extent of damage and area of involvement (Jordan *et al*, 1986). Based on this scale, a study done among 1089 infants which revealed that half of the children had visible dryness and/or erythema; and only 5% had severe lesions (Jordan *et al*., 1986). In this study, approximately half (53%) used disposable diapers exclusively where as 43% used both cloth and disposable diapers; and very minority (4%) of them used cloth exclusively. Study done in nine US children's hospital, among 1064 inpatients between birth to 17 years of age revealed prevalence of diaper dermatitis of 42% (McLane *et al*., 2004). Similarly another similar type of study among 1500 community-based infants who used disposable diapers with absorbent gel polymer showed 33% having mild dermatitis and 2-6% having severe dermatitis (Akin *et al*., 2001). One day assessment of 283 infants in a pediatric tertiary-care hospital demonstrate 16% with diaper dermatitis of which 60% were incontinent and 25% had no intact epidermis (Noonan *et al*., 2006). One eighth (12%) of them had fungal infection with candida. A large survey done among 12,103 mothers of infants regarding the diaper rash practice revealed 25% of their infants had experienced diaper rash of different severity ranging from mild to severe (Philipp *et al*., 1997). Of total, 34% used cloth diapers exclusively, 25% used disposable diapers exclusively and 33% used a mixture of disposable and non- disposable diaper types. Regarding belief and practice of diaper use, among parents of 532 children (preterm to 24 months old), all of them believed that rash was associated with diaper use and approximately half (52%) of children had at least one event of diaper rash (Adalat *et al*., 2007). Of the total number of infants, 15% had three or more rash events and 99% of them used disposable diapers.

Premature infants as high risk group

Premature infants are often vulnerable for development of diaper rash since they have a poorly formed barrier with few cornified layers (Cartlidge, 2000; Evans and Rutter, 1986). Study has revealed an abnormal desquamation pattern among very premature infants for several weeks and they lack the covering of vernix caseosa (Visscher and Hoath, 2006). As it takes approximately around 2 to 9 weeks postnatal age for full barrier maturation, environmental humidity often influences barrier development (Nonato *et al*., 2000; Agren *et al*., 1998). Environmental humidity also play a role in epidermal filaggrin proteolysis to water soluble amino acids (NMF) that facilitate water binding (Rawlings *et al*., 1994). When NMF levels is inadequate, skin become dry, has low water-holding capacity and does not desquamate properly which is usually found in premature infants (Prasad *et al*., 2003). On the other hand, skin pH decreases for 4 weeks after birth in low birth-weight (<1000 gram birth weight) (Fox *et al*., 1998). Thus, during barrier development, the preterm infant is at risk for increased permeability to exogenous agents that result in skin damage (Visscher and Hoath, 2006).

Clothes versus disposable diaper

At present two types of diapering systems: reusable cloth diapers and disposable diapers are available (Steele, 2014). Cloth diapers provide containment through multiple layers of cotton fabric that is usually aided by the use of plastic or cloth over-pants where as all disposable paper diapers now contain an absorbent gelling material within the cellular core (Steele, 2014). Those babies wearing superabsorbent disposable diapers with a central gelling material have fewer episodes of diaper dermatitis compared with their counterparts wearing cloth diapers (Visscher, 2009). However, there is a risk of allergic contact dermatitis due to dye as shown by a study that reviewed the effect on the skin of dye-free diapers as

compared with dye-containing diapers (Alberta *et al*., 2005). Study revealed that highly absorbable disposable diapers were found better and also reduce the incidence of irritant dermatitis (Baer *et al*., 2006). In addition, they also reduce associated other skin infections in the diaper region, such as those caused by Staphylococcus, group A beta-hemolytic streptococcus (GABHS) (Brilliant, 2000), Candida (Wolf *et al*., 2000), Jacquet's erosive dermatitis (Kazaks and Lane, 2000), and herpes progenitalis (Pandhi *et al*., 2003). There are no controlled clinical trials comparing infections in cloth versus disposable diapers in children (Steele, 2014).

Management

The important strategy should be targeting to minimize or eliminate the contributing factors and to explore compromise at the earliest. The treatment goal is to facilitate healing process and minimize further irritation (Visscher, 2009). For the treatment of primary irritative diaper dermatitis, simple measures are applied according to the severity and type of dermatitis (Scheinfeld, 2005; Prasad *et al*., 2003; Henry *et al*., 2006). In case of mild dermatitis, increase in frequency of diaper change and use of superabsorbent diapers can be helpful (Heimall *et al*., 2012). Cloth diapers should be avoided that allow contact of urine and feces with the skin and also require specific measures to eliminate microorganisms (washing with soap and boiling). To clean the diaper region, it is recommended to first use cotton ball soaked in oil (mineral or vegetal) to remove the zinc oxide and residues of feces adhered to the skin, then diaper area should be washed with soaps but not aggressively. Running water can be used to provide better removal of residues. Another treatment method could be the use of cold compresses with Burow's 1:30 solution three times a day, which provides calming, antiseptic and drying effect (Virgili *et al*., 1998).

In case if erythema persists, low power topical corticoid such as hydrocortisone 1% up to two times a day for 2 to 7 days can be used to avoid inflammation (Fernandes *et al*., 2009). If dermatitis does not improve, maintaining marked erythema and pustules, the key suspicion is fungal infection with Candida. In this case, anti-fungal preparation such as ketoconazole, nystatin 100,000U/g or miconazole nitrate 1% topical should be used twice a day for 7 to 15 days, which are found to be effective and safe (Virgili *et al*., 1998). In case of prolonged dermatitis, tar in creams can be used; however it is contraindicated in some countries because of the risk of carcinogenesis (Fernandes *et al*., 2009). Bacterial infections are very rare with disposal diapers but can occur with cloth diapers, and may be treated with topical neomycin, gentamycin or mupirocin 2%. Oral antibiotics should be used with precaution since it may aggravate the picture due to action on the intestinal flora (Virgili *et al*., 1998). The follow-up of children with diaper dermatitis should be regular and special attention to be given during the periods of diarrhoea and/or systemic antibiotic use (Fernandes *et al*., 2009).

Step wise general and specific management

Hydration

Diaper rash or dermatitis can be reduced by reducing diaper skin moisture and it is an important component of treatment (Visscher *et al*., 2001). In new born period, the negative effects of moisture can be minimized by changing the diaper frequently (Visscher, 2009). In some studies, it is found that changing the diaper every 2-4 hours may help to protect the disruption of the skin barrier (Nield and Kamat, 2007; Visscher *et al*., 2001; Gupta and Skinner, 2004; Leyden, 1986; Wolf *et al*., 2000). It is also recommended to keep child un-diapered when possible as well as to make the skin dry before applying a new diaper and application of hair dryer to dry the skin preventing the related problems (Gupta and Skinner, 2004; Shin, 2005). Diaper practice differs from race, culture, ethnic community and geographical areas. Some people practice use of cloth that is covered with plastic or impermeable over pants and other use disposable diapers with a cellulose core and a plastic outer cover (Visscher and Hoath, 2006; Erasala *et al*., 2007; Odio and Friedlander, 2000; Runeman, 2008). In addition, diaper practice such as disposable diapers with highly absorbent polymers (AGM diapers) and AGM diapers with a permeable or 'breathable' outer cover are also seen in developing society (Visscher and Hoath, 2006; Erasala *et al*., 2007; Odio and Friedlander, 2000). Recently advanced versions of AGM diapers have been made with skin protectants using petroleum and zinc oxide on the inner sheet for transfer to the skin (Visscher, 2009).

Disposable diaper has many advantages over cloth diaper. A comparison study of the technologies showed that reusable cloth diapers absorb urine but generally do not reduce humidity or remove skin surface moisture where as disposable diapers absorb urine/moisture, wick it away from the skin and prevent rewetting over time (Visscher, 2009). AGMs were found to reduce wetness compared with other disposables and cloth diaper resulting decrease in rash and skin pH (Davis *et al*., 1989; Campbell, 1987; Campbell *et al*., 1987; Grove *et al*., 1998; Seymour *et al*., 1987). Recent studies demonstrated a decreased frequency of severe rash in non disposable cloth (60%), cellulose disposables (39%), AGM disposables (29%) and AGMs with a breathable outer cover (13%) (Erasala *et al*., 2007; Adam, 2008). Although Cochrane Review (Baer *et al*, 2006) gave no conclusive impression regarding effective type of diaper due to lack of quantitative data, disposable diaper was found better and cause less rashes in several studies (Visscher and Hoath, 2006; Erasala *et al*., 2007; Odio and Friedlander, 2000; Runeman, 2008; Seymour *et al*., 1987). With advancement in technology and availability of several disposable diaper along with increased awareness, prevalence of diaper rash has been decreased (Odio and Friedlander, 2000; Runeman, 2008).

Friction and Irritants

Emphasis in cleaning diaper skin is important part of management. The aim of treatment is to minimize chemical and mechanical irritation from urine, faeces, products and cleansing practices (Adam, 2008). The skin should be cleansed frequently as soon as possible after soiling that will minimize fecal exposure time (Nield and Kamat, 2007). Diaper skin should be cleansed with a soft cloth and an oil-in-water lotion to assist in soil removal (Visscher *et al*., 2001). There is availability of wipes containing substrate with cleansing agents and/or emollients (Visscher, 2009). It is important to avoid

products used on diapered skin containing volatile alcohol (ethyl and isopropyl), fragrance and ingredients of known irritancy which increase the risk of irritation and rash (Atherton, 2005). Excessive rubbing and over cleaning should be avoided that can cause mechanical stripping and skin barrier damage (Visscher, 2009).

Infections Control

As bacterial and fungal infections are commonly encountered, appropriate drug should be used to control the infection. Treatments for bacterial diaper rash are often based on the organisms involved (Visscher, 2009). For fungal infection, topical nystatin, miconazole, clotrimazole and ciclopirox are indicated and found to be effective (Concannon *et al*., 2001). Topical corticosteroids are also found to be effective (Ward *et al*., 2000). However, combinations of antifungals and corticosteroids are not recommended because of risk of skin atrophy from steroids and the ability of the occlusive environment to enhance penetration (Ward *et al*., 2000). Use of ciclopirox is found to be effective since it significantly reduces the severity and an increase in cure rate has been observed in infants (Gallu and Plott, 2005). In addition, it is recommended due to its additional antibacterial and anti-inflammatory effects. A study revealed that children who were treated with 0.25% miconazole nitrate in zinc oxide/petrolatum had significantly lower rash scores than the control group who received the zinc oxide/petrolatum vehicle (Concannon *et al*., 2001).

Future direction

Study on diaper dermatitis is rare despite the universal use of diaper. As we move to the scientific era, majority of parents and carer do not have sufficient time to look after their child. Majority of the diaper dermatitis may be preventable. Changing of diaper by carer or parents at appropriate time may decrease the risk. Moreover, development of sophisticated disposable diaper that can be used for more hours and contain antibacterial and antifungal agents, may decrease the prevalence of diaper dermatitis. Education related to diaper dermatitis is essential to be shared with parents that offer them details and the basis for recommendations on approaches to the care of their child and make decisions to improve the quality of their children's lives (Steele, 2014). This also aid in improving treatment adherence (Jha *et al*., 2015). Although Diaper dermatitis is a common condition, determination of the severity is hampered by the lack of standardization of the definition and use of different grading schemes and assessment tools. Despite prevailing limitations, majority of diaper rash cases fall into the category of contact irritant dermatitis (Visscher, 2009). There is a need of development of specific grading schemes and assessment tools for appropriate diagnosis and management. Despite being a very common condition among children, definitive optimal prevention and treatment strategies are still debatable as there is a lack of randomized controlled trial (Heimall *et al*., 2012). More emphasis in studies are needed to identify the best options available.

Conclusion

Diaper dermatitis is a common and preventable condition. Emphasis on hygiene as well cleaning diaper skin and frequent change of diaper may decrease the risk. Early identification of diaper associated infections need to be treated. Decline in the prevalence of diaper dermatitis improves the quality of life of children.

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REFERENCES

Adalat, S., Wall, D., Goodyear, H. 2007. Diaper dermatitis-frequency and contributory factors in hospital attending children. *Pediatr. Dermatol*., 24(5):483-488.

Adam, R. 2008. Skin care of the diaper area. *Pediatr. Dermatol*., 25(4):427-433.

Agren, J., Sjors, G., Sedin, G. 1998., Transepidermal water loss in infants born at 24 and 25 weeks of gestation. *Acta Paediatr*. 87(11):1185-1190.

Akin, F., Spraker, M., Aly, R., Leyden, J., Raynor, W., Landin, W. 2001. Effects of breathable disposable diapers: reduced prevalence of Candida and common diaper dermatitis. *Pediatr. Dermatol.,* 18(4):282-290.

Alberta, L., Sweeney, S.M., Wiss, K. 2005. Diaper dye dermatitis. *Pediatrics*., 116(3):e450-452.

Atherton, D. 2005. Maintaining healthy skin in infancy using prevention of irritant napkin dermatitis as a model. *Community Pract*., 78(7): 255-257.

Baer, E.L., Davies, M.W., Easterbrook, K.J. 2006. Disposable nappies for preventing napkin dermatitis in infants. Cochrane Database Syst Rev., (3):CD004262.

Boulais, N., Misery, L. 2008. The epidermis: a sensory tissue. *Eur. J. Dermatol*., 18(2):119-127.

Brilliant, L.C. 2000. Perianal streptococcal dermatitis. Am Fam Physician., 61:391-393.

Davis, J.A., Leyden, J.J., Grove, G.L., Raynor, W.J. 1989. Comparison of disposable diapers with fluff absorbent and fluff plus absorbent polymers: effects on skin hydration, skin pH, and diaper dermatitis. *Pediatr. Dermatol*., 6(2):102-108 .

Campbell, R.L. 1987. Clinical tests with improved disposable diapers. Pediatrician., 14(1):34-38

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. *J. Am. Acad. Dermatol*., 17(6):978-987.

Cartlidge, P. 2000. The epidermal barrier. Semin. Neonatol. 5(4):273-80.

Concannon, P., Gisoldi, E., Phillips, S., Grossman, R. 2001. Diaper dermatitis: a therapeutic dilemma. Results of a double-blind placebo controlled trial of miconazole nitrate 0.25%. *Pediatr. Dermatol*., 18(2):149-155.

Denda, M., Nakatani, M., Ikeyama, K., Tsutsumi, M., Denda, S. 2007. Epidermal keratinocytes as the forefront of the sensory system. *Exp. Dermatol*., 16(3):157-161.

Elias, P.M. 2007. The skin barrier as an innate immune element. *Semin. Immunopathol*. 29(1):3-14.

Erasala, G.N., Merlay, I., Romain, C. 2007. Evolution of disposable diapers and reduction of diaper dermatitis. *Arch. Pediatr*., 14(5):495-500.

Evans, N.J., Rutte,r N. 1986. Development of the epidermis in the newborn. *Biol. Neonate*., 49(2):74-80.

Fernandes, J.D., Machado, M.C.R., Oliveira, Z.N.P. 2009. Quadro clínico e tratamento da dermatite da área das fraldas - Parte II. *An Bras Dermatol*., 84(1):47-54.

Fox, C., Nelson, D., Wareham, J. 1998. The timing of skin acidification in very low birth weight infants. *J. Perinatol*., 18(4):272-275.

Gallup, E., Plott, T. 2005. A multicenter, open-label study to assess the safety and efficacy of ciclopirox topical suspension 0.77% in the treatment of diaper dermatitis due to Candida albicans. *J. Drugs Dermatol*., 4(1):29-34.

Grove, G.L., Lemmen, J.T., Garafalo, M., Akin, F.J. 1998. Assessment of skin hydration caused by diapers and incontinence articles. *Curr. Probl. Dermatol*., 26:183-195.

Gupta, A.K., Skinner, A.R. 2004. Management of diaper dermatitis. *Int. J. Dermatol*., 43(11):830-834.

Heimall, L.M., Storey, B., Stellar, J.J., Davis, K.F. 2012. Beginning at the Bottom: Evidence-Based Care of Diaper Dermatitis. *The American Journal of Maternal/Child Nursing*., 37(1):10 - 16

Henry, F., Thirion, L., Piérard-Franchimont, C., Letawe, C., Piérard, G.E. 2006. How I treat diaper dermatitis. *Rev Med Liege*., 61:212-216.

Jha, S., Bhagat, S., Pandey, B.R., Ghimire, S.R., Parajuli, S., Sedhain, R. 2015. Non-adherence in acne vulgaris: a review. *International Journal of Analytical, Pharmaceutical and Biomedical Sciences*., 4(3):50-57.

Jordan, W.E., Lawson, K.D., Berg, R.W., Franxman, J.J., Marrer, A.M. 1986. Diaper dermatitis: frequency and severity among a general infant population. *Pediatr. Dermatol*., 3(3):198-207.

Kazaks, E.L., Lane, A.T. 2000. Diaper dermatitis. *Pediatr Clin North Am*., 47:909-919.

Levy, M. 2001. Diaper rash syndrome or dermatitis. *Cutis*., 67:37.

Leyden, J.J. 1986. Diaper dermatitis. *Dermatol. Clin*., 4(1):23-28.

Longhi, F., Carlucci, G., Bellucci, R., di Girolamo, R., Palumbo, G., Amerio, P.1992. Diaper dermatitis: a study of contributing factors. *Contact Dermatitis*., 26(4):248-252.

McLane, K.M., Bookout, K., McCord, S., McCain, J., Jefferson, L.S. 2004. The 2003 national pediatric pressure ulcer and skin breakdown prevalence survey: a multisite study. *J. Wound Ostomy Continence Nurs*., 31(4):168-178.

Nield, L.S., Kamat, D. 2007. Prevention, diagnosis, and management of diaper dermatitis. *Clin Pediatr* (Phila)., 46:480.

Nonato, L.B., Lund, C.H., Kalia, Y.N., Guy, R.H. 2000. Transepidermal water loss in 24 and 25 weeks gestational age infants. *Acta Paediatr*., 89(6):747-748.

Noonan, C., Quigley, S., Curley, M.A. 2006. Skin integrity in hospitalized infants and children: a prevalence survey. *J. Pediatr. Nurs*., 21(6):445-453.

Odio, M., Friedlander, S.F. 2000. Diaper dermatitis and advances in diaper technology. *Curr. Opin. Pediatr*., 12(4): 342-346.

Pandhi, D., Kumar, S., Reddy, B.S. 2003. Sexually transmitted diseases in children. *J Dermatol*. 30:314-320.

Philipp, R., Hughes, A., Golding, J. 1997. Getting to the bottom of nappy rash: ALSPAC survey team. Avon Longitudinal Study of Pregnancy and Childhood. *Br. J. Gen. Pract*., 47(421):493-497.

Prasad, H.R., Srivastava, P., Verma, K.K. 2003. Diaper dermatitis--an overview. *Indian J Pediatr*., 70:635-637.

Rawlings, A.V., Scott, I.R., Harding, C.R., Bowser, P.A. 1994. Stratum corneum moisturization at the molecular level. *J. Invest. Dermatol*., 103(5):731-741.

Runeman, B. 2008. Skin interaction with absorbent hygiene products. *Clin. Dermatol*., 26(1):45-51.

Scheinfeld, N. 2005. Diaper dermatitis: a review and brief survey of eruptions of the diaper area. *Am J Clin Dermatol*., 6:273.

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. *J. Am. Acad. Dermatol*., 17(6):988-997.

Shin, H.T. 2005. Diaper dermatitis that does not quit. *Dermatol. Ther*., 18(2):124-135.

Steele, R.W. 2014. Diaper Care for Happier and Healthier Babies. *Clinical Pediatrics*., 53(9S):7S–8S.

Virgili, A., Corazza, M., Califano, A. 1998. Diaper dermatitis in an adult. A case of erythema papuloerosive of Sevestre and Jacquet., *J Reprod Med*.43:949-951

Visscher, M., Hoath, S.B., Conroy, E., Wickett, R.R. 2001. Effect of semi permeable membranes on skin barrier repair following tape stripping. *Arch. Dermatol. Res*., 293(10): 491-499.

Visscher, M., Hoath, S.B. 2006. Diaper dermatitis. In: Irritant Dermatitis. Chew A (Ed.). Springer, Berlin, Germany. pp.37-51.

Visscher, M.O. 2009. Recent Advances in Diaper Dermatitis: Etiology and Treatment. *Pediatr Health*., 3(1):81-98.

Visscher, S.B.H. 2005. Diaper Dermatitis. In: Irritant Dermatitis. Chew A (Ed.). Springer, San Francisco, CA, USA, pp. 37-51

Ward, D.B., Fleischer, A.B., Feldman, S.R., Krowchuk, D.P. 2000. Characterization of diaper dermatitis in the United States. *Arch Pediatr Adolesc Med*., 154(9):943-946.

Wolf, R., Wolf, D., Tüzün, B., Tüzün, Y. 2000. Diaper dermatitis. *Clin Dermatol*., 18:657-660.

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