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 ORIGINAL ARTICLE

A Consensus About the Importance of Ceramide Containing Skincare for Normal and Sensitive Skin Conditions in Neonates and Infants

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ABSTRACT

Background: Neonates and infants are susceptible to skin barrier disruption as their skin anatomically and functionally is still developing. The process of skin acidification plays a vital role in barrier maturation and the activation of enzymes involved in the extracellular processing of stratum corneum lipids. The current consensus paper explores challenges, and current treatment approaches in neonatal and infant normal and sensitive skin and the role of ceramides containing moisturizers.

Methods: For this purpose, an expert panel of pediatric dermatologists and dermatologists discussed information from systematic literature searches, coupled with expert opinion and experience of the panel, to adopt eight statements. The consensus process consisted of a modified Delphi technique.

Results: During the first years after birth, the neonatal and infant skin is more permeable to topical agents and, therefore, requires particular caution with topical skincare regimens. Mildly acidic or pH-neutral cleansers have benefits for neonates and infants. Skincare for neonates and infants should be safe, effective, and fragrance free as well as sensitizing agent-free. Additionally, the skincare should be pleasant to use, containing ingredients that benefit the lipid and water content of the SC, such as those products containing ceramides.

Conclusion: Taking into consideration the maturation process of neonatal and infant skin, the application of moisturizers and cleansers containing barrier lipids may help maintain the protective skin barrier and soothe with long-term moisturizing benefits.

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BACKGROUND

At birth, the neonates' skin is structurally and functionally immature compared to adult skin.[1]

Neonates and infants exhibit distinct anatomical and functional skin properties making it susceptible to skin barrier disruption.[1-3] Infant skin functionally is still developing as indicated by elevated trans-epidermal water loss (TEWL), skin surface pH and desquamation.[2-5] Several mechanisms may play a role in the slightly alkaline skin pH at birth; the most relevant could be the exposure to the alkaline amniotic fluid during the preborn life.[4,5]

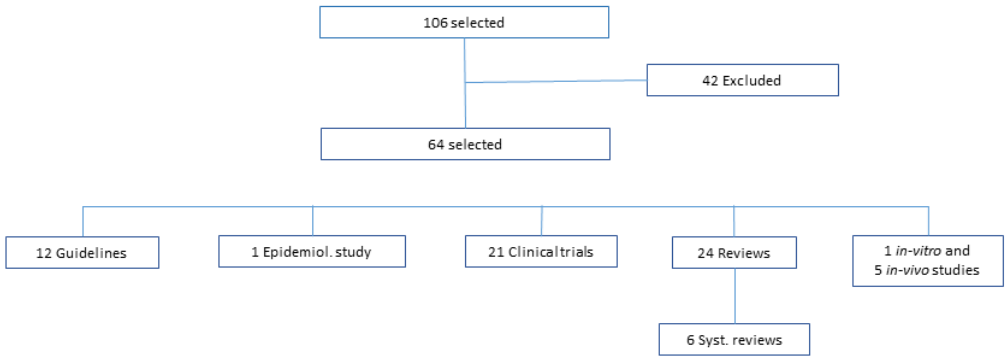
The process of skin acidification, which takes place during the first years after birth, plays a vital role in barrier maturation and the activation of enzymes involved in the extracellular processing of stratum corneum lipids.[4,5]

The definition of sensitive skin is normal-appearing, not atopic skin, which overreacts to various factors that would not cause a reaction in healthy skin.[2] Neonatal and infant skin is more fragile, at risk of heat loss, has elevated thermal conductance, and is more susceptible to infections and chemical and thermal damage.[1-5] During the first years after birth, the infant skin is more permeable to topical agents, which may induce systemic toxicity.[3] The neonatal and infant skin, therefore, requires particular caution with topical skincare regimens.[1-3]

PH-neutral or mildly acidic cleansers have benefits for neonates and infants.[1-3]

Taking into consideration the maturation process of neonatal and infant skin, the application of moisturizers and cleansers

FIGURE 1. Literature search results.



[1]Excluded were: Duplications, In case of an update on a review article the latest version was used; Poor quality.
[2]Epidemiological (Epidemiol), Systematic (Syst.)

containing barrier lipids may help maintain the protective skin barrier and soothe with long-term moisturizing benefits.[1-3]

The current consensus paper explores challenges, and current treatment approaches in neonatal and infant normal and sensitive skin conditions and the role of ceramides containing moisturizers.

SCOPE

The current consensus paper explores challenges, and current treatment approaches in neonatal and infant normal and sensitive skin conditions. The statements and recommendations aim to provide information for pediatric dermatologists, dermatologists, and pediatric healthcare providers treating neonates and infants. Other skin conditions that differ from neonatal and infant normal and sensitive skin conditions are outside the scope of this publication.

METHODS

Literature Review

A literature review explored present clinical guidelines, treatment options, and therapeutic approaches addressing neonatal and infant normal and sensitive skin conditions. For this purpose, searches were made in PubMed and on Google Scholar, on 13-15 January 2020, for English-language literature (2010–2020) using the following terms:

Pediatric skin; maturation; skin physiology of neonates and Infants; vernix; infant skin barrier physiology; function; pathology; dysfunction; epidermal maturation's markers; protection infant skin barrier; fragility of epidermis in infants; depletion of stratum corneum lipids; atopic dermatitis (AD); AD pathogenesis; skin barrier function; skin microbiome in AD; pediatric AD guidelines; algorithm; pediatric AD consensus recommendations; prevention; treatment; maintenance; topical treatment; moisturizers; emollients; skincare in newborns and infants; ceramides; ceramide containing skincare; skin maturation and moisturization.

The selected publications were manually reviewed for additional resources.

The searches yielded 106 papers deemed clinically relevant to neonatal and infant normal and sensitive skin conditions. After the exclusion of duplicates and articles not related to neonatal and infant skin, 64 papers were included (Figure 1). Of the selected articles, there were twelve guidelines (Table 1), one epidemiology study, twenty-four reviews that included six systematic reviews. (Table 2). Twenty-one clinical trials were selected, which addressed neonatal and infant skin conditions. Table 3 illustrates the selected papers on newborn and infant skin barrier function.

Role of the Panel

The expert panel of pediatric dermatologists and dermatologists who commonly treat pediatric skin conditions convened for a one-day meeting (February 7, 2020; Miami Beach, FL), to define statements on neonatal and infant normal and sensitive skin conditions and the role of ceramides containing moistur-

TABLE 1.

Systematic Literature Reviews		
No	**Subject**	**Reference**
1	Skin barrier function in infancy: a systematic review.	Ludriksone L. *Arch Dermatol Res.* 2014; 306: 591– 599.[4]
2	Consensus recommendations on adjunctive topical management of AD.	Del Rosso. *J Drugs Dermatol.* 2018;17: 1070-1076.[37]
3	Emollients and moisturizers for eczema.	van Zuren. *Cochrane Database Syst.* Rev. 2: CD012119.[39]
4	Pediatric AD	Galli E. *Ital J Pediatr.* 2016;42:26.45
5	Topical treatment of mild-to-moderate pediatric and adult AD.	Lynde CW. *J Cutan Med Surg.* 2019;23:3S-13S.[47]
6	AD, depression in children and adults. a systematic review and meta-analysis.	Ronnstadt ATM. *J Am Acad Dermatol.* 2018;79(3):448-56. e430.[63]

TABLE 2.

Guidelines and Algorithms		
No	**Subject**	**Reference**
1	A practical algorithm for topical treatment of AD	Reda AM. *J Dermatol Treat.* 2019;30(4):366-373.[43]
2	Practitioners guide	Irvine AD. *Br J Dermatol.* 2019 Nov;181(5):895-906.[56]
3	Part I. European guidelines for AD in adults and children	Wollenberg A. *J Eur Acad Dermatol Venereol.* 2018;32(5):657-682.[52]
4	Part II. European guidelines for AD in adults and children	Wollenberg A. *J Eur Acad Dermatol Venereol.* 2018;32(6):850-878.[53]
5	Guidelines AD	Saeki H. *J Dermatology.* 2016;43(10):1117-1145.[48]
6	Position paper	Wollenberg A. *J Eur Acad Dermatol Venereol.* 2016;30(5):729-747.[51]
7	Guidelines for the management of AD	Tay YK. *Ann Acad Med Singapore.* 2016;45(10):439-450.[44]
8	Clinical pathway AD adults and pediatric patients	Guenther LC. *JDD.* 2016;15(12):1485-1494.[50]
9	Guidelines AD	Sidbury R. *J Am Acad Dermatol.* 2014;71(6):1218-1233.[55]
10	Guidelines AD Section 2: topical therapies	Eichenfield LF. *J Am Ac Dermatol.* 2014;71(1):116-132.[46]
11	Guidelines AD Part I.	Ring J. *J Eur Acad Dermatol Venereol.* 2012;26(8):1045-1060.[49]
12	Guidelines AD Part II.	Ring J. *J Eur Acad Dermatol Venereol.* 2012;26(9):1176-1193.[54]

TABLE 3.

Publications on the Infant Skin Barrier		
No	**Subject**	**Reference**
1	Staphylococcus aureus and the cutaneous microbiota biofilms in AD.	Di Domenico EG. *Microorganisms.* 2019;7(9).[59]
2	From skin barrier dysfunction to allergic sensitization, and the role of moisturizers.	Stugar TL. *J Drugs Dermatol.* 2019;18(6):581.[23]
3	SC barrier ceramides.	Moore JM. *Int J Cosmetic Sci.* 2017;39(4):366-372.[19]
4	Cutaneous microbiota harmony in maintaining a functional barrier.	Baldwin H. *J Drugs Dermatol.* 2017;16:12-18.[60]
5	Development of the SC from birth compared with adults.	Chittock J. *Br J Dermatol.* 2016;175(3):713-720.[10]
6	The fragility of the epidermis in newborns.	Blume-Peytani U. *J Europ Acad Dermatol Venerol.* 2016;30(5)S4:3-56.[1]
7	Skin barrier dysfunction.	Kelleher M. *J Allergy Clin Immunol.* 2015; 135: 930– 935.[16]
8	The relation between skin micro-topography, roughness, and skin age.	Trojahn *C. Skin Res Technol.* 2015;21:69–75.[18]
9	Skin barrier function in infancy: a systematic review.	Ludriksone L. *Arch Dermatol Res.* 2014;306: 591– 599.[4]
10	Development and organization of human SC after birth.	Fluhr JW. *Br J Dermatol.* 2014 Nov;171(5):978-86.[8]
11	SC maturation and moisturization.	Rawlings AV. *Br J Dermatol.* 2014;171(Suppl 3):19-28.[5]
12	Fragility of epidermis.	Stadler JF. *J Eur Acad Dermatol Venereol.* 2014; 28(Suppl 4):1–18.[2]
13	The infant skin barrier.	Telofski LS. *Dermatol Res Pract.* 2012; 198789.[14]
14	Infant epidermal skin physiology: adaptation after birth.	Fluhr JW. *Br J Dermatol.* 2012;166:483–490.[7]
16	Microbiota across multiple body habitats in newborns.	Dominguez-Bello MG. *Proc Natl Acad Sci USA.* 2010;107:11971–11975.[59]
17	Functional skin and adaptation in infancy.	Fluhr JW. *Exp Dermatol.* 2010;19:483–492.[9]

izers. For this purpose, selected information from the literature searches, coupled with expert opinion and experience of the panel, was used to adopt statements. The consensus process consisted of a modified Delphi technique.[6]

The panel voted on the inclusion of statements after group discussion; consensus required a minimum of 83.3% (five of the six physicians who voted) agreement.

During the meeting, the consensus statements were assessed systematically and refined further following established standards.[6]

Statements Defined by the Panel

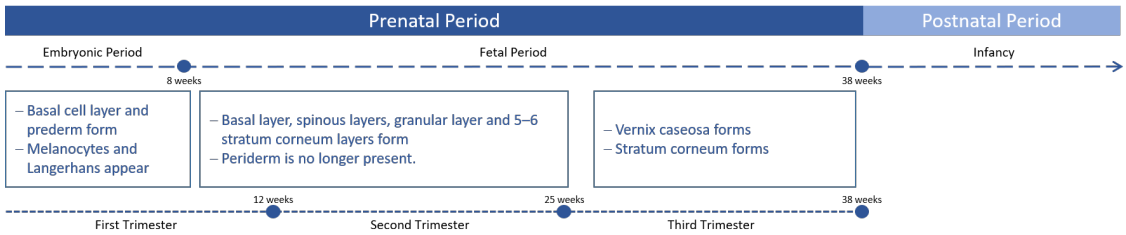
Starting from a list of twenty-four draft messages, advisors developed and voted affirmatively on eight statements (statement 1: 6 [100%], statement 2: 5 [83.3%], statement 3: 6 [100%], statement 4 up to statement 7: 5 [83.3%], and statement 8: 6 [100%]) (Table 4).

Statement 1: *At birth, the skin is structurally and functionally immature, with elevated skin surface pH and lower resistance to chemicals and pathogens.*

Functional and structural skin maturation of the neonatal skin is a dynamic process, which starts at the moment of birth and continues over the first years of life.[1-4,7-10]

At thirty-four weeks gestation, the epidermis is well developed. By thirty-seven weeks, the fetal maturity of the stratum corneum is complete, which further matures extrauterine during the first years of life.[1,4,5,7-10] In utero, there is a naturally occurring substance on the skin, the vernix caseosa, which progressively covers the fetal skin surface during the last trimester. Its production coincides in utero with terminal differentiation of the epidermis and formation of the stratum corneum (SC).[7-11] In utero, the SC consists of a hydrophobic lipid matrix with embedded fetal corneocytes and possesses unique biomechanics and water-binding properties.[5] The role of the vernix caseosa is "waterproofing" the fetus during the critical period of epidermal barrier development before birth.[11,12] When transitioning to extrauterine life, the skin barrier with its extra-cellular lipid

FIGURE 2. Timeline for skin development.



Information from Visscher et al.[9]

TABLE 4.

Publications on the Infant Skin Barrier

No	Statement	Votes Frequency (%)
1	At birth, the skin is structurally and functionally immature, with elevated skin surface pH and lower resistance to chemicals and pathogens.	6 (100%)
2	The complete maturation process of neonatal skin takes from two to four (2–4) years.	5 (83.3%)
3	The permeability barrier is provided by the intercellular lipid-enriched matrix, which is composed of ceramides, free fatty acids, and cholesterol.	6 (100%)
4	Ceramides are important lipids found within the stratum corneum, contributing to the intercellular lipid bilayer, essential in the regulation of trans-epidermal water loss (TEWL) and healthy barrier function. Ceramide depletion results in dermatologic problems e.g. atopic dermatitis.	5 (83%)
5	Skincare of newborns and infants has to be safe and effective and has to exclude agents that can negatively influence the skin barrier or induce systemic toxicity. Baby skincare with ceramides mimics physiological lipids and supports natural homeostasis.	5 (83.3%)
6	Daily use of moisturizers that contain humectants and ceramides reduces the rate of AD flares and reduces the need for topical steroid treatment.	5 (83.3%)
7	Parents and caregivers need to understand how to avoid irritants and triggers, cleanse and hydrate the skin, and how to apply moisturizers. Cleansers close to physiological skin pH (4-6) containing emollients are preferable to water alone or to soap (pH 8-10).	5 (83.3%)
8	Skincare started shortly after birth may avoid skin damage inducing dermatological conditions, such as atopic dermatitis, that can affect the overall well-being of the pediatric patient.	6 (100%)

FIGURE 3. Timeline for skin development.

Ceramide rich fetal coating with vernix caseosa. *(Photograph courtesy of Prof. Schachner)*

membrane inhibits water evaporation, which is essential for terrestrial life (Figure 2).[9-11]

The Vernix caseosa also protects the immature barrier function of neonatal skin (Figure 3).[11,12] Previously, removed entirely after birth; it is now often allowed to separate over six hours to five days after birth naturally.[12] The vernix layer increases hydration, suppleness, and plasticity of the SC.[3,11,12]This protective layer decreases skin surface pH, inhibiting pathological bacteria growth, and facilitates commensal growth.[3,11-13] The main component of vernix caseosa is water, which is much higher than the water content of some barrier creams, such as those that lack humectants mimicking natural moisturizer factors (NMF).[11-14] The lipid content of vernix caseosa is comprised of cholesterol (52.8%), free fatty acids (27.7%) and ceramides (20.1%).[11]

Research of the past ten years has shown that at birth, neonatal skin is structurally and functionally immature compared to adult skin.[4,7-10] The skin of neonates and infants is considered as a fragile physiological skin, with lower resistance to aggressions, eg, microbes and has an elevated skin surface pH.[1,2,15,16] The pH of the neonatal skin surface is typically more alkaline than mature skin, ranging from 6.34 to 7.5, depending on the anatomical site.[1,2,4,5] Several mechanisms may play a role in elevated skin pH at birth; the most relevant could be the exposure to the alkaline amniotic fluid during the preborn life.[1,2,4,5]

A slightly acidic skin surface pH or "acid mantle" defends the skin against infection, influencing the composition of cutaneous bacterial flora.[4] The process of skin acidification plays an important role in barrier maturation and the activation of enzymes involved in the extracellular processing of stratum corneum lipids.[4,5,7-10]

Statement 2: *The complete maturation process of neonatal skin takes from two to four (2–4) years.*

Studies on the physiological maturation process of neonatal skin revealed that dynamic changes in the NMF content take place during infancy, with the lowest amount present at six months of age.[8-11] An in-vivo study on full-term newborns (1–15 days), infants (5–6 weeks and six months), children (1–2 years and 4–5

years of age) and adults (aged 20–35 years) evaluating maturation and organization of the SC showed a relative immaturity of the epidermal barrier from birth to one to two years of age.[8]

A randomized controlled study on biophysical, biological, and functional properties of neonatal SC from birth to four weeks of age revealed that impaired skin barrier function correlated with elevated protease activity and reduced amounts of NMF at birth.[9]

The hydration of the stratum corneum is lower over the first two weeks of life and increases from two weeks onwards.[5,10] Compared to adults SC, the level of hydration is lower in children up to the age of five.[5,10] Although the content of the SC NMF content in neonatal skin compared to adult SC is higher during the first two weeks of life due to the presence of vernix caseosa; there is a higher water vapor loss.[5,10] Two weeks after birth, NMF content of the SC is lower compared to adults, and during maturation, over six months, NMF content of the SC reaches adult levels.[5,10] Variations in SC lipids throughout infancy may be associated with a disease, such as lower levels of ceramides in atopic dermatitis.[13,16]

Neonatal and infant stratum corneum is about 30% thinner (mean of µm 7.3 [SD ± 1.1]) than adult stratum corneum (mean of µm 10.5 [SD ± 2.1]) and reaches a similar thickness of the SC of adults by three to five years of age.[17,18]

Statement 3: *The permeability skin barrier of the skin is controlled by the intercellular lipid-enriched matrix, which is composed of ceramides, free fatty acids, and cholesterol.*

The stratum corneum is essential for the protective barrier functions of the skin.[19] Corneocytes are the building blocks of the epidermal barrier. A water-resistant layer of lipid lamellae encases the corneocytes (cornified lipid envelope), preventing water loss and controlling barrier permeability.[19,20] The cornified lipid envelope and the extracellular mortar-like multilayered lipid lamellae are crucial elements of the epidermal barrier.[19,20] The lipids contained in the lamellar bodies can be derived from both epidermal lipid synthesis and extracutaneous sources. The integrity of the lipid lamellae is dependent on a cocktail of proteases and protease inhibitors. The balance between expression and activity of proteases and protease inhibitors determines the rate of desquamation and, thereby, the thickness of the skin barrier.[19,20] The SC extracellular lipids are mainly composed of ceramides, cholesterol, and free fatty acids and contain NMF, derived from pro-filaggrin, a mix of hygroscopic compounds, which help maintain skin hydration.[19,20]

Ceramides have an essential role in maintaining the water permeability barrier function of the skin (Table 5).[19-23]

TABLE 5.

Composition of Lipids in the Vernix and Stratum Corneum	
Vernix	Postnatal Stratum Corneum
52% cholesterol	25% cholesterol
28% free fatty acids	25% free fatty acids
20% ceramides	50% ceramides

After birth, the lipids that constitute the extracellular matrix now have a different and unique composition compared to the intrauterine period.[1,3,5] The ratio of free fatty acids/cholesterol/ceramides is not static in neonatal skin.[1,3,5] The ceramide proportion changes from 20% in the vernix to 50% in postnatal skin.[1,3,5] Without the proper ratio of ceramides, the stratum corneum can become incompetent.[21-25] Impaired synthesis of cholesterol, ceramides, and fatty acid adversely affects lamellar layer formation, thereby impairing barrier homeostasis, leading to dryness, irritation, erythema, and itching.[19,21-25] Essential fatty acid deficiency results in abnormalities in SC structure and function.[19,21-25]

Statement 4: *Ceramides are important lipids found within the stratum corneum, contributing to the intercellular lipid bilayer, essential in the regulation of trans-epidermal water loss (TEWL) and healthy barrier function. Ceramide depletion is associated with dermatologic problems, eg, atopic dermatitis.*

Most skin barrier disorders, including atopic dermatitis (AD), are associated with decreased ceramide content impairing skin barrier function.[22-36] The lifelong condition AD commonly occurs in early childhood and may present without signs of sensitization.[27-30] The initial phase of AD in a genetically predisposed child presents with non-pathological xerosis only, in the absence of positive specific serum immunoglobulin E (IgE) serology.[16,27-36] In a cohort study including over 1900 infants evaluated at six and twelve months of age, the impaired skin barrier function correlated with elevated protease activity and reduced natural moisturizing factors at birth shown at two months of age and preceding clinical AD.[16] Abnormalities in skin barrier function and ceramide content as well as highly expressed ceramide synthase four was shown in AD affected skin.[30-36] The atopic child with extrinsic AD typically presents with a defective skin barrier and sensitivity to allergens in the presence of an IgE response to environmental allergens.[29-36]

Statement 5: *Skincare of neonates and infants has to be safe and effective and has to exclude agents that can negatively influence the skin barrier or induce systemic toxicity. Baby skincare with ceramides mimics physiological lipids and supports natural homeostasis.*

Newborns and infants have an increased vulnerability to poisoning from transcutaneous exposures due to their high surface-to-weight ratio, immature epidermis, and compromised

skin barrier.[15] Neonates and infants are particularly susceptible to toxicity through the skin of non-therapeutic and therapeutic topical agents, which may lead to systemic signs and symptoms that can be severe.[15] Systemic toxicity resulting from percutaneous absorption of substances is rare but increases in those with impaired skin barrier function, eg, neonates and infants, AD, and ichthyosis.[15] When no obvious source of poisoning is found in infants, children, and adolescents, transcutaneous exposures must be considered.[15] Dermatologists, emergency physicians, and pediatricians need to be comfortable diagnosing and managing such cases of poisoning through percutaneous absorption.[15]

Topical agents that are harmless in adults may cause methemoglobinemia, respiratory distress, neurological toxicity, and even death in the pediatric and neonatal age groups depending upon how much has been absorbed systemically.[15] These agents include, among others, isopropanol, benzocaine, pyrethrin, hexachlorophene, and salicylic acid.[15]

A compromised skin barrier susceptible to toxicity through the skin may be seen in up to 25% of infants and young children.[15] Increased vulnerability is secondary to increased body surface area to weight ratio, taking into consideration that full maturity of the epidermis may take one to three years or more.[1-4, 7-9,15]

An ideal moisturizer for neonates and infants is safe, effective, inexpensive, and fragrance as well as sensitizing agent-free. Additionally, the skincare should be pleasant to use, containing ingredients that benefit the lipid and water content of the SC.

Statement 6: *Daily use of moisturizers that contain humectants and ceramides reduces the rate of AD flares and reduces the need for topical steroid treatment.*

Vernix caseosa contains cholesterol (52.8%), which forms the significant barrier lipid fraction, followed by free fatty acids (27.7%) and ceramides (20.1%).[11,36] Topical formulations that contain ceramides mimic physiological lipids supporting homeostasis and improving skin condition.[11,22,36-42] Those with dry and sensitive skin and particularly neonates and infants with AD prone skin or having AD greatly benefit from frequent moisturizer use.[23-25,36-57] Moisturizer use decreases pruritus and symptoms as well as the severity of AD, improving quality of life.[36-41] Moreover, the number of AD flares reduces as well as the time to flaring when ceramide-containing skincare is frequently applied.[38,39]

A ceramide-containing cleanser and moisturizer substantially improved clinical outcomes and quality of life in adult and pediatric patients with mild-to-moderate AD when used over six weeks.[41] The study products were easy to use, with no adverse reactions reported. [41]
Although direct comparisons between various types of moisturizers are lacking, those moisturizers that contain ceramides showed benefits over standard emollients.[58]

TABLE 6.

Types of Cleansers	
Type of Cleanser	**pH**
Soap: Contains fat and alkali-treated salts of fatty acids.	pH 9.0–12
Syndet bar: Contains synthetic detergents.	pH: 4.0–6.0
Combar: Contains equal parts of soap-based detergent mixed with synthetic detergent.	pH: 10–12
Liquid cleanser: Contains synthetic detergents, can be ionic or non-anionic in lotion, cream, oil or gel form.	pH: 6.0–7.0
Gentle lipid-free cleansers and or ceramides-containing cleansers: Do not contain soap.	pH: 5.0–7.0
Cleanser with polymer-surfactant complexes: Has a low concentration of free surfactant micelles as well as polymer-surfactant compounds.	pH: 4.0–5.8

Statement 7: *Parents and caregivers need to understand how to avoid irritants and triggers, cleanse and hydrate the skin, and how to apply moisturizers. Cleansers close to physiological skin (pH 4–6) containing emollients are preferable to water alone or soap (pH 8–10).*

Barrier development continues during the first year of life. Exposure to common unwanted irritants, including saliva, nasal secretions, urine, feces, fecal enzymes, dirt, and microbial pathogens for long periods can lead to discomfort, irritation, infection, and skin barrier disruption. To maintain a healthy skin barrier, several aspects of the SC, such as skin surface pH, filaggrin, pH-dependent lipid processing, and serine proteases, must be protected.[57] Skin surface pH usually is acidic (4.0–6.0), while the body's internal pH is neutral to slightly alkaline (~7.4).[57] Soaps, surfactants, and detergents, especially those products with an alkaline pH, may excessively remove NMF and skin lipids, elevating skin surface pH, which is explicitly damaging to neonatal and infant skin.[57] Liquid skin cleansers with a near physiologic skin surface pH (4.0–6.0) containing ceramides and no soap are less aggressive than alkaline soaps and may reduce skin irritation (Table 6).[41, 57]

When applied from birth onwards, gentle cleansers and moisturizers containing barrier lipids help to maintain the protective skin barrier and soothe the skin with long-term moisturizing benefits.[41,57]

The choice of cleanser and moisturizer is dependent on individual preference.

Maintaining a high diversity of skin microbiome using appropriate skincare is another area of interest for the prevention of skin irritation and elevated inflammation, especially in neonates and infants who a prone to AD or have AD.[59,60]

Statement 8: *Skincare started shortly after birth may avoid skin damage-inducing dermatological conditions, such as atopic dermatitis, that can affect the overall well-being of the pediatric patient.*

Data on the effects of skincare for neonates and infants with sensitive, non-atopic conditions is lacking. However, there is a growing body of evidence supporting skincare starting early in life and ongoing for inflammatory skin conditions. Clinical guidelines and consensus papers on AD worldwide recognize the benefits of ongoing daily use of moisturizers aiming to reduce inflammation and to restore skin barrier function.[43-57] Parental education on avoiding triggers of AD and how to apply gentle cleansers and moisturizers are an integral part of AD prevention, treatment, and maintenance.[43-57]

Promoting the skin barrier function, starting early in life by using moisturizers from birth, may not only be beneficial for the neonatal and infant skin but also may help to prevent AD.[21,23] Two prospective, randomized controlled trials revealed that daily use of a moisturizer prevented AD in 32% of Japanese and 50% of Anglo-American high-risk neonates.[24,25] More extensive research is needed to study whether moisturizer use from birth onwards reduces allergic sensitization by preventing the development of AD.[24,25]

Another randomized controlled study examined the effects of the twice-daily application of a ceramide-containing emollient for the first six months of life on the incidence of AD and skin barrier dysfunction in high-risk infants up to 12 months of age.[36] Clinical follow-up revealed that twice-daily prophylactic use of the moisturizer might have a more substantial potential to prevent the development of food sensitization than the once-daily application of emollients used in previous trials.[36]

AD represents a significant health expenditure and is associated with multiple comorbidities.[60-63] Daily moisturization may represent a cost-effective, preventative strategy to reduce the burden of AD and as prevention for AD among high-risk newborns.[64]

CONCLUSIONS

The skin of neonates and infants exhibits distinct anatomical and functional properties that might be clinically reflected by its susceptibility to skin barrier disruption. Infant skin functionally is still developing, as indicated by elevated TEWL, skin surface pH values, and elevated desquamation. Neonates and infant skin is more fragile and susceptible to infections, chemical, and thermal damage.

Skincare for neonates and infants should be safe, effective, inexpensive, and fragrance as well as sensitizing agent-free. Additionally, the skincare should be pleasant to use, containing ingredients that benefit the lipid and water content of the SC, such as those products containing ceramides.

Several studies have shown that skincare, including appropriate cleansers and moisturizers, can reduce the risk of AD in AD-prone newborns. More robust studies are needed to confirm the perceived benefits of skincare in neonates and infants.

DISCLOSURES

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