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Neonatal Skin Care to Maintain Skin Integrity: A Scoping Review

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Abstract

Introduction. Neonatal skin is essential for maintaining physiological homeostasis; however, its structural and functional immaturity - particularly in preterm infants - makes it highly susceptible to dehydration, infection, thermal instability, and environmental damage. Maintaining skin integrity is therefore a critical component of neonatal and early pediatric care to reduce morbidity and support healthy development.

Methods. A scoping review was conducted following the PRISMA-ScR guidelines to synthesize current global evidence on neonatal and pediatric skin care practices. Five electronic databases were systematically searched for studies published between 2014 and 2025 in English, Italian, or Spanish. Eligible studies addressed skin care interventions in neonates and children, including bathing practices, emollient use, perineal care, prevention of atopic dermatitis and management of skin lesions. A total of 38 studies met the inclusion criteria, encompassing randomized controlled trials, observational and quasi-experimental studies, qualitative research, and expert consensus documents.

Results. The reviewed evidence indicates that delayed bathing after birth, gentle cleansing routines, and careful selection of skin care products contribute to improved skin barrier function. Early and regular use of emollients containing physiological lipids was associated with enhanced hydration, reduced transepidermal water loss, and a lower incidence of irritant and atopic dermatitis. Structured perineal care protocols were shown to reduce diaper-related skin breakdown. Preterm infants emerged as a particularly vulnerable group, requiring highly cautious

and individualized approaches due to their markedly underdeveloped skin barrier. The review also highlights substantial global disparities in skin care practices, especially in low-resource settings, where access to appropriate products and standardized protocols is limited.
Discussion. Overall, the findings underscore the importance of evidence-based, standardized, and culturally sensitive skin care guidelines tailored to neonatal and pediatric populations. Implementing consistent practices across diverse clinical settings may improve skin integrity, reduce preventable complications, and support optimal neonatal outcomes, particularly among high-risk neonates.

Keywords: Infant, Newborn, Neonates, Premature Infants, Skin Care, Skin Integrity

Introduction

The skin of the newborn represents one of the most dynamic and vulnerable organs during the early phases of life. It is responsible for essential physiological functions including protection against pathogens, regulation of body temperature and maintenance of hydro-electrolytic balance. Although the epidermal structure of term infants already resembles that of adults, complete functional maturation continues throughout childhood and is not achieved until late infancy.[1]

The comparison between human fetal and adult skin is shown in Figure 1.[2]

Preterm infants, whose epidermal and dermal layers remain incompletely developed, are significantly more susceptible to mechanical injury, dehydration and infection.[1]

During embryogenesis, skin maturation begins with the formation of the periderm at around the seventh week of gestation. This temporary cellular layer disappears between the twenty-fourth and twenty-fifth week, allowing the maturation of epidermal cell populations such as melanocytes, Merkel cells and Langerhans cells. The dermal–epidermal junction is markedly immature in preterm infants because its anchoring structures, including hemidesmosomes and collagen fibrils, are fewer and less cohesive than in term newborns and adults.[1,3,4]

The stratum corneum, consisting of corneocytes embedded in a lipid matrix, is the primary physical barrier against trans epidermal

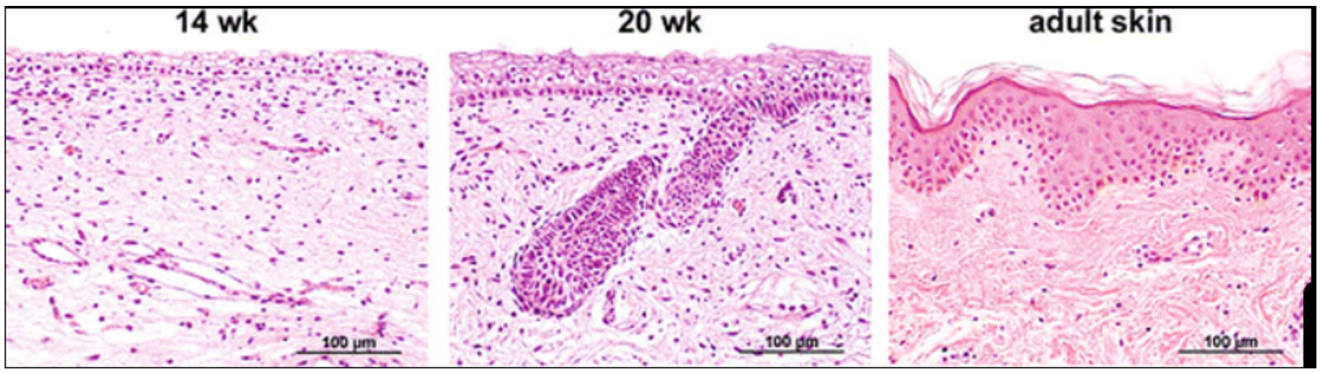

Figure 1. Histological progression of human skin development from fetal to adult stages.
Representative histological sections of human integument showing skin development at 14 weeks of gestation, 20 weeks of gestation, and adult skin. Early fetal skin (14 weeks) is characterized by a thin, poorly stratified epidermis and a loosely organized dermis. At 20 weeks of gestation, increased epidermal stratification and early formation of adnexal structures can be observed. Adult skin displays a fully differentiated, multilayered epidermis and a well-organized dermis. Scale bar: 100 µm.
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water loss and external insults. Its development begins around the fifteenth week of gestation. Term infants typically possess multiple corneocyte layers, whereas extremely preterm infants may have only a few layers or none at all in those born at the limits of viability. [4,5]

At approximately twenty-four weeks, the skin appears red, gelatinous and translucent, reflecting profound immaturity.[3]

Sebaceous glands become active during late gestation and contribute to the formation of vernix caseosa, a hydrophobic, lipid-rich biofilm composed of water, sebaceous lipids, epidermal lipids, proteins, cytokines and antimicrobial peptides.[6-8]

Vernix provides barrier protection in utero, prevents maceration from amniotic fluid and supports thermoregulation and innate immunity immediately after birth. Preterm infants, particularly those born before twenty-eight weeks, often lack vernix coverage, which further compromises their skin barrier.[7]

Key structural and functional characteristics of neonatal and pediatric skin, with clinical implications for wound prevention and integrity management, are summarized in Table 1.[1]

Table 1. Structural and functional characteristics of neonatal and pediatric skin and their associated clinical implications for wound prevention and skin integrity management.

This table represents a reworked synthesis and academic reinterpretation of data derived from previously published literature (IMAG, 2004; White and Butcher, 2006; Visscher et al., 2013; Kanti et al., 2014)[1]

Neonatal skin characteristics	Physiological and functional implications	Clinical considerations
The stratum corneum is composed of approximately 2–3 cell layers, compared with 20–30 layers in adult skin	Immature barrier function increases vulnerability to mechanical injury, chemical penetration, microbial colonization, and infection. Trans epidermal water loss is elevated, potentially compromising fluid balance, particularly in extremely preterm infants.	Topical exposure to substances known to exert irritant or cytotoxic effects, including iodine, alcohol, and high-concentration chlorhexidine, should be minimized or avoided. Maintain strict hand hygiene Monitor hydration status and consider humidity-controlled environments. Reduce pressure-related skin damage.
Reduced number and wider spacing of dermal–epidermal junction fibrils in preterm infants; dermis is poorly developed and less dense during the early postnatal period	Increased susceptibility to skin stripping, particularly during adhesive removal, and to shear forces associated with handling, movement, jewelry, and contact with medical devices	Limit the use of adhesives and prefer sterile silicone-based adhesive removers. Minimize handling. Remove jewelry and maintain short fingernails. Prevent device-related pressure injuries through regular repositioning and frequent skin inspection.
Reduced or absent subcutaneous fat in very preterm infants	Limited energy reserves, reduced shock absorption, and impaired thermoregulation	Ensure adequate caloric intake in accordance with dietetic guidance . Reposition infants regularly to prevent pressure injuries. Minimize exposure to cold stress during care procedures.
Increased expression of type III collagen	Potential influence on tissue remodeling and mechanical properties during skin development.	Potential implications for tissue repair, although clinical relevance remains uncertain and influenced by multiple local and systemic factors.
Immature acid mantle in term and preterm newborns, developing during the first weeks of life.	Increased vulnerability to biochemical and microbiological insults and higher risk of irritant-associated dermatitis	Emphasize rigorous hand hygiene to reduce healthcare-associated infections. Perform frequent nappy changes and apply appropriate barrier products to protect skin integrity
Increased sebaceous gland activity in newborn infants	Transient development of facial or nasal skin lesions	Reassure parents that this is a physiological and self-limiting condition that typically resolves within a few weeks as postnatal hormonal activity stabilizes

Hydration of the stratum corneum is essential for elasticity, proper desquamation and protection against mechanical stress. Natural Moisturizing Factors (NMF), composed of hydrophilic amino acids and derivatives, contribute to moisture retention and are present at lower levels in preterm infants than in term newborns.[4]

Skin surface pH plays a critical role in microbial colonization, enzymatic lipid processing and lipid organization. While term infants rapidly transition from a neutral to acidic skin surface during the first two weeks of life, preterm infants experience delayed acidification, which increases their vulnerability to infection.[5,9,10]

Trans Epidermal Water Loss (TEWL) is one of the most sensitive indicators of skin barrier maturity. However, the time it takes for TEWL to stabilize can vary depending on gestational age, environmental humidity, clinical condition, and skin care practices. Extremely preterm infants typically have significantly elevated TEWL at birth due to the immaturity of the stratum corneum and may require a prolonged postnatal adjustment period before achieving more stable barrier function parameters.

Term newborns gradually reach stable TEWL values within four to six weeks after birth, whereas extremely preterm infants display dramatically elevated TEWL levels at birth due to the absence of an adequate stratum corneum.[7]

They may require one to two weeks of postnatal life to achieve TEWL levels comparable to term infants.[9]

Figure 2 shows the TEWL difference between newborn and adult skin.[10]

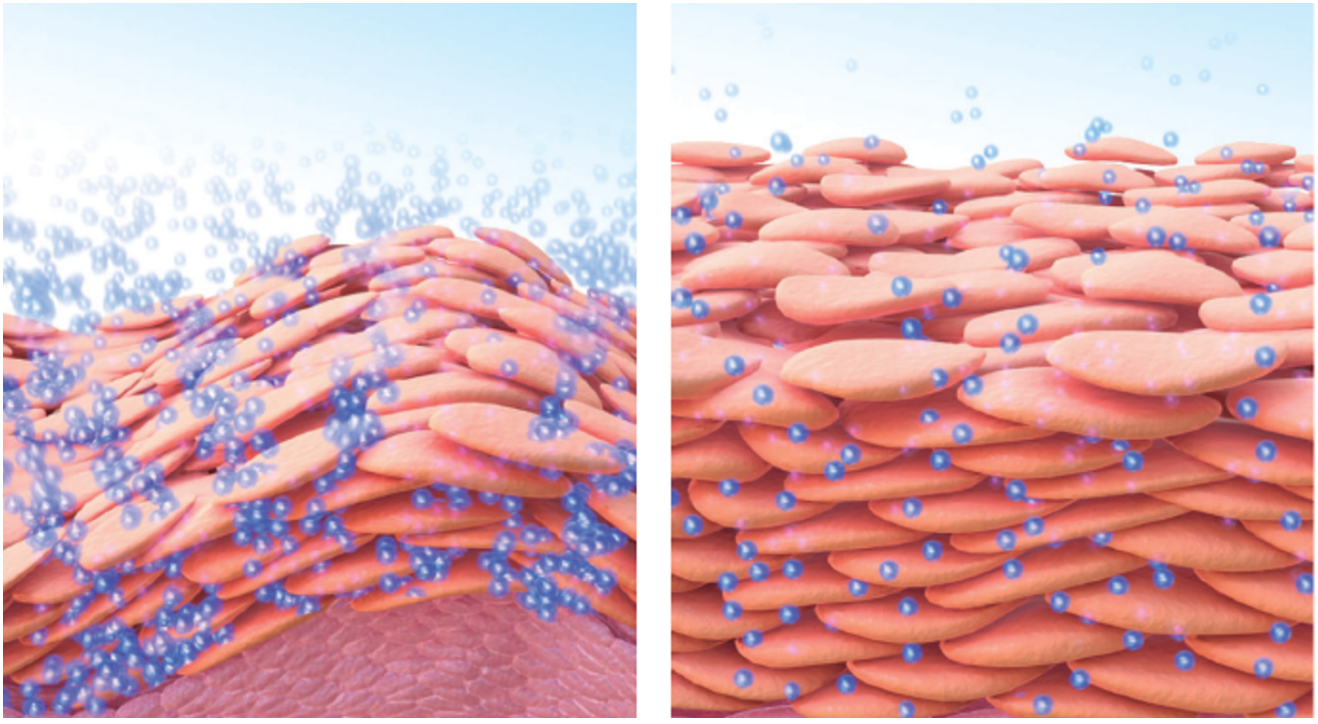

Figure 2. Infant and adult skin: stratum corneum (SC) hydration and water transport properties. The SC of infant skin (a) and adult skin (b) is hydrated (small blue spheres) under normal conditions. Infant SC is more hydrated but also loses water at higher rates than adult SC.
(Image available under the terms of the creative commons attribution-noncommercial- no derives license (CC BY-NC-ND 4.0) [10]

At the same time, skin microbiota colonization begins immediately after delivery and is shaped by the mode of birth, environmental exposure and healthcare practices.[5]

Vaginally delivered newborns show a predominance of Lactobacillus and Prevotella species, whereas cesarean-delivered infants display early colonization by Staphylococcus and Corynebacterium.[5,6]

Preterm infants, especially those requiring intensive care, show restricted microbial diversity and increased susceptibility to colonization by pathogenic bacteria.[4,7,11]

This biological immaturity, combined with frequent handling, invasive procedures and exposure to medical devices, explains why neonatal skin care is a critical component of overall clinical management.[12-14]

Evidence-based practices are essential to preserve skin integrity, prevent complications and promote healthy development.[15]

In this context, this scoping review aims to map the available literature on neonatal and pediatric skin care, with particular attention to bathing routines, emollient therapy, perineal care, prevention of atopic dermatitis, management of cutaneous lesions, microbiota-related aspects and global disparities in care.

Methods

This scoping review followed the methodological framework of the PRISMA-ScR guidelines to ensure transparency, reproducibility and methodological rigor. The research question was developed using the Population-Concept-Context (PCC) framework, as recommended for scoping reviews, with the aim of mapping the breadth of existing literature rather than evaluating the superiority of specific interventions.[16]

The population of interest comprised neonates, infants, preterm and extremely preterm infants, children and adolescents, including patients cared for in hospital settings and in neonatal and pediatric intensive care units. The concept of interest encompassed skin care practices and methods aimed at maintaining skin integrity and preventing skin damage, including cleansing routines, bathing practices, use of emollients, perineal care, prevention of dermatitis and management of cutaneous injuries such as pressure injuries (PIs), incontinence associated dermatitis (IAD), diaper rash, wounds and skin tears.

The context included hospital environments, with particular focus on neonatal and pediatric intensive care units, across different healthcare systems and geographical contexts. Maintenance of skin integrity was considered the overarching outcome of interest and was explored through reported measures of skin hydration, skin surface pH, trans epidermal water loss, incidence of dermatitis or cutaneous lesions, and patterns of microbial colonization.

The literature was mapped using a structured approach. The search was conducted from September 2024 to May 2025 across five electronic databases: PubMed, CINAHL, Cochrane Library, Trip Database and Embase. Keywords and MeSH terms related to infants, children, skin care, emollients, pressure ulcers, diaper dermatitis and wounds were combined using Boolean operators AND and OR. The search strategies are presented in Appendix 1.

Studies were included if published between 2014 and 2025 in English, Italian or Spanish and if they addressed skin care in neonatal or pediatric populations. Literature reviews were excluded to avoid redundancy in the synthesis of evidence.

Two independent reviewers screened all titles and abstracts identified by the search strategy. When disagreements arose, a third reviewer evaluated the article to reach consensus. Full texts of potentially eligible studies were reviewed in detail to confirm eligibility and relevance to the scope of the review. Extracted data included study design, population characteristics, type of intervention, outcome measures and main findings.

Because of the clinical and methodological heterogeneity among the included studies, statistical pooling was not appropriate. The findings were therefore synthesized narratively and organized thematically into key domains: bathing practices, emollient therapy, perineal care, prevention of atopic dermatitis, cutaneous lesions and wound management and global disparities in neonatal and pediatric skin care.

The PRISMA-ScR flow diagram for the selection process is shown in Figure 3.

Results

The search yielded thirty-eight studies that met the inclusion criteria. The selected articles were geographically diverse, originating from the United States, Turkey, Brazil, South Korea, the United Kingdom, Zambia, Egypt, Japan, Ireland, Spain and multinational collaborations. They encompassed randomized controlled trials, quasi-experimental research, qualitative studies, observational cohorts, expert consensus statements and quality improvement initiatives. This diversity reflects the global interest in neonatal and pediatric skin care and the range of clinical questions explored.

The included articles are presented in Table 2 and Summary Table 1 which provide an overview of bibliographic details, country, study design, sample characteristics, intervention components, outcomes, and a narrative summary of the findings.

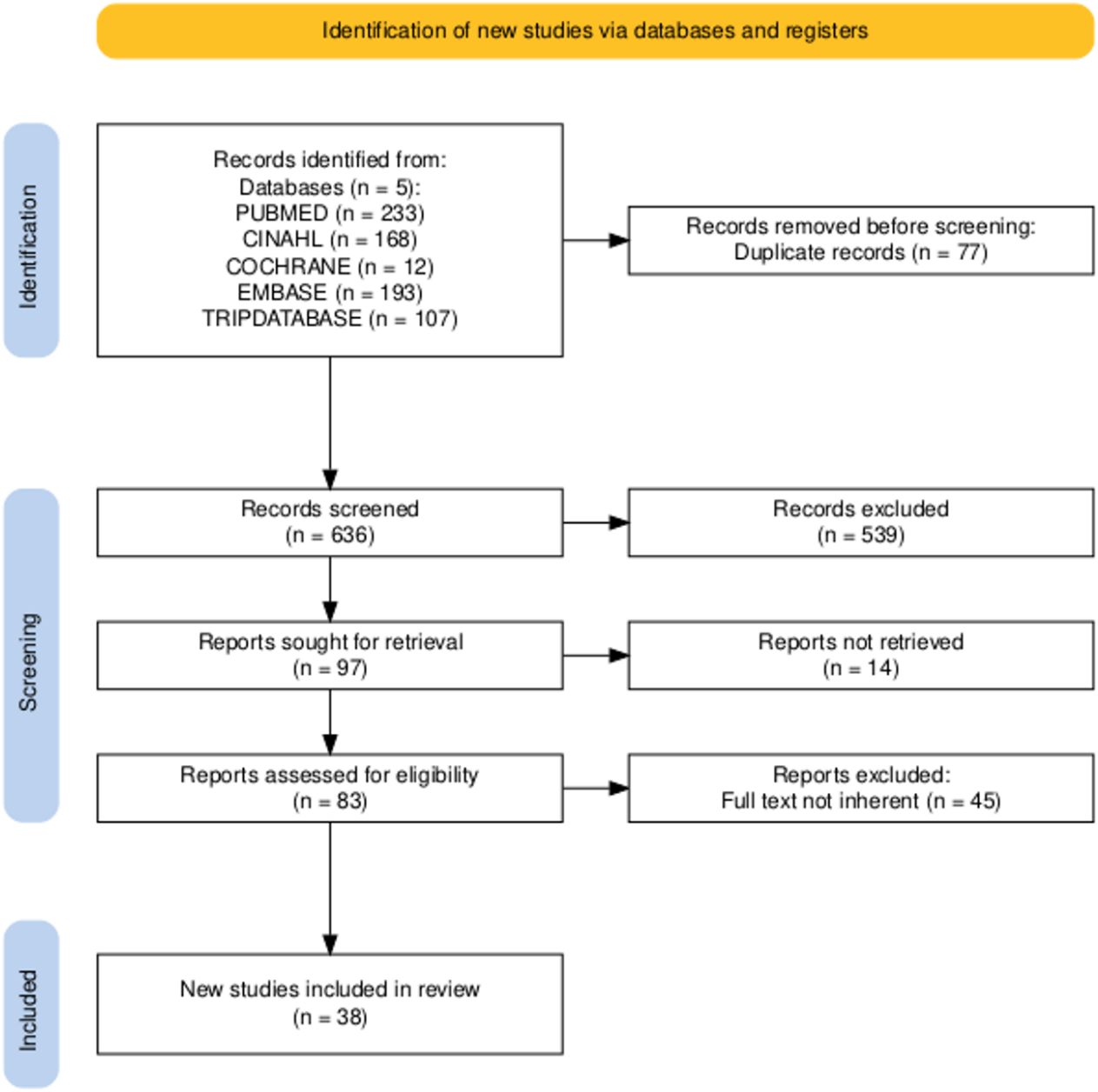

Figure 3. PRISMA-ScR flow diagram showing the selection of sources of evidence included in the scoping review.[16,17]

Table 2. Included studies in the scoping review (N = 38): publication years, study types, and geographic distribution.

Total number of articles	**38**
Publication years	2014: 2 (5.3%); 2015: 4 (10.5%); 2017: 3 (7.9%); 2018: 2 (5.3%); 2019: 5 (13.2%); 2020: 7 (18.1%); 2021: 2 (5.3%); 2022: 3 (7.9%); 2023: 3 (7.9%); 2024: 5 (13.2%); 2025: 2 (5.3%).
Study types (% of total)	Randomized studies (RCT/crossover): 14 (36.8%); Quasi-experimental / pre-post studies: 6 (15.8%); Observational studies (cohort): 3 (7.9%); Consensus statements / guidelines: 4 (10.5%); Qualitative studies: 3 (7.9%); Quality improvement: 3 (7.9%); Survey: 2 (5.3%); Descriptive study: 1 (2.6%); Methodological study: 1 (2.6%); Case series: 1 (2.6%).
Geographic origin (% by continent)	Asia: 14 (36.8%); North America: 12 (31.6%); Europe: 4 (10.5%); Africa: 3 (7.9%); South America: 3 (7.9%); Global / Multicontinental: 2 (5.3%).

Regarding bathing practices, studies suggested considerable variation in timing, frequency and cleansing methods. Evidence indicated that delaying the first bath supported thermoregulation, stabilized vital parameters and improved parental involvement in routine care.[13,14,18]

Infants who received delayed immersion baths were less prone to hypothermia than those bathed early with sponge methods.19

In preterm infants, extending the interval between baths from two to four days did not worsen skin condition or increase bacterial colonization, supporting the practice of reduced bathing frequency to minimize stress and heat loss.[20]

Comparisons between water-only baths and baths using mildly acidic, soap-free cleansers revealed no significant differences in trans epidermal water loss or skin surface pH reduction. Nevertheless, the timing and nature of post-bath care influenced hydration in the hours following bathing. Infants receiving emollients ten minutes after bathing appeared to maintain more sustained hydration levels than those treated immediately after the bath, suggesting that a short interval may favor better absorption and barrier support.[21]

Studies on emollient therapy revealed substantial variability in effectiveness depending on lipid composition and neonatal maturity.[22-30]

While sunflower seed oil is widely used across different settings, one randomized trial showed that its application in extremely preterm infants increased TEWL and reduced hydration, suggesting adverse effects on barrier maturation.[22,23,25,27]

In contrast, topical coconut oil consistently enhanced barrier function, reduced TEWL and limited pathogenic colonization.[26,27]

Almond and olive oils improved hydration and skin condition without causing irritation, and no major adverse events were reported.[24]

Qualitative studies conducted in African and other low-resource settings highlighted substantial variability in cultural skincare practices. In many regions, traditional oils such as coconut, olive or shea butter were commonly used, sometimes accompanied by vigorous massage that risked damaging fragile neonatal skin. Harmful substances, including motor oil, were also reported.[28-30]

Ceramide-containing moisturizers were associated with beneficial effects. Their lipid profile resembles the physiological composition of the stratum corneum, supporting lipid organization and reducing the frequency of dermatitis episodes. Infants treated with ceramide-rich emollients experienced fewer relapses of atopic dermatitis and required less frequent use of topical corticosteroids.[31,32]

Perineal care emerged as another critical domain. Regimens combining emollient-infused diapers with acid-buffered wipes produced lower perianal pH levels and reduced erythema compared with standard products.[33]

Zinc oxide barrier creams seem to perform better than topical human milk in moderate to severe diaper dermatitis, although human milk showed partial benefits in mild cases.[34]

The introduction of standardized perineal care guidelines appeared to significantly decrease the incidence and severity of diaper dermatitis and shortened healing time.[35]

Studies focusing on atopic dermatitis prevention emphasized that early skin care plays a pivotal role in high-risk infants. Consensus recommendations highlighted gentle cleansing with mildly acidic products, brief lukewarm baths two to three times per week and daily use of ceramide-enriched emollients.[36]

A prospective cohort study from Japan suggested that structured skincare protocols may have season-dependent effectiveness, with infants born in winter benefiting most from proactive moisturizing routines that enhance barrier development.[37]

Research conducted in neonatal and pediatric intensive care settings revealed a high incidence of cutaneous lesions, particularly among preterm infants. These lesions included hematomas, abrasions, erythema, candidiasis, diaper dermatitis and moisture-associated skin damage.[38]

Cyanoacrylate-based skin protectants may represent a promising intervention for the management of moisture-associated skin damage and device-related irritation. Their application formed a flexible, breathable barrier that adhered effectively to moist areas, supporting rapid healing of granulomatous tissue around tracheostomies, peri-stomal irritation and superficial lacerations.[39]

PIs were frequently associated with medical devices, especially in younger infants whose facial and scalp skin is particularly fragile.[40-42]

Implementation of pressure injury prevention bundles incorporating regular repositioning,

risk assessments, protective products and staff education successfully reduced both incidence and severity of PIs.[1,43,44]

These findings highlight the potential importance of culturally sensitive educational interventions that integrate evidence-based recommendations with respect for local traditions.[45-52]

Discussion

Our mapping underscores the breadth of evidence on neonatal and pediatric skin care, spanning bathing and cleansing routines, emollient therapy, perineal care, strategies to prevent atopic dermatitis, management of skin lesions and international variation in care practices.

Bathing practices suggest that delaying the first bath may support thermal stability, preserve vernix caseosa, and facilitate parent–infant bonding, in line with international recommendations.[53]

In preterm infants, reduced bathing frequency appears safe and may minimize physiological stress by limiting handling and temperature fluctuations.[53]

The evidence on emollient therapy highlights the importance of selecting products appropriate to neonatal maturity and skin physiology. Although sunflower seed oil is widely available and inexpensive, data suggesting increased TEWL in extremely preterm infants urge caution in its use in this vulnerable population.[25]

In contrast, coconut oil appears to offer advantages in improving hydration, promoting barrier maturation, and reducing colonization with potentially pathogenic organisms.[26,27] Almond and olive oils can also be considered safe options when used under appropriate clinical supervision.[22]

Ceramide-containing products are of interest because they closely resemble the natural lipid composition of the stratum corneum. Their early use not only improves hydration but also appears to reduce the incidence and severity of atopic dermatitis, with a consequent reduction in the need for topical corticosteroids.[31]

These findings support the proactive use of ceramide-rich emollients in infants with a family history of atopy or other risk factors for barrier dysfunction.[32]

Perineal care studies highlight the potential importance of maintaining an acidic skin surface to inhibit pathogenic colonization and reduce irritant damage. Structured protocols incorporating pH-buffered wipes and barrier creams based on zinc oxide or other protective agents have been associated with reductions in the incidence and severity of diaper dermatitis.[33]

Such protocols may be particularly relevant for hospitalized neonates and preterm infants, who are frequently exposed to prolonged moisture and irritants.[34,35]

Cutaneous lesions, especially pressure injuries in neonatal and pediatric intensive care settings, remain a significant clinical problem. Several studies suggested that multidisciplinary bundles including systematic risk assessment, repositioning strategies, appropriate support surfaces, and careful device management may help reduce the incidence and severity of pressure injuries.[40,43,44]

Younger infants, and particularly those with complex cardiac or respiratory conditions, appear to be at greatest risk, emphasizing the need for consistent preventive strategies.[41]

Global disparities in skin care practices reflect differences in cultural traditions, resource availability and educational support.[49,50]

While certain traditional practices, such as the use of natural oils and delayed bathing, may align with evidence-based recommendations, others pose significant risks and require modification. Educational interventions that respect cultural norms while promoting safe and effective practices are essential to improving outcomes in low-resource settings.[54]

This review has several strengths, including its broad international scope and the use of a structured methodological approach. However, it is limited by variability in study design, sample size and outcome measures across the included articles. Few randomized controlled trials are available for some interventions, and long-term outcomes are rarely reported. Further high-quality clinical research is needed to clarify optimal product selection, frequency of interventions and tailored strategies for different subgroups of neonates and children.

Conclusions

Neonatal and pediatric skin care requires an approach that acknowledges the unique vulnerability and physiological immaturity of early life. Across the literature synthesized in this scoping review, evidence supports delayed

bathing, careful use of emollients tailored to developmental stage, structured perineal care, preventive strategies for atopic dermatitis and targeted interventions for wound management. Preterm infants, particularly those born at extremely low gestational age, require highly individualized care and access to specialized products that support rapid yet safe maturation of the skin barrier.

Significant disparities persist between high- and low-resource settings, where economic constraints, infrastructural limitations and cultural practices influence the feasibility of implementing standardized protocols. Developing and disseminating culturally sensitive, evidence-based guidelines is therefore essential. Educational initiatives for healthcare professionals and parents, as well as the integration of skin care bundles into routine clinical practice, can contribute to improved outcomes and to the recognition of neonatal skin health as a fundamental component of the right to health for all infants.

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