



Neonatal Skin: A Dynamic Adaptation Process

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Recently I became an aunt, and as I held my precious and practically perfect niece, I contemplated the fascinating and intricate postpartum changes that occur in neonatal skin to adapt to our dry terrestrial life. During this physiologic adaptation, newborns may develop a range of cutaneous entities due to undeveloped adnexal structures, maternal hormone stimulation, or other unknown mechanisms. Rarely, cutaneous lesions may be indicators of underlying systemic diseases or congenital syndromes. I recognized the yellowish papules across my newborn niece's nose as sebaceous hyperplasia, which prompted my curiosity to revisit the challenging subject of pustular and acneform lesions in neonates. I became acutely aware that I may be called on for a curbside consultation from her concerned first-time parents and therefore sought to brush up on this subject.

To understand the abnormal, one must first understand the normal. Neonatal skin is dynamic, continuously adapting to its new extrauterine environment and providing protection, thermoregulation, and electrolyte homeostasis both prepartum and postpartum. The inside-out and outside-in barrier function of the skin is competent at birth in full-term newborns¹; however, a rapid process of change and adaptation ensues after birth to adapt to the dry terrestrial environment. Full-term neonates are born with a protective waxy covering termed the *vernix caseosa*, a hydrophobic film that covers the fetus in the third trimester and fulfills a variety of functions, including electrolyte transport, thermoregulation, protection provided by antioxidants, and epidermal barrier development.² The sebaceous glands directly contribute to the formation of the *vernix caseosa* via lipid

production (eg, triglycerides, wax esters, squalene).³ Interestingly, sebum production increases at birth and reaches the rate of an adult within the first week after birth,⁴ with good correlation between the sebum excretion rates of neonates and their mothers.⁵ It is likely that hormonal stimuli play a role in sebaceous gland activity, which explains the occurrence of sebaceous hyperplasia in neonates in the first few days of life, with subsequent resolution in the ensuing weeks.

Although full-term neonatal skin is similar to adult skin in many ways, it also demonstrates many interesting differences. In full-term newborns, a physiologic adaptation process begins immediately after birth to adapt to extrauterine life.⁶ This process is expedited in preterm newborns, such that by 2 to 3 weeks after birth, the skin is comparable to a full-term newborn.¹ The structure and function of the skin (eg, stratum corneum thickness, transepidermal water loss, pH, natural moisturizing factor [NMF]) continue to develop and evolve over the first few years of life.

The stratum corneum is fully formed in full-term newborns, albeit thinner than in adults; however, the barrier function of the skin is intact at birth.^{6,7} Transepidermal water loss is a recognized measure of barrier function and mirrors adults.⁷ The pH of adult skin ranges from 4.0 to 5.5, creating an acidic environment known as the acid mantle, which is necessary to maintain bacteriological, chemical, and mechanical resistance.¹ Interestingly, newborn skin is substantially more alkaline than adult skin at birth and during the first 24 hours of life.¹ Over the next few days to weeks, the pH continues to decrease, dropping to an approximate pH of 5.1 where it remains until the second year of life when it typically normalizes to the adult level. An alkaline pH increases the activity of serine proteases, which inhibits lamellar body secretion and induces inflammation. A high pH also favors the colonization of *Staphylococcus aureus* and *Candida albicans* and provides a compelling

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Differential Diagnosis of Pustules in Newborns⁸

Disease	Description	Treatment
Infantile acropustulosis	Recurrent crops of acral pustules; neutrophils in the pustules	Usually resolves spontaneously within 2–3 years; antihistamines for pruritus
Eosinophilic pustular folliculitis	Follicular pustules most commonly on the scalp and extremities that recur in crops; may occasionally be the presenting sign of hyperimmunoglobulin E syndrome	Topical corticosteroids and antihistamines for symptomatic relief; usually resolves spontaneously by 3 years of age
Erythema toxicum neonatorum	Blotchy erythema and evanescent macules, papules, and pustules that can present anywhere on the body, especially the forehead, face, trunk, and extremities; histology typically reveals folliculocentric eosinophils; usually occurs in the first 3–4 days of life; benign	Self-limited
Impetigo	Superficial vesicles that rupture easily; honey-colored crusting	Topical antibiotics
Milia	Discrete white papules on face; retention cysts composed of keratin; common in neonates	Usually resolves spontaneously by 3–4 weeks of life (persistent and/or widespread cases may be a manifestation of hereditary trichodysplasia, dystrophic epidermolysis bullosa, Bazex syndrome, Rombo syndrome, oral-facial-digital syndrome, or Down syndrome)
Miliaria rubra	Occluded sites, especially intertriginous areas; greater incidence in the first few weeks of life due to relative immaturity of eccrine glands	Avoidance of excessive heat and humidity; occlusive ointments in climates with high humidity
Neonatal acne	Acneform eruption thought to be due to stimulation of the sebaceous glands by maternal hormones	Daily cleansing with mild soap and water; occasionally, mild keratolytics or topical antibiotics
Neonatal cephalic pustulosis	Acneform eruption associated with the <i>Malassezia</i> species; pinpoint pustules on the cheeks, chin, and forehead	Topical antifungal agents
Sebaceous hyperplasia	Physiologic phenomenon of yellowish papules on the nose, chin, or cheeks; representative of stimulation of the sebaceous glands by maternal androgens	Usually resolves spontaneously in the first few weeks of life
Transient neonatal pustular melanosis	Darker skin; hyperpigmentation that typically persists for months; collarettes of fine white scale smears of the pustules; often variable numbers of neutrophils	Lesions usually resolve spontaneously within 24–48 hours; hyperpigmentation gradually fades

explanation for the high incidence of seborrheic dermatitis in newborns.⁷ The acid mantle highlights the importance of avoiding alkaline soaps and detergents in the postnatal period. Neonatal skin has lower water content in the stratum corneum despite high content of NMFs.⁷ In fact, Fluhr et al¹ demonstrated that NMF reaches its highest levels within the first 15 days of life, followed by a dramatic decline at 6 months of age and slow increase over the following years to adult levels but never to the immediate postpartum level.⁷ Fluhr et al⁷ provided an extensive evaluation of the maturation of infant skin over the first 2 years of life compared to adult skin using in vivo evaluation of the above-mentioned properties; I recommend this study for a more in-depth discussion, as the results are beyond the scope of this article.

Along with dynamic physiologic adaptation of the skin, neonates also have an increased susceptibility to infection due to the cutting of the umbilical cord during delivery as well as possible circumcision in males, which creates at least 1 and potentially 2 open surgical wounds. Newborns also are exposed to numerous fomites at the hospital and at home. It is well known that neonates have up to 5 times the surface area to mass ratio compared to adults and thus increased risk for percutaneous absorption of topical medications.⁸

Many skin appendages are not fully functional at birth¹; therefore, miliaria rubra and sebaceous gland hyperplasia are common in neonates but usually resolve spontaneously.⁸ Although these 2 conditions often are benign and are easily diagnosed, they engender a vast differential diagnosis, including infantile acropustulosis, eosinophilic pustular folliculitis, erythema toxicum neonatorum, impetigo, milia, neonatal acne, neonatal cephalic pustulosis, and transient neonatal pustular melanosis (Table).⁸ Most of these conditions are benign and are known to resolve spontaneously without treatment, but they are important to recognize. Oftentimes, good skin care is all that is necessary to prevent or treat many common neonatal dermatoses. Unfortunately, skin care guidelines for neonates and infants are somewhat lacking and evidence-based studies are inconsistent in their design; however, based on the available data and reviews, several conclusions can be drawn. For instance, bathing seems to be superior to washing, and neonates can be bathed twice a week after the

first week following delivery. Cleansing with syndets or liquid baby cleansers seems comparable or superior to cleansing with water alone; these products also are less likely than soaps to raise the pH of the skin, thereby causing less irritation.⁹

Neonatal dermatoses often are daunting, especially given the heightened concern of new parents. Backed with this basic understanding of cutaneous physiologic adaptation processes and common dermatoses in neonates, I now welcome any curbside consultations my brother may throw my way about his baby girl.

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