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Emollient Therapy for Newborn Infants—A Global Perspective

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ABSTRACT

Research on emollient therapy as a strategy to reduce mortality in newborn infants is a global priority. This paper discusses the use of emollients on newborn infants. Since the question is "Should emollients be applied to newborn infants, particularly premature infants?" the focus is on reports that discussed some measure of skin condition such as skin grades, skin effects, transepidermal water loss (TEWL), or impact on infection/mortality. The investigations on the use of emollients for premature infants are reviewed. Consideration is also given to the infant caregiver interactions during the applicaton as the process itself may be important for achieving benefits on skin barrier development and integrity. The remaining questions and subjects of future research are presented.

Research on emollient therapy as a strategy to reduce mortality in newborn infants is a global priority.[1] The term "emollient" is broadly defined as a topical material composed of fat or oil that hydrates and softens the skin. It may refer to a specific materials and/or combinations.

Daily application of emollients with whole body massage is a cultural norm in some countries. In rural Nepal, massage with mustard seed oil was conducted in 99.8% of households.[2] The primary reasons were to (a) make the baby's body strong (69.6%), (b) keep the infant healthy (41.4%), (c) keep the infant warm (36.8%), and (d) make the skin look good (23.7%). Infants are massages 2–3 times daily and nearly 50% have the first massage within an hour of birth (Table 1).

This paper discusses the use of emollients on newborn infants. Since the question is "Should emollients be applied to newborn infants, particularly premature infants?" the focus is on reports that discussed some measure of skin condition such as skin grades, skin effects, transepidermal water loss (TEWL), or impact on infection/mortality. Transepidermal water loss occurs when water from respiration passes through the skin layers and into the environment at rates of 4–8 $g/m^2/h$ in healthy full term infants (Fig. 1).[3,4] Measures of TEWL are used to determine the integrity of the stratum corneum (SC) with low values indicating an effective barrier. High TEWL means that water is passing through at a greater rate, indicating a SC barrier is damaged, not well formed, or has fewer layers than normal. Any topical treatment, including oils, creams, petrolatum-based treatments, films and humidity was considered to be an emollient. More than 350 citations used these terms: infant skin and emollient, premature infant skin and emollient, premature infant skin and development, newborn skin and oil, newborn skin and topical treatment, and newborn skin and animal models. There were 29 studies on infants encompassing 2882 subjects. Seventeen studies included one or more of these outcomes and the specific emollients were: (1) sunflower oil or safflower oil ($n = 8$), (2) petrolatum, paraffin, or Aquaphor® ($n = 11$), olive oil ($n = 2$), soybean oil ($n = 1$), coconut oil ($n = 2$), meadowfoam oil ($n = 1$) and almond oil of varying compositions ($n = 2$).

"Premature infant" broadly refers to infants of 23–37 weeks gestational age (GA). The extent of stratum corneum maturation depends upon GA and, therefore, varies considerably over the 23–37 week prematurity period. Extremely premature infants have a significantly underdeveloped SC and may have only a few layers, depending upon GA. The question of skin response to emollients is discussed in the context of premature age.

Emollient Properties and Technical Rationale for Use

Emollients are usually mixtures of a few or many ingredients. They are composed largely of fatty acids of varying chemical chain lengths. Oils, like those used in India, often come from natural plant sources. Table 2 lists the types and amounts of fatty acids in oils such as sunflower, mustard seed, coconut, and safflower. The fatty acids are mixtures of saturated and unsaturated (containing at least one double bond) compounds. Another emollient type is derived from the distillation of petroleum, including petrolatum and brands such as Aquaphor®. They range for liquid (mineral oil) to more solid forms.

The use of fatty acid containing emollients is based, in part, on their effects on skin. For example, linoleic acid activates protein transcription factors that increase the rate of stratum corneum barrier formation.[5] Linoleic acid has anti-inflammatory properties.[6] The SC contains three classes of lipids, namely fatty acids, cholesterol and ceramides. Treatment of tape-stripped skin with SC type lipids increased the rate of barrier repair.[7] The ceramide component influenced the SC barrier properties in model systems.[8] A mixture of physiological lipids cholesterol,

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Table 1
Characteristics of infant massage in rural Nepal.

Frequency	$N = 22,871$
Daily	5.0%
2–3 times daily	83.8%
>3 times daily	9.5%
Once per week	0.6%
Twice per week	0.3%
First Massage	$N = 22746$
Within 1st hour	49.3%
1–6 hr after birth	41.6%
6–24 hr after birth	6.8%
24–48 hr after birth	1.4%
After 48 hr	0.9%

ceramide, palmitate and linoleate (ratio 3:1:1:1) is optimum for SC barrier repair.[9] The ceramide and fatty acid components can be replaced by mixtures of triglyceride, sphingomyelin and glycosyl ceramides, and the improvement in SC repair is maintained.[10]

Emollient use in premature and vulnerable newborns has been based on the premise that improving skin integrity will mitigate the negative consequences of exposure to infectious agents The premature epidermal barrier has few cornified layers and is at risk for increased permeability to exogenous materials, additional skin compromise and delayed skin barrier maturation and infection.[11–13] Very premature infants frequently exhibit an abnormal pattern of desquamation several weeks after birth, indicative of a hyperproliferative stratum corneum. A compromised SC barrier is more susceptible to entry and/or penetration by microorganisms.[14] Although the findings may not be directly applicable to premature infants, studies among health care workers have shown that irritated hand skin had significantly more colony-forming units than normal skin.[15] Total bacteria counts were higher as skin damage increased.[14] Efforts to reduce hospital acquired infections in premature infants in highly developed countries are ongoing.

Emollient Therapy for Premature Infants

Films

The effect of continuous application of a semipermeable film on TEWL was compared to untreated skin in ten infants of 24–32 weeks GA for ten days. TEWL of the untreated skin decreased through day 7 (Fig. 2). When the film was removed on day 14, TEWL for the protected site and untreated skin was not different.[16] It is possible that some SC was removed with the dressing causing the increase. No differences were found for coagulase-negative staphylococcus for the two sites. *Staplyococcus aureus* was found on day 1 at the film and *Malassezia furfur* was found on the controls.

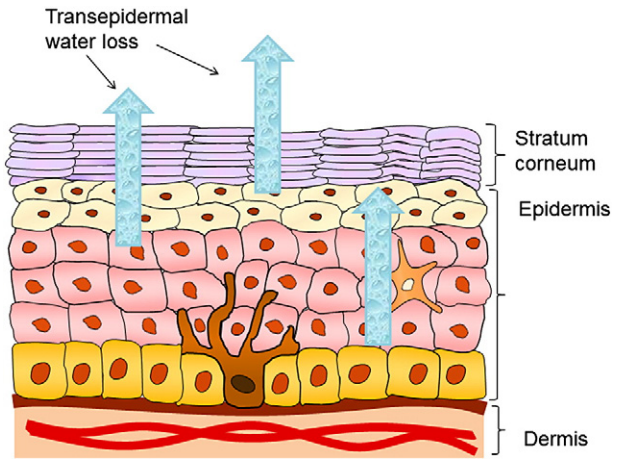

Fig. 1. Transepidermal water loss. TEWL occurs when water from respiration passes through the skin layers and into the environment at rates of 4–8 g/m^2/h in healthy full term infants. Measures of TEWL are used to determine the integrity of the SC with low values indicating an effective barrier. High TEWL means that water is passing through at a greater rate, indicating that an SC barrier is damaged, is not well formed, or has fewer layers than the normal.

TEWL was lower for skin treated with a semipermeable film for 7 days (both before and after removal) versus untreated control skin in 15 infants of 24–29 weeks.[17] Ten minutes after film removal, TEWL was higher than the value through the dressing but lower than the control (Fig. 2B). Coagulase-negative staphylococcus was lower on the film site at day 4 ($p < 0.05$). Two subjects had coagulase-negative staphylococci positive blood cultures.

Emollients

Skin grades were significantly lower on days 7–11 ($p < 0.05$) and directionally lower on the abdomen on day 14 (Fig. 3) following emollient cream application twice daily for 12 days in parallel groups ($n = 17$) of infants of 29–36 weeks GA.[18] The skin condition score increased (worsened) over the study period. No differences were observed for TEWL. Coagulase-negative staphylococci cultures were the same in both groups. One control subject had *Candida parasilosis* and *Trichosporon beigelii*.

Petrolatum-Based Emollient Studies

A petrolatum-based cream (Aquaphor®) was applied twice daily for 14 days to parallel groups of infants ($n = 30$ each) 24–32 weeks GA. TEWL was significantly lower at 0.5, 1 and 4–6 hours after application versus the untreated control group ($p < 0.05$) (Fig. 4A).[19] TEWL decreased for both groups over 14 days of treatment ($p < 0.05$) (Fig. 4B). When the data were adjusted for starting TEWL values, the differences were not significant. The skin scores were lower for the treatment group ($p < 0.05$). Bacterial counts were reduced for the emollient treatment at the axilla site on day 14. One treated subject and 8 in the control group had positive blood or CSF cultures for coagulase-negative staphylococci.

Eleven premature infants of 28.3 ± 1.4 weeks GA were treated twice daily for 14 days with a petrolatum-based cream (Aquaphor®) with eight infants of 27.5 ± 1.3 weeks GA as untreated controls. Skin condition scores were significantly lower for the Aquaphor® beginning on day 4 ($p < 0.05$) (Fig. 5).[20] Five infants developed sepsis, 2 receiving treatment and 3 controls. The groups did not differ in fluids, urine output, or sodium levels. Skin condition scores (dryness) *increased* over the first four days for the untreated control. Ten infants of 24–26 weeks GA with and 30 without systemic candidiasis were compared. The odds ratio for systemic candidiasis was significantly higher when a petrolatum-based topical treatment had been used.[21] The age an onset of systemic candidiasis was 21.5 ± 24 days (range 6–82). The number of cases decreased when petrolatum treatment was discontinued. Since the SC barrier is not fully developed at 22 days post birth for 23–25 GA infants,[22] insufficient barrier integrity may have been a factor for the 24–26 week infants in this study.

A multicenter trial among parallel groups of premature infants ($n = 1206$ total), compared twice daily application of a petrolatum-based cream (Aquaphor®) for 14 days with conventional skin care (petrolatum cream applied to problem areas as needed).[23] There were no differences in mortality rates but hospital acquired blood stream infections were significantly higher in the emollient group for the subset weighing 501–750 grams. The number of infants with skin damage (grade >3) was significantly lower for the twice daily emollient group. Hospital acquired bacterial sepsis was caused by gram positive bacteria in 82% of cases and coagulase-negative staphylococcus in greater than