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Epidermal barrier lipids in human vernix caseosa: corresponding ceramide pattern in vernix and fetal skin.

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BACKGROUND: Vernix caseosa is a protective biofilm covering the fetus during the last trimester. Vernix and epidermal barrier lipids (i.e. cholesterol, free fatty acids and ceramides) appear to share protective functions for fetal and neonatal skin. OBJECTIVES: To analyse vernix samples for epidermal barrier lipid content, and to compare lipid profiles of vernix with those of fetal and postnatal epidermis. METHODS: Vernix samples were collected from 21 healthy term neonates. Skin samples were collected from 10 fetuses aborted between gestational week (GW) 16 and 25, nine infants and 11 older children. Lipids were extracted according to standard protocols and analysed by high-performance thin-layer chromatography. RESULTS: Vernix contained 196.5 +/- 70.1 microg barrier lipids mg-1 protein (mean +/- SD). Cholesterol formed the major barrier lipid fraction (52.8%), followed by free fatty acids (27.7%) and ceramides (20.1%). The ceramide composition of vernix resembled that of mid-gestational (GW 23-25) fetal epidermis both qualitatively and quantitatively, while there were major differences from postnatal epidermis. The total epidermal ceramide concentration increased significantly between prenatal and postnatal samples. CONCLUSIONS: The composition pattern of ceramides mirrors that of mid-gestational fetal epidermis. Vernix thus represents a 'homologous' substitute for the immature epidermal barrier in fetal skin. The differential role of individual ceramides in this process remains to be established.

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Surface free energy characterization of vernix caseosa. Potential role in waterproofing the newborn infant.

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BACKGROUND/AIMS: Vernix caseosa is a proteolipid biofilm synthesized by the human fetus, which progressively covers the fetal skin surface during the last trimester of pregnancy. The exact physiological functions of vernix are unclear. Hypothetically, it serves a role in "waterproofing" the fetus during the critical period of epidermal barrier development before birth. Vernix may also play a role in adaptation of the fetal skin surface to the dry, cool extrauterine environment after birth. Given the strategic position of vernix on the fetal skin surface and the rapidly changing environment encountered by the skin at birth, we proposed that investigation of vernix surface characteristics would facilitate understanding its putative physiological roles. METHODS: In this paper, we focused on the determination of the surface free energy

(SFE) of vernix caseosa. Different approaches were used to calculate the SFE of vernix from contact angle (theta) measurements between vernix and various liquids (benzyl alcohol, diiodomethane, glycerol, and water). The critical surface tension (CST) of vernix was calculated using Zisman plots. The dispersive and the polar components of vernix SFE were calculated using the Owens-Wendt geometric mean method. Vernix was contrasted with petrolatum, a commonly used skin protectant. RESULTS: CST of fresh vernix was 40.5 dyne/cm while that of petrolatum was 35.8 dyne/cm. Fresh vernix polar SFE was 1.5 dyne/cm while petrolatum had almost no polar SFE component (0.03 dyne/cm). For all liquids (except the nonpolar diiodomethane) there was a significant decrease in contact angle with time. CONCLUSIONS: The CST and the total SFE values suggest that vernix has very low surface energy and is highly unwettable. These findings are significant insofar as the main component in vernix is water, which is highly energetic. Although vernix has a very high water content, the major part of its SFE is hydrophobic (dispersive). The limited interaction between vernix and hydrophilic liquids supports the hypothesis that vernix acts as a natural protectant cream to "waterproof" the fetus in utero while submerged in the amniotic fluid.

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Characterization of vernix caseosa: water content, morphology, and elemental analysis.

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Recent studies have prompted interest in the use of epidermal barrier creams as protective biofilms for very low birthweight preterm infants. The key to understanding the role of epidermal barrier films is an elucidation of their interaction with water and a basic knowledge of their composition. In this study, we investigated the morphologic properties and elemental composition of the naturally occurring biofilm, vernix caseosa. This biofilm is typically lacking in preterm infants and its production coincides in utero with terminal differentiation of the epidermis and formation of the stratum corneum. Significantly, vernix (80.5+/-1.0% H2O) had a much higher water content than other barrier creams (Eucerin: 17.1+/-0.6%, Aquaphor: 0.33+/-0.03%, Ilex: 0.19+/-0.02%, petrolatum: 0.03+/-0.01%; all $p<0.05$). Phase contrast microscopy of vernix showed multiple cellular elements with nucleic "ghosts" embedded in a putative lipid matrix. Transmission electron microscopy revealed flattened structures approximately 1-2 microm in thickness with distinct cellular envelopes indicative of differentiated corneocytes. Compared with mature corneocytes in adult stratum corneum, vernix corneocytes appeared swollen, the density of the keratin filaments was less, and there was a relative lack of tonofilament orientation. Cryofractured specimens were examined by cryoscanning electron microscopy with subsequent elemental localization by X-ray beam analysis. The findings indicate the high water content of vernix is largely compartmentalized within fetal corneocytes. These results are consistent with the novel view of vernix as a "fluid phase" stratum corneum consisting of a hydrophobic lipid matrix with embedded fetal corneocytes possessing unique biomechanical and water-binding properties.

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Characterization of vernix caseosa as a natural biofilm: comparison to standard oil-based ointments.

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The application of occlusive films and oil-in-oil ointments has been reported to improve epidermal barrier function in very low birthweight, preterm infants. Such infants have a structurally immature stratum corneum and lack a surface coating of vernix caseosa. In this study we examined the short-term effects of topical application of vernix caseosa to human skin and contrasted these effects with commonly used ointments and water-in-oil emulsions. Specifically, vernix, Eucerin(R), Aquaphor(R), and petrolatum were applied to the volar skin surface of adult volunteers. Surface electrical capacitance (SEC) and transepidermal water loss (TEWL) were measured as indices of surface hydration. Sorption-desorption profiles were performed to determine skin surface hydrophobicity. Particular attention was given to monitoring the acute (0-120 minutes) changes following vernix treatment in order to compare these effects with earlier reports on the rate of skin surface drying in newborn infants following birth. Immediately after vernix application there was an increase in the rate of water loss from the skin surface. Relative to control skin and skin treated with the ointments and water-in-oil emulsions, the application of vernix to freshly bathed human skin resulted in a unique profile of temporal change in baseline surface hydration, moisture accumulation, and water-holding capacity. These results demonstrate major differences between human vernix and standard oil-based topical ointments. The results provide a framework for discussing the various properties of topical barriers applied to the very low birthweight infant.

Publication Types:

- Clinical Trial
- Randomized Controlled Trial

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Barrier properties of vernix caseosa.

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Experiments are described which show that vernix caseosa has a mechanical barrier effect if it is deposited in an unbroken layer. Specific antibacterial properties were not detected in vernix. It is suggested that vernix is best left on a newborn infant because of its mechanical obstruction to bacterial passage.