

REVIEW PAPER

Structure of children's skin and rules for its care – what's new? Children's skin structure

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ABSTRACT

A newborns' skin is significantly different in its structure and functions compared to that of adult skin. The differences include the structure of the epidermis, dermis, and subcutaneous tissue, as well as skin appendages. Significant disproportions are also observed in the structure of elements of the nervous, circulatory, and lymphatic systems.

Rules of infant and baby care should be adapted to the requirements of their delicate, thin, and underdeveloped skin. Inadequate choice of newborn care may disturb the balance of microbiota, impairing interactions between microorganisms and between microbiota and skin. It may also impair the pH of the skin, leading to infections.

Data from research present various strategies used to select dermocosmetics and care methods in the everyday hygiene of infants and babies. They now recommend that the quantity of cleaning agents should be reduced, as well as the frequency of hygienic and care treatment.

KEY WORDS:

newborn, skin care, child's skin, dermocosmetics.

EPIDERMIS

The epidermis in infants and babies is about 20% thinner than in adults. Keratinocytes that build the epidermal layer are smaller and not as tightly connected. The basal layer (stratum basale) is composed of one layer of cells and is about 30% thinner. There are scarce hemidesmosomes, connecting the epidermis with the basement membrane. The spinous layer creates weaker intercellular connections, forming fewer desmosomes. The granular layer (stratum granulosum) is weakly marked and practically interspersed. The squamous layer (stratum corneum) is very thin and delicate. Therefore, it does not constitute an effective barrier against external factors, which are absorbed faster by the body. Additionally, a higher level of TEWL (transepidermal water loss) is observed in infants, which is linked to differences in the structure of corneocytes and

the composition of an intracellular cement. The epidermal barrier is immature. Up to the first year of life, the level of NMF (natural moisturizing factor) is gradually growing, ensuring a better level of epidermis moisturization. The epidermis of newborns is about 50 µm thick, whereas in adults its can be up to 0.5 mm thick [1-4].

Immediately after birth, the so-called vernix ensures that TEWL is very low. In foetal life, the vernix is protecting against amniotic fluid and enzymes, has antimicrobial properties, reduces skin surface pH, and provides lipids and moisturization [5].

DERMIS

Paediatric skin is about 10 times thinner than adult skin. Also, the dermis-epidermis border in children is thicker. Studies conducted by Stamatas *et al.* state that

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the borderline between the papillary and reticular regions is visible only in adults. The dermis is characterised by rich cellular structure, with predominant fibroblasts. The collagen and elastin fibre network is immature and the fibres are thin and insufficiently resistant to mechanical stimuli. The correct network of collagen and elastin fibres develops between 3 and 5 years of age. Type III collagen is a dominant fibre in foetal life and is gradually replaced by type I collagen, which prevails in the skin of an adult. Immediately after birth, the infant's skin is rich in glycosaminoglycans, that bind water molecule and provide correct level of skin moisturization. During the first months of life, the skin vascular network gradually develops to form the deep vascular plexus, upper vascular plexus, and capillary loops in dermal papillae. Small blood vessels in dermal papillae supply nutrients, oxygen, hormones, etc. to the epidermis [1, 3-4, 6].

The differences between babies' and adults' skin are shown in the density and arrangement dermal papillae. The ratio between a baby's skin to body weight is 3 times greater than in adults. Therefore, the potential of concentrating collected substances in the tissue of infants and babies is significantly higher. The higher body surface to body mass ratio increases biological accessibility [1, 3-4, 7-8].

SUBCUTANEOUS TISSUE

The subcutaneous tissue develops at around the sixth month of foetal life. After birth, it resembles the subcutaneous tissue of an adult, but it is thinner. Throughout childhood, fat tissue and adipocytes gradually increase. Therefore, the number of adipocytes is predetermined in our childhood. The underdeveloped network of collagen and elastin fibres, as well as subcutaneous tissue, is responsible for the lack of proper isolation that serves to retain body heat. Thermoregulatory mechanisms do not operate effectively yet [9].

SEBACEOUS GLANDS

In foetal life, the baby is covered with a mixture of dead cells and sebum, constituting vernix. For about 3 months after the birth, the sebaceous glands are regulated under the influence of the mother's hormone management system, especially androgens. Generation of sebum is increased, and infants may have neonatal acne, milia, and milky skin. The most sebum is secreted several hours after birth, reaching a peak in the first week of life, after which it gradually reduces. The level of sebum excretion decreases after the first month of life and almost stops when the baby is 3 months old. Subsequently, most babies have normal skin, alternatively dry, until puberty. The quantity of sebaceous glands remains more or less the same throughout their whole life, whereas they become bigger with age [1, 10].

SWEAT GLANDS

Infants are born with fully formed eccrine sweat glands, but the nervous system and vascular network managing them has yet to fully develop. The thermoregulatory system is not fully efficient, so it is essential for the baby to not become overheated. The secretion by the sweat glands shows differences depending on the place of the body. After birth, secretion decreases or remains stable on hands, soles, and forearms. It does not reach the level found in adults until the baby turns one year old. The forehead, upper limbs, and abdomen areas show sweat gland secretion values similar to those of adults as early as on the 2nd and 7th day of life [4, 8].

APOCRINE GLANDS

They are not developed in children. They begin to operate in adolescence [8].

PH OF THE CHILD'S SKIN

Since first contact, babies delivered naturally are colonized by their mother's microflora of the birth canal and the skin. Development of a proper microbiome of the digestive system and the skin ensures healthy, sustainable development. Newborn babies who are born naturally aggregate *Lactobacillus* spp., *Prevotella* spp., and *Sneathia* spp., while the skin of babies born by caesarean section is mainly inhabited by the *Staphylococcus*, *Corynebacterium*, and *Propionibacterium* species. The composition of bacterial flora on the skin surface evolves during the first year of a child's life. Microbial imbalance causing disturbance of interspecies and intraspecies interactions of microorganisms can lead to infection. The pH of the newborn skin is neutral or even slightly alkaline, ranging from about 6.34 to 7.5, and only starts to fall over time and become acidic at pH 5.5. According to various sources, the pH of a child's skin is normalised between 14 days and about 1 year of age. Colonization of bacteria on the infant's body occurs during the first 2-3 days of his/her life. It is estimated that 50-60 million bacteria develop on 1 cm² of skin. Overly aggressive, particularly strongly alkaline detergents and high-temperature bath water may disrupt the pH of the hydrolipidic layer of babies skin and cause microbiota dysbiosis [1, 11].

CARE OF INTIMATE AREAS

Single-use diapers

Disposable diapers are made on the basis of mixtures involving hydrophilic polymers, e.g. sodium polyacrylate. The inner absorbent layer of the diaper is fluffy cellulose, in which the polyacrylate is evenly distributed. The outer layer is water-impermeable polyethylene. Comfort, result-

ing from wearing a dry diaper, has a significant influence on weaning the baby from diapers. African countries and India propose giving up diapers completely, even defining their wearing as restraining the babies movements. It is recommended to change diapers at least 6-7 times a day, cleaning the intimate area and applying a greasy protective cream after it has dried. The use of talcum powder in daily infant care is not recommended because in combination with urine and faeces it forms a moist, adherent environment [12].

Wet wipes

It is important that the hygiene wipes are odourless and do not contain irritants, alcohol, perfumes, essential oils, soap, detergents, or dyes. The use of wipes is less common and often abandoned in favour of water alone [11, 12]. The results of the clinical trials of Ehretsmann *et al.*, in which the effects of using moistened wipes were tested in daily infant care regarding severity of erythema and diaper rash, showed that the overall condition of the skin did not differ between the group using the wipes and the group using water only. Studies of the moisturizing balm in the wipes indicate its low irritating potential under occlusive conditions. Good tolerance of wipes through the skin is also confirmed in clinical trials in children with atopic dermatitis [13].

INFANT CARE

The World Health Organisation has developed general guidelines for neonatal skin care, with a particular focus on preterm babies. Information on neonatal skin care is rarely available in standard paediatric manuals. Literature for nurses describes various methods of bathing and care; unfortunately, the information presented there is often contradictory [11].

The guidelines for the first cleaning of the newborn baby after birth recommend a gentle towel dry of the skin to keep the vernix in direct contact with the skin. The vernix will lower the pH of the skin surface, and provide lipids and moisture. Washing with water should be performed only after the newborn's body temperature has stabilized [11, 25].

No differences were observed in life functions and morbidity of newborns who were bathed directly in water compared to those treated with so-called dry care immediately after birth [11].

Taking a bath before going to bed, according to the daily schedule, mobilizes babies' nervous system to sleep [14, 26].

More often, babies and children are not bathed every day. Scientific reports recommend bathing 2-3 times a week for children with healthy skin, while for children with dry skin – only once a week. It is recommended that the face, hands, neck, armpits, and intimate areas

are cleaned every day using mild cleansers with neutral or slightly acidic pH – emollients or water alone. Soaps with high alkaline pH can remove the natural moisturizers and lipids from the skin, potentially leading to skin irritation, erythema, and itching. Dedicated liquid baby cleaners-syndets are well tolerated by newborns. After the bath, it is recommended that the body is rinsed with clean water. It is also recommended that the bath time be shortened (5-10 minutes for newborns and small children, to 20 minutes for older children) [14-16]. Bathing is preferable to washing with a cloth [25]. Dizon *et al.* suggest that caring for a child with water alone or washing with balanced syndets has similar clinical effects on skin hydration, skin surface pH and TEWL [17]. Adjusting the free Ca²⁺ concentration in the bath water is an important guideline in creating the ideal bath for babies. The softening properties of cleaning agents can help to reduce water hardness [18]. It was found that in infants up to 4 weeks of age regular use of syndets lowers skin pH. Also, adjusting the right temperature guarantees that the lower pH will last longer. It has also been shown that the use of a bath immediately after birth does not increase the risk of infection and inappropriate colonisation of bacteria on the newborn's body [25].

The substance used for washing should not be applied and foamed too intensively because it destroys the skin's natural hydrolipid layer. In the case of children born before the due date, it is not recommended to rub vernix intensively; often after gentle washing it is allowed to peel off itself. The bath water temperature should be 37-37.5°C. However, it is important that the temperature in the bathing room is not lower than 24°C. Bathing at the right temperature causes less heat loss and gives more comfort for the baby. After bathing, the baby should be gently dried with a towel without any frictional movements. Particularly hard-to-reach parts of the body, such as skin folds and spaces between toes, should be dried thoroughly. This prevents skin irritation and development of skin infections. If oils have been used in the bath, the skin should be left to dry naturally. Baby care oils should be certified and originate from safe sources. Untested oils can oxidize and change the level of biological activity. Mineral oils are chemically inert, stable, and generally considered safe [11].

The water environment favours the development of *Pseudomonas aeruginosa* bacteria on the surface of plastic toys and cosmetic bottles, which children willingly put into their mouths. It is recommended that toys are dried and kept clean after bathing, rather than chemically disinfected [14, 15].

Studies by Garcia Bartels *et al.* indicate the advisability of using emollients to maintain or improve the skin barrier function after bathing, at least twice a week. There are clinical benefits of using emollients in healthy infants to prevent typical in early progression of the allergic diseases at development. Emollients with more enriched formulas may be required in cold climates. They should be applied in a thin

layer to avoid occlusive effects. Washing of hair is recommended once a week, by applying a small amount of shampoo and rinsing it out relatively quickly [15, 19, 27, 28].

Dermocosmetics should be hypoallergenic and enriched with active ingredients, specific for children, and to the extent that it is suitable for immature skin with higher permeability than in adult human skin. Therefore, the level of active substances in cosmetics intended for children should be relatively low. The most common substances in such dermocosmetics are almond oil, panthenol, zinc oxide (which may dry out), and products of bee origin (which may cause allergies). It is worth choosing natural and organic cosmetics with quality confirmed by appropriate certificates, such as ECOCERT-COSMEBIO, BDIH, NaTrue, or the Soil Association [8].

BABY AND INFANT CARE DERMOCOSMETICS

The right choice of dermocosmetics for infants is crucial for the health of the whole body. Their choice should be very carefully thought out. The pH of washing dermocosmetics should be neutral or slightly acidic, so alkaline soaps are not suitable for infant care. It is important that, apart from the balanced composition in cosmetics, there should be as few preservatives, dyes, fragrances, and petroleum products as possible [22]. According to the legal regulations in force since 2013 in the whole of the European Union, the preservatives used can only be substances included in the list of preservatives constituting Annex V to Regulation (EC) no. 1223.2009 of the European Parliament and of the Council of 30.11.2009. Currently, there is a tendency to introduce natural preservatives into cosmetics instead of synthetic preservatives. Examples of essential oils used as preservatives are manuka, kanuka, aniseed, cinnamon, eucalyptus, mint, clove, thyme, and tea tree oil [23]. The substances boron, iodine, ethanol, denatured alcohol, detergent and the emulsifier sodium lauryl sulphate (SLS), and parabens (methyl-, ethyl-, propyl-, butylparaben) should not be included in children's cosmetics. The European Union considers the safe dose of parabens to be 0.4% for a single compound and 0.8% for a mixture of parabens. According to the law, a triclosan with a strong bacteriological and fungicidal effect can have a pro-neoplastic effect, interfere with the hormonal balance, and impair the immune system, so it can be used in cosmetics at a maximum concentration of 0.3%. Propylene glycol E 1520 can cause irritation and allergic reactions, inflammation, itching, and burning. Cosmetics with their addition should not be used by pregnant or breastfeeding women because they may adversely affect the development of the foetus [24, 25].

UMBILICAL CORD STUMP CARE

Care of the umbilical cord stump is important in the overall care of a newborn. Any negligence in this re-

spect may lead to inflammation. Therefore, it is recommended that the stump be gently moved and rubbed with a gentle disinfectant. It is important that the area around the stump is dry and has a constant air supply. During the umbilical cord stump healing period, the child can be bathed in a bath or on a changing table [8, 12, 15].

NASAL AND EARS HYGIENE

Currently, isotonic solutions of physiological fluid are used for nasal hygiene. It is not recommended that cotton sticks are used for cleaning children's ears because they may push wax into the ear canal [12].

The role of massage in baby care

Massage is a form of positive touch supporting the proper psychomotor development of the child. Massaging a child after bathing can calm him/her down after an intensive day and helps in the development of motor skills. Massage performed with the use of an appropriately selected oil calms, eliminates muscle tensions, oxygenates, improves the respiratory, circulatory, and digestive systems, and develops the mother-child relationship [20]. Research suggests that infant massage may improve neonatal jaundice and weight gain [29].

Child's skin versus sun

The production of melanin in infants' skin starts immediately after the first exposure to sun, but the melanogenic system is immature. The proper level of melanin in the skin is only reached during puberty. Therefore, children's skin is often defenceless against exogenous environmental factors. Children under 12 years old should not be exposed to direct UV radiation at all. Frequent sunburns and exposure to sunlight in childhood are strongly associated with the development of melanoma in adulthood. The sun lotion, as a form of photo protection, should be applied to exposed skin at least every 2 hours. After bathing, the application should be repeated [1, 21].

CONCLUSIONS

Skin is the largest organ of the human body. Its main function is to protect the body from harmful environmental factors and at the same time, by receiving stimulants from outside, allow the body to react accordingly. A newborn's skin is significantly different in its structure and functions in comparison to adult skin. The differences include the structure of epidermis, dermis, and subcutaneous tissue, as well as skin appendages: hair, nails, glands. Infant skin is considerably thinner. The epidermal barrier in infants is immature. Poorly developed hydro-lipid skin coat, deficiency of sebum produced by sebaceous glands, as well as food and inhalation allergies, induce

skin dryness, which is often observed in infants. Dry skin, on the other hand, is very sensitive to exogenous factors, such as wind, low or high temperature, high humidity, and mechanical stimuli. Knowledge of the structure and functions of the child's skin, and the use of appropriate dermocosmetics and principles of daily care for infants and children are therefore crucial for the proper functioning of the young body. Improperly selected care may disturb the balance of microbiota and may impair the pH of the skin, leading to infections.

DISCLOSURE

The authors declare no conflict of interest.

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