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Understanding Moisturisers

Dr Benjamin Chun-Man Lee explains why and how skin can benefit from moisturisers, listing key factors to look out for when selecting appropriate products for patients

Not all moisturisers are the same and they have very different effects on the skin barrier depending on formulation. Effective moisturisers contain bioactive ingredients that strengthen and potentially repair skin barrier homeostasis,[1-3] while others can be hydrating without effecting the skin barrier and some have even been found to be damaging.

Individuals with impaired skin barrier functions such as atopic dermatitis (AD), also known as eczema, are the most likely to notice the difference; therefore, the choice of moisturiser has significant implications for the treatment and long-term control of dry skin and skin sensitivity. The Eczema Priority Setting Partnership, a collaboration between patients, clinicians and researchers in England and Wales, has set out the priority of identifying the most effective and safe emollients for treating AD, and differentiating moisturising cream based on mechanism of action.[4,5]

The skin barrier

The epidermis is the outer layer of skin which is rich in skin cells, known as keratinocytes, that are arranged in stratified layers. The epidermis is continuously regenerated by the process of terminal differentiation of keratinocytes, in which plump cells in the basal layer of epidermis multiply, undergoing morphological changes and rise through the layers to the stratum corneum (SC), the outermost layer of the epidermis.[6] Lipids are released during terminal differentiation to form the 'mortar' into which keratinocytes are laid. Each keratinocyte forms a tough, chemically-resistant 'cornified enveloped (CE)' by cross-linking proteins.[7] The epidermis is completely renewed every 28 days.[8]

The epidermal barrier has many important functions, such as regulating loss of water and electrolytes, antimicrobial barrier and immune protection, skin hydration and moisturisation, protection from chemicals and toxin penetration, as well as acting as a barrier to terrestrial UV radiation and oxidative stress from air pollution.[9] The physical skin barrier is mainly localised to the outermost, protein-rich SC, in which keratinocytes adopt a flattened shape enclosed in a cornified cell envelope.[9] The epidermal barrier is constantly under threat from the environment. Therefore, it requires full functionality to protect and maintain health of the body.

Regulation of skin barrier

The skin barrier is a balanced system of many functions localised in the SC. Out of all functions, the epidermal permeability barrier appears to be the most important; genetic defects in the barrier function underlie some common skin diseases such as AD and psoriasis.[10] Barrier homeostasis is controlled by a number of factors, discussed below.

Skin pH

Skin surface pH is maintained in a value between 4.5 and 5.5 (slightly acidic) in humans by the endogenous processes of fatty acids from phospholipids and urocanic acid from natural-moisturising factors (NMF) in SC, as well as exogenous sources of free fatty acids from sweat glands and lactic acid derived from sebaceous glands by the action of bacterial lipase.[11] Furthermore, a lot of protein-degrading enzymes (proteases) in SC are pH dependent, activated by alkaline pH to induce desquamation.[12]

The use of soap can result in a disruption of skin pH, leading to skin barrier dysfunction and ultimately dry skin. Gel formulations on the other hand, which are commonly used and often a preferred choice for oily or acne-prone skin types, may raise the skin's pH, ultimately leading to weakening skin barrier and its innate immunity against infections.[13] Doublebase gel is an example of a gel-based moisturiser.

Epidermal lipids

The studies of skin barrier dysfunction in AD have found insufficient levels of intercellular lipids, in particular ceramide 1 (CER EOS) in AD skin.[14] In normal skin, ceramide is synthesised from a particular form of cell membrane phospholipids called sphingomyelin. In AD, upregulation of a converting enzyme that depletes sphingomyelin in turn depletes a reserve of ceramides.[15] In recent years, Cork *et al.* have reported an emollient mixture containing a pseudoceramide, which showed structural resemblance to human intercellular lipids in SC, promoting superior effect on epidermal permeability barrier function in comparison with a control emollient without the additives.[1] Niacinamide, also known as vitamin B3, induced up to a five-fold increase in ceramide synthesis by cultured skin cells.[16]

Environmental and physiological factors

The effect of environmental humidity and temperature on skin barrier function is huge. Absolute humidity (AH) is a measure of water content in a given volume of air. AH

Application

Moisturisers ought to be applied thinly in the same direction of hair growth to avoid clogging hair follicles; for example, in downward strokes over the body in the direction towards hands and feet over the arms and legs, and from the mid-line of face to the outside.[32] This is particularly important when moisturising acne-prone skin or using thicker and greasier products.

is independent of temperature, but studies on mice and humans have concluded that cold temperatures have a negative effect on skin barrier function, regardless of epidermal water content.[17,18]

Relative humidity (RH), on the other hand, is defined as a percentage of the amount of water vapour divided by the moisture-holding capacity of air. Therefore, it is a much more reliable measure in clinical studies on the effect of climate on skin barrier function.[19] Exposure of human skin to low RH (32% and below) renders skin more susceptible to contact sensitivities, increased transepidermal water loss (TEWL) and dryness, and a longer recovery period to regain normal permeability barrier function.[19] Human skin has the ability to adopt to a new environment. However, at low temperatures the adaptability to low humidity appears impeded, causing dry skin and breakdown of skin barrier. The effect of low RH seems to be more significant in the first two days of exposure, after which period, skin gradually adopts to a dry environment and restore integrity and barrier functions.[19] Population studies found that individuals working in particular environments, such as the airline industry, fish factories and plumbing, are most susceptible to contact allergies and skin complaints relevant to dry and sensitive skin.[19]

Choosing the right moisturiser

Moisturising fulfils an important need by providing skin comfort and alleviating dryness. A systematic review of clinical studies looking at the effect of moisturisers on eczema development conclude that regular moisturising restores skin homeostasis and defence against microbial penetration, correcting microbial dysbiosis, as well as reducing TEWL in humans.[10]

A moisturiser is a topically-applied substance or product that overcomes the signs and symptoms of dry skin. Cosmetic creams and lotions are emulsions, either in oil-in-water (O/W) which are non-greasy or water-in-oil (W/O), which are more occlusive.[20] Moisturisers are typically made of O/W emulsions.

Composition of moisturising cream

Moisturiser composition can vary, mostly in a base, actives and choice of preservatives. They will generally feature a mix or all of the following:

- **Emulsifiers:** preserve the composition of an emulsion, O/W or W/O, and help delivery of active ingredients into the skin, through its protective skin barrier, whilst avoiding disturbance to its barrier properties.[21] The choice of emulsifier will determine the constructive or disruptive nature of the emulsion, as well as pH and stability when applied.
- **Surfactants**: added to 'active' moisturisers (that have some scientific basis of clinical effect) to boost penetration of water-soluble active ingredients such as vitamin C, by solubilising them into SC. Surfactants are potent irritants but the damaging effect on human skin barrier may vary.[22] Sodium lauryl sulphate (SLS) is found in aqueous cream BP, whilst sorbitan laurate, isopropyl myristate and cetostearyl alcohol are surfactants commonly used in moisturisers without noticeable side effects to human skin such as Diprobase cream and Doublebase gel.[13]
- **Emollients:** the terms 'emollient' and 'moisturiser' are often used interchangeably and lack consistency in their use in the literature. An emollient is classically an oil-phase ingredient of a moisturiser that softens skin to improve feel and delivery of active ingredients.[23] Silicones such as dimethicone and cyclomethicones have increased in popularity in this decade. They are added to produce a water-in-silicone emulsion (gelée) that is similar in texture to gels, offering improved skin feel and the perception of a youthful, hydrated skin.[24]
- **Humectants:** able to absorb and retain moisture, and are added to counteract with some dehydrating ingredients such as alcohols in gel formulation. Humectant properties confer a moisturising effect on skin, but not necessarily the restoration of permeability barrier function.[13] Furthermore, from my knowledge, they play a role as a solvent for some active ingredients, such as salicylic acid in acne-treatment products. Glycerol, butylene glycol, and urea have humectant properties.
- **Occlusives:** humectants offer an artificial and transient moisturising effect to dry skin. For a more sustain maintenance of hydration and preserved barrier function of SC, occlusive agents are added to complement the water-absorbent nature of humectants. Traditional occlusives such as petrolatum and lanolin form a waterproof barrier over the skin surface, and compounds such as silicone derivatives and behenyl alcohol, confer an emollient effect.[20,24] Lanolin (wool fat) is recognised as an important sensitiser based on the analysis of patients with eczema;[25] anecdotal evidence has suggested that dermatologists have generally advised that occlusive such as E45 cream should be avoided for the treatment of atopic eczema.
- **Fragrances:** with the development of vigorous protocols to assess tolerance of formulations on human skin models and ensure product safety,[26] in

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addition to realistic *in-vivo* screening by manufacturers in both normal and sensitive populations, the fear of irritation and induction of contact allergy is, in my opinion, no longer substantial as manufacturers are extra careful in their creation. Fragrances improve the overall aesthetic qualities of a moisturiser, added at the minimum concentration required to mask the unpleasant smell of certain ingredients.

- **Preservatives:** crucial components in moisturisers as they confer a cosmetic product a shelf life. With the exception of ointments, moisturisers have preservatives to protect organic ingredients and their moisture content from rancidity. There is no such thing as a preservative-free formulation. Ingredients that are 'natural', such as botanicals and creams, require the additional preservative to completely inhibit bacterial growth and oxidation – preservatives are sometimes, quite inappropriately, labelled as antioxidants.[27] Manufacturing protocols are developed, and ingredients are formulated to minimise sensitisation and irritation of skin, but common preservatives such as propolis (bee-wax), formaldehyde-release agents, and methylisothiazolinone to name but a few, continue to make headlines for allergic contact dermatitis.[28-30]

Conclusion

Dry skin is a common problem affecting a lot of people. The development of dry skin is associated with a skin barrier defect in conditions such as atopic dermatitis in the young, asteatotic eczema and winter xerosis in older people.[31] Skin barrier homeostasis maintains integrity and permeability barrier function by regulation and control of pH, microbiome, and desquamation; it can be affected by environmental and health factors including stress. Moisturisers have very different effects on the skin barrier depending on their formulation. An evidence-based approach is always recommended for selecting moisturisers, as not all formulations are the same.

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