The impact of emollients on phototherapy: A review

Manuela L. Asztalos, MD,[a] Misha M. Heller, MD,[b] Eric S. Lee, MD,[c] and John Koo, MD[d]
Tucson, Arizona; Los Angeles and San Francisco, California; and Omaha, Nebraska

When treating psoriasis, various topical emollients exist that can affect the penetration of ultraviolet radiation in phototherapy. Compared with normal-appearing skin with a reflectance of 4% to 5%, psoriatic skin has higher reflectance as a result of its increased air-to-corneocyte interfaces. Studies have tested the effect of emollients on light penetration by assessing psoriatic plaque clearance, differences in minimal erythema dose, and physical properties of the emollient (eg, monochromatic protection factor and absorbance). Psoriatic plaque clearance was found to improve with serous (thin liquid)-based emollients (eg, Vaseline oil [Unilever, Blackfriars, London, UK], mineral oil, and glycerol), whereas clearance decreased with salicylic acid and viscous-based emollients (eg, petrolatum). Emollients with high ultraviolet absorbance properties increased minimal erythema dose, and those with low absorbance properties decreased minimal erythema dose. Interestingly, when a liquid emollient with a refractive index close to that of normal-appearing skin was applied, there was a net increase in light absorption, or a reduction in reflection that exceeded the emollient's innate ability to absorb light. (J Am Acad Dermatol 2013;68:817-24.)

Key words: broadband; emollient; Goeckerman; mineral oil; narrowband; phototherapy; psoriasis; refractive index; skin optics; ultraviolet; Vaseline.

Phototherapy is one of the oldest therapeutic modalities for generalized psoriasis, yet it remains today one of the safest and most effective treatment options for generalized psoriasis. Unlike biologics and oral immunosuppressants, phototherapy lacks serious systemic risks such as nephrotoxicity, hepatotoxicity, tuberculosis, and malignancy. Phototherapy works by reducing epidermal hyperproliferation, reducing angiogenesis, and acting as an immunosuppressor. Ultraviolet (UV) radiation reaches the proliferative compartment of the skin, where it temporarily decreases synthesis of DNA, RNA, and proteins, in turn leading to normalization of cell differentiation and cell kinetics.[1-3] UV light affects the cutaneous immune system and changes the cytokine pattern of the dermis and epidermis by reducing the number of Langerhans cells, therefore decreasing the ability of dendritic cells to present antigens.[3-5]

As compared with normal-appearing skin, psoriatic plaques pose more obstacles to penetration of UV radiation. Psoriatic plaques have a thicker and generally deeper proliferative compartment at the bottom of the epidermis.[6] There is also an increased thickness of stratum corneum. The study by Nielsen et al[7] showed that the protein keratin, one of the main components of the stratum corneum, absorbs a proportion of UV radiation. As such, psoriatic plaques, with a thicker stratum corneum, might prevent an adequate amount of therapeutic radiation from reaching the proliferative compartment.

In addition, psoriatic plaques often have increased scales with multiple air-corneocyte interfaces, which can increase the reflectance of optic radiations and prevent complete penetration of the therapeutic UV rays.[8,9] In normal-appearing skin,

Abbreviations used:

MED:	minimal erythema dose
MPF:	monochromatic protection factor
nD:	refractive index
SPF:	sun-protection factor
UV:	ultraviolet

From the University of Arizona, College of Medicine[a]; University of Southern California, Keck School of Medicine, Los Angeles[b]; University of Nebraska Medical Center, College of Medicine[c]; and Department of Dermatology, University of California—San Francisco.[d]

Funding sources: None.
Conflicts of interest: None declared.
Disclosure: Dr Koo is a clinical researcher for Abbott, Amgen, PhotoMedex, Pfizer, and Teikoku, and is a speaker and consultant for Leo, Galderma, and Glaxo-Smith-Klein. Dr Asztalos, Ms Heller, and Dr Lee have no conflicts of interest to declare.

Reprint requests: Manuela L. Asztalos, MD, 301 S 19th St, Apt 4B, Philadelphia, PA 19103. E-mail: mlm6@email.arizona.edu.

Published online February 11, 2013.
0190-9622/$36.00

http://dx.doi.org/10.1016/j.jaad.2012.05.034

only a small fraction of an incident radiation (usually about 4%-7%) will be reflected as a result of refractive index (nD) mismatch of air (nD = 1.0) to stratum corneum (nD = 1.55).[8,10] Thick, micaceous scales characteristic of psoriatic plaques can dramatically refract incident radiation, causing it to scatter and significantly impede light penetration.[8]

Ultimately, the success of phototherapy depends on achieving adequate penetration of UV radiation into the deeper portions of the epidermis.[11] It is thought that emollients can improve the efficacy of phototherapy by reducing the reflectance and scattering of light as it transmits through psoriatic plaques.[12] However, some emollients can have the contrary effect, diminishing UV penetration.

Multiple studies have examined the effects of topical agents on UV penetration. In this review, we take these studies a step further, evaluating the properties of the emollients and determining the most effective emollients to enhance UV penetration.

CAPSULE SUMMARY

- Light therapy is known to be a highly effective treatment option for psoriasis. There are conflicting thoughts, however, regarding an emollient's ability to increase ultraviolet penetration when combined with light therapy.
- Our review analyzes the findings in multiple articles, including assessing psoriatic plaque clearance, differences in minimal erythema dose, and physical properties of the emollient (eg, monochromatic protection factor and absorbance) and their affect on plaque clearance.
- Our article will improve patient care by providing a better understanding of emollients when combined with phototherapy. It will guide the physician to choose the most effective emollient to increase psoriatic plaque clearance.

METHODS

Studies on the use of emollients in phototherapy were identified in PubMed's MEDLINE databases from January 1966 to November 2010 using the key search terms "emollient," "phototherapy," "photooptics of skin," and "psoriasis." Search terms were also used in combinations. Reference lists of relevant publications were manually searched for additional relevant studies. The search was limited to articles published in the English language or with English-language abstracts.

RESULTS

Several aspects of emollients were considered to determine their effectiveness when combined with light therapy. These different methods are discussed below.

Effects of emollients on transmission

Several studies analyzed how emollients affect the penetration of the UV light. Leroy et al[13] performed an in vitro study measuring UV transmission before and 3 minutes after applying Vaseline oil onto 10 epidermal specimens. Vaseline oil and Vaseline petrolatum are both primarily petrolatum but Vaseline oil is in the highly refined liquid form whereas Vaseline petroleum is in the semisolid form. The study found that penetration of UV rays through the specimens with Vaseline oil had a 2- to 3-fold increase in transmission.[13] Hoffmann et al[14] similarly showed that Vaseline can enhance UV transmission. In addition, Farr et al[15] carried out an in vivo study demonstrating that the application of the lipophilic liquid, glycerin, increased transmission of light through psoriatic plaques by roughly 2-fold by decreasing its backscatter.

Effects of emollients on minimal erythema dose

Some studies demonstrate that certain emollients have no effect on minimal erythema dose (MED), suggesting that the emollients do not block UV penetration.[16-18] Behrens-Williams et al[16] used *unguentum emulsificans* (cetylstearyl alcohol, paraffin. subliq, Vaseline. alb.) in 4 aqueous dilutions on nonpsoriatic skin and demonstrated no significant difference in MED.[16] Similarly, Lebwohl et al[18] found that mineral oil and clear liquid emollient (Theraplex clear lotion, The Theraplex Company, LLC, Memphis, TN) did not significantly affect UV transmission or erythemogenicity of UVB.

Studies using crude coal tar,[18] salicylic acid,[11,18-20] petrolatum,[18,19,21] and sunflower oil[22] have demonstrated increased MED after topical application, indicating that UV radiation may be partially blocked.[18,19,23,24]

The thickness of the application of the individual emollient can affect whether there is a difference in the MED. For instance, Lebwohl et al[18] demonstrated that petrolatum and white emollient cream (Eucerin, Beiersdorf, Inc, Wilton, CT) when applied as thin layer (0.4 mL/24 cm^2 of skin) had a negligible effect on MED. However, when applied as a thick layer (0.8 mL/24 cm^2 of skin), petrolatum and white emollient cream increased the MED.[18] Lebwohl et al[17] also observed that a thin layer of calcipotriene ointment did not change the erythemogenicity of UVB or the minimal dose of UVA required for immediate