European Dermatology Guideline for the photodermatoses

3. Photoprotection

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Abstract

Comprehensive guidance in photoprotection of patients suffering from photodermatoses is important. Several studies have reported efficacy of high-protection sunscreens in the prevention of rash. The sunscreen should effectively protect from both UVB (SPF 30-60) and UVA. Lack of compliance among patients suffering from photodermatoses has been reported and thorough instructions and insight of the patients in sunscreen application and amount used is imperative. Besides sunscreens, photosensitive patients should at times of possible sun exposure always cover themselves with clothing, as most fabrics provide good protection from ultraviolet radiation. In the clinic, phototherapy with UVA, UVB and PUVA has been shown to significantly increase the patient's tolerance of sunlight. Dihydroxyacetone used in sunless tanning products provides a modest protection from UVB, UVA and visible light and may supplement other ways of photoprotection. Finally, photosensitive patients should avoid direct sun exposure. This may be achieved by protection from different glass types in cars or houses, by seeking shade and considering the time of day and time of year when outside.

Introduction

Sunlight consists of ultraviolet radiation, visible light and infrared radiation. The ultraviolet spectrum of solar radiation is arbitrarily divided into three ranges: short-wave (UVC, 200-280 nm); mid-wave (UVB, 280-320 nm); and long-wave (UVA, 320-400 nm). Wavelengths shorter than 290 nm are absorbed by stratospheric ozone and do not reach the surface of the Earth. The most energetic component of solar radiation is UVB that is the main cause of sunburn. However, several patients with photodermatoses react both to UVB, UVA and/or visible light and comprehensive guidance in photoprotection of such patients is important.

Sunscreens

The protective effect of a sunscreen from sunburn is given by its sun protection factor (SPF). The SPF is defined as the dose of solar radiation needed to induce just perceptible erythema (minimal erythema dose, MED) on skin treated with 2 mg/cm^2 sunscreen divided by the MED on untreated skin. Thus, the SPF primarily describes protection from UVB, as it reflects protection from the erythema action spectrum [1]. No standard method exists to measure the UVA protection of sunscreens but protection from immediate pigment darkening is commonly used. Topical sunscreens are broadly divided into organic (chemical) and inorganic (physical) agents.

Inorganic sunscreens (titanium dioxide and zinc oxide) reflect and scatter UVB, UVA and visible radiation by forming an opaque barrier of inert metal particles. Also, inorganic sunscreens may absorb ultraviolet radiation depending on the particle size. No adverse events in humans have been described [2]. The main problem with inorganic sunscreens in their current form is that they are often cosmetically unacceptable by the white appearance that

follows their physical properties, and the amount applied by users of inorganic sunscreen is often less compared with organic sunscreen [3]. Micronized forms of physical sunscreens are less visible on the skin but the reduction in particle size results in less UVA protection. However, the absorption of UVB is higher.

Organic sunscreens act by absorbing ultraviolet radiation and re-emitting chemical energy as heat or light. Several chemical filters exist that shield against UVB, UVA or both [4]. Since the filters are specific for given wavelengths, they are often combined in sunscreens to obtain broad-spectrum protection. Adverse events from the use of organic sunscreens occur more often in patients suffering from photodermatoses and include allergic and irritant contact dermatitis, phototoxic and photoallergic reactions, contact urticaria, and in rare cases anaphylactic reactions [5-7].

The effect of sunscreens as photoprotection in particular photodermatoses is described in subsequent chapters. Several studies have reported efficacy of broad-spectrum, high-protection sunscreens in the prevention of polymorphic light eruption [8-10]. Lack of compliance among patients suffering from photodermatoses has been reported [11] and may account for variable effect. The median application thickness was found only to be 0.5 mg/cm^2 [11], which will reduce a declared SPF 50+ into an effective SPF of as low as 2-3 [12] . This is important since the use of a broad-spectrum sunscreen SPF 50+ in a correct amount has been shown to be highly effective protecting very UV-sensitive patients suffering from idiopathic solar urticaria when tested in a standardised setting [13]. The patients in this study reported only slight protection from previous use of sunscreens while they after the study reported much better protection. This stresses the need for thorough instructions and

insight of the patients in sunscreen application, amount used and effect from correct use. Especially the ears, temples, posterior and lateral neck tend to be completely overlooked when applying sunscreen [11]. The instructing physician needs to be aware of this. The sunscreen should effectively protect from both UVB (SPF 30-60) and UVA and preferably the sunscreen should contain a combination of inorganic and organic sunscreen filters since they have been shown to act synergistically [14].

Adequate clothing

Apart from sunscreen, clothing is considered one of the most important tools for sun protection of photosensitive patients. The European Standard for Sun-protective Clothing states that fabrics labelled as UV-protective must give an UPF larger than 40 as well as an average UVA transmission lower than 5% to provide sufficient protection from sun exposure [15]. The protection afforded by clothing fabrics is measured as the Ultraviolet Protection Factor (UPF) based on the transmittance of ultraviolet radiation through a given fabric. The UPF is commonly determined in vitro by a radiometer or a spectrophotometer [16]. The UPF is calculated as the ratio of the UV intensity before and after passing through a fabric sample weighted against the erythema action spectrum. The UPF thus mainly describes protection from sunburn caused by UVB. In vivo determination may be carried out similar to SPF determination for sunscreens comparing the MED on protected and unprotected skin. Several factors affect the degree of transmission through clothing fabric [16]. Thicker, tight-woven, dry and dark-coloured clothing provide good protection and polyester, denim and wool are superior to cotton, linen and rayon [17;18]. This may not be comfortable in warm weather and instead addition of UV absorbers can increase the UPF of light-weight clothes [16].

Whether clothing with an UPF 40+ is necessary is controversial since clothing is not put on in a layer too thin as for sunscreens and thus the protection achieved even by summer-weight garments is in most instances higher than an UPF 10 [19;20]. To increase compliance, recommendations for photosensitive patients at times of possible sun exposure should therefore be to wear clothing but supplement with other ways of photoprotection to avoid UVA exposure.

Photoadaptation

In the clinic, phototherapy with UVA, UVB and PUVA is frequently used in the treatment of photodermatoses. This treatment induces pigmentation and thickening of the stratum corneum, which provide the skin a certain degree of natural photoprotection [21]. However, other mechanisms through immunomodulation are believed also to account for the effect of phototherapy [22]. The use of a narrow-band UVB (TL-01) or UVA phototherapy course in springtime has been shown to effectively increase the UV tolerance of patients with photodermatoses [23;24]. The use of narrow-band UVB (TL-01) phototherapy or photochemotherapy with PUVA improve symptoms significantly [25]and is equally effective [26].

Dihydroxyacetone

The sugar dihydroxyacetone (DHA) is used in sunless tanning products to darken the skin by non-enzymatic glycosylation of skin proteins in stratum corneum (the Maillard reaction). DHA has been found to shield against UVA and visible (blue) light and offer protection of photosensitive patients [27-29]. Moreover, DHA offers a modest sun protection factor (SPF) of 2-3 in humans lasting for days to weeks [30;31]. Since it is bound to the skin, it is still

present when other sunscreens may be lost for example during swimming and application of DHA will leave no spots untreated since it can be seen as a lack of browning. The use of DHA creams may therefore provide a basic broad-spectrum and durable photoprotection. However, the protection afforded by DHA is modest and DHA must be combined with other ways of photoprotection. No adverse effects have been described using DHA.

Window glass protection

Patients with photodermatoses may describe provocation of their rash from sun exposure through windows. Nearly all UVB is filtered by window glass whereas the transmission of UVA varies a lot depending on the type of glass. Several different types of glass exits including clear glass, tinted or heat-absorbing glass, reflective glass, low-emissivity glass, laminated glass, UV-blocking-coated glass, and spectrally selective and UV-blocking insulating glass (reviewed in [32]). A study of transmission of UVA through different types of automobile glass showed that gray-tinted laminated glass resulted in the highest UV protection with a UVA transmission of only 0.9% compared with a UVA transmission of 62.8% through nonlaminated clear glass [33]. In patients with severe photodermatoses, a dose of 5 J/cm^2 UVA may be enough to induce a cutaneous reaction. Transmission through a nonlaminated clear glass will then lead to a reaction within 30 minutes while exposure through a gray-tinted laminated glass will require 50 hours to induce the photodermatoses [33]. Measurements of transmittance through different types of architectural glass similarly show that laminated glass completely blocks wavelengths shorter than 380 nm [32;34]. However, the protection from visible light is less effective by laminated glass and other glass types are superior protecting from longer wavelengths of the solar spectrum [32]. Also, it is

possible to combine window glass with a UV-absorbing film to reduce UV transmission further [35].

Patients with photodermatoses should be aware of the possible exposure to causal wavelengths when staying inside a house or a car, especially near the windows, and additional protection by plastic films, clothes or sunscreens should be considered. They should be informed about the significant variation in protection from different forms of glass.

Exposure behaviour

In general, patients suffering from photodermatoses should avoid sun exposure. A study of outdoor behaviour among photosensitive patients indicated that the incidence of rash on a particular day was influenced by the dose of ambient ultraviolet radiation and length of time spent outdoor [36]. When outside, the patients must seek shade to reduce their dose of ultraviolet radiation. Shade reduces the dose of ultraviolet radiation by 50-95% depending on the shade setting with dense foliage showing the most protection [37]. Moreover, the time of year is important since the sun is higher in the sky during summertime and more ultraviolet radiation passes through the atmosphere. In Northern Europe, the UV dose is very low in the wintertime from November to March. In December-January only 12-15 SED per month may be received [38]. In the summertime, the UV dose increases rapidly and is very high in Southern Europe. Also, the time of day must be considered. Around 50% of the daily UV dose reaches the earth between noon and 3 PM in the summertime in Denmark [38].

Concluding remarks

Despite careful photoprotection by a combination of the sunscreens, clothing, photoadaptation, dihydroxyacetone, window glass, and sun avoidance, this may not always be sufficient to prevent rash in patients with photodermatoses. In such cases, systemic treatment may be needed to provide the patients a tolerable living.

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