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Perspectives of the antipsoriatic heliotherapy in Poland

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ABSTRACT

Statistical analysis of the daily course of exposures to TL-01 tube radiation for 93 psoriatic patients from the Medical University of Łódź during 20-day phototherapy shows that the dose of 1 J/cm^2 represents a unit of single exposure necessary for psoriasis healing. This value is converted to the antipsoriatic effective dose of 317.9 J/m^2 using the TL-01 lamp irradiance spectrum and the antipsoriatic action spectrum. It is proposed that the daily exposure of 317.9 J/m^2 serves as the standard antipsoriatic dose (SAPD) providing a link between the cabinet and the out-door exposures and it could be used for planning heliotherapy in Poland. A model is proposed to calculate ambient antipsoriatic doses for 3 h exposures around the local noon (9 am–12 am GMT) based on satellite measurements of ozone and cloud characteristics. The model constants are determined by a comparison with pertaining antipsoriatic doses measured by the Brewer spectrophotometer in central Poland. It is found that 3 h exposures to solar radiation in the period 15 May–15 September provides the mean (2005–2013) doses in the range 2.7–3.1 SAPD over Poland. Thus, heliotherapy could be treated as an alternative to the cabinet phototherapy for almost 4 months. It seems that the most effective site for antipsoriatic heliotherapy is the south/east part of Poland (the Bieszczady Mountains). The heliotherapy could be carried out in existing national health centers equipped with the standard easy-to-use biometers for on-line monitoring of UV level and controlling duration of sunbathing to avoid erythema risks. It is even possible to control the antipsoriatic heliotherapy by a patient himself, using low-cost hand-held instruments measuring UV index.

1. Introduction

Ultraviolet (UV) phototherapy is widely used in treatment of various skin diseases including psoriasis [1,2]. For decades the in-door UV radiation produced by the fluorescent tubes, mounted in medical cabinets, was widely used for irradiation of psoriatic patients [3,4]. The antipsoriatic effectiveness of artificial UV light has been supported by many authors [5,6]. The solar UV radiation is recognized mainly as source of health problems, i.e. development of erythema and photocarcinogenesis. However, some positive effects of solar UV in the skin synthesis of vitamin D_3 have been discussed [7]. Limited empirical studies on using solar light for psoriasis treatment in sunny low latitudinal resorts showed that heliotherapy could be an alternative to the in-door treatment [8–10]. Nowadays, the climate therapy is carried out rather sporadically; only at a very few holiday resorts with intense solar radiation throughout almost the whole year [9,10]. However, in 19th century sunbathing was recognized as basic part of the antipsoriatic therapy that resulted in appearance of health centers in the seaside resorts across England and Germany [11].

Theoretical basis for heliotherapy has been presented in our recent studies implementing the antipsoriatic action spectrum from experiments carried out in the early 1980s and UV doses received during routine in-door treatments in the Medical University of Łódź [12,13]. Antipsoriatic healing potential of solar radiation was found for several sites in Poland during late spring/summer months [14]. In this paper we examine extended record of the antipsoriatic exposure data stored in the MUL archive to introduce a standard antipsoriatic dose (SAPD) that can be used for planning antipsoriatic heliotherapy over any site. The mean antipsoriatic healing potential of 3 h (9 am–12 am GMT) sunbathing will be estimated for the whole territory of Poland based on the satellite data for the period 2005–2013. The recommendations of controlling the sunbathing in a potential antipsoriatic center and by a psoriatic patient himself will be discussed.

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2. Methods

2.1. In-door measurements

The antipsoriatic phototherapy routine of using narrow-band ultraviolet tube irradiation is established based on individual records of the Medical University of Łódź patients. The whole body exposure is carried out inside the MEDISUN 2800 PC-AB phototherapy cabinet (Schulze & Böhm Co., Germany) containing twelve TL-01 fluorescent tubes fixed on the cabinet inner walls. TL-01 tube emits narrow-band UVB radiation with the maximum ~311 nm (Fig. 1). The cabinet software allows us to calculate the dose received by a patient during his individual exposure sessions. The doses are expressed in standard energy density unit i.e. J/cm^2. The patient routinely receives 20 exposures with 2–3 treatments per week starting with low doses, 0.2–0.3 J/cm^2, to adapt the skin for following stronger exposures at the end of phototherapy.

The examined data consist of the time series of daily doses taken during 20 whole body exposure sessions for 93 patients in age between 23 and 85 years old. Table 1 summarizes statistical parameters of the doses for the whole patient group and for various sub-groups according to the patients' age and sex. There is a statistically significant difference (at the level of 95%) between the mean cumulative dose received by the old (over 64 yr) patient sub-group and that by other patient sub-groups. Fig. 2 shows the time series of the mean daily cabinet dose and the pertaining standard deviations for the selected age sub-groups. It is seen that the daily exposure stabilizes approximately around 1 J/cm^2 on the tenth day of the phototherapy course. After next ten exposures the final daily exposure reaches ~1.2–1.3 J/cm^2. For some patients it appears that the maximum dose at the end of the exposure sessions should be as high as ~2.5 J/cm^2. The minimum of ~0.7 J/cm^2 at the end of the phototherapy is found for patients with non-adapting skin that prohibits gradually increase of the next day dose.

Based on studies of the psoriasis healing sensitivity on UV wavelengths, which were carried out in the 1980s [15,16], Krzyścin et al. defined the analytical form of the antipsoriatic action spectrum [12].

$$Antipsoriasis\,(\lambda) = \begin{cases} 0.6504 \times 10^{-0.6304(296-\lambda)} & \lambda < 296\,\text{nm} \\ 1.0000 \times 10^{-0.0467(300-\lambda)} & 296\,\text{nm} \leqslant \lambda < 300\,\text{nm} \\ 1.0000 \times 10^{-0.1067(\lambda-300)} & 300\,\text{nm} \leqslant \lambda \leqslant 304\,\text{nm} \\ 0.3743 \times 10^{-0.1571(\lambda-304)} & 304\,\text{nm} \leqslant \lambda < 313\,\text{nm} \\ 0.0144 \times 10^{0.08233(313-\lambda)} & 313\,\text{nm} \leqslant \lambda < 330\,\text{nm} \\ .00057 \times 10^{0.00937(330-\lambda)} & 330\,\text{nm} \leqslant \lambda < 400\,\text{nm} \end{cases} \quad (1)$$

Spectrum (1) is used for weighting of the cabinet and solar irradiance spectra to estimate the antipsoriatic healing potential of the irradiation, i.e., the biologically weighted irradiance for psoriasis clearance. Fig. 1 shows the non-weighed and weighted (by the antipsoriatic action spectrum, see embedded figure) irradiance spectrum due to TL-01 tube.

In photobiological studies specific units of biologically effective doses are introduced to express characteristic biological effect that appears after exposure to this 1 unit of biologically weighted dose. For example, the minimum erythemal dose (MED) describes erythemaly weighted dose causing skin burning; standard vitamin D_3 dose (SDD) is the daily effective dose that keeps adequate level of vitamin D_3 [17,18]. Here we would like to define a unit to be used for psoriasis healing.

The antipsoriatic effective dose is calculated as the time integral of spectral irradiances, *Irradiance*(t,λ), that are weighted by antipsoriatic action spectrum, *Antipsoriasis*(λ), defined by formula (1):

$$Dose_{\text{ANTIPSOR}}(t_2,t_1) = \int_t \left(\int_\lambda Irradiance(t,\lambda) \times Antipsoriasis(\lambda) d\lambda \right) dt \quad (2)$$

Based on the pattern of the daily doses received during the whole series of exposure (Fig. 2) we propose to take the dose of 1 J/cm^2 due to TL-01 tube irradiation as the standard antipsoriatic dose (SAPD). It could be calculated that the antipsoriatic effective dose of 1 SAPD is equal to 317.9 J_{PSOR}/m^2, where subscript "PSOR" means that the irradiation spectrum underwent weighting by the antipsoriatic action spectrum.

2.2. Out-door ground-based measurements

The solar spectrum in the UV range is much different than that by TL-01 tube and depend on the local geographical (e.g. latitude,

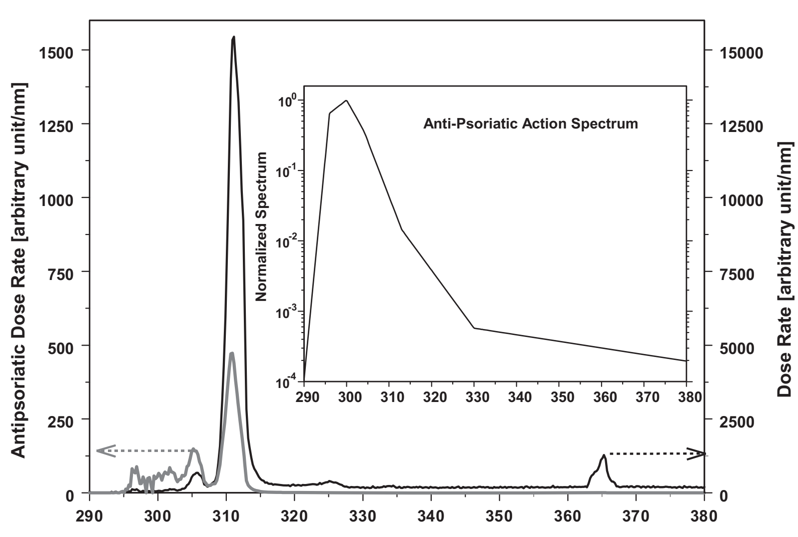

Fig. 1. The cabinet non-weighted and antipsoriatic irradiance spectra due to TL-01 fluorescent tube in arbitrary units. The embedded figure shows antipsoriatic action spectrum according formula (1) of this paper.