

## INVESTIGATIVE REPORT

# UVB 311 nm Tolerance of Vitiligo Skin Increases with Skin Photo Type

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**It is assumed that skin is protected against sunburn by melanin. In patients with vitiligo, there are white patches in the normal pigmented skin. We noticed that there is a difference in burning capacity of these white patches between people with different skin types. With UVB 311 nm lamps, we irradiated both lesional and non-lesional skin with increasing doses in 33 patients with vitiligo, divided into 5 groups according to skin type (II–VI). Twenty-four hours later we assessed the minimal erythema dose and found a correlation between skin type and UV sensitivity in both lesional skin and normal skin. We suggest that there must be a protection mechanism, other than that offered by melanin pigmentation. The antioxidant status may play a role in this phenomenon. Key words: minimal erythema dose; skin types; UVB 311 nm; vitiligo.**

(Accepted June 21, 2004.)

Acta Derm Venereol 2005; 85: 24–26.

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Melanin is generally regarded as the major defence of the skin against the hazardous effects of the sun (1). This photoprotective role of melanin results from its ability to absorb radiation in the ultraviolet (UV), visible and infrared spectra.

The ratio of eumelanin and pheomelanin plays an important role in the degree of protection: the darker the skin type, the more eumelanin the skin contains (2), which has a protective role as a scavenger of radicals. In lighter skin types, the ratio is lower, so the role of pheomelanin is more prominent here. This pheomelanin, instead of protecting the skin against UV radiation, contributes to UV-induced skin damage by producing radicals such as superoxide (3), which may explain the hypersensitivity of red-haired people.

The severity of sunburn also depends on constitutional factors such as skin thickness and the antioxidant status of the skin (4). Furthermore, the age of the person may play a role; very young children and the elderly tend to have a lower minimal erythema dose (MED) (5, 6). There is also a body area-dependent difference in UV

sensitivity (7, 8), e.g. the face has a lower MED than the hand.

To classify the susceptibility of a person to develop erythema following exposure to UV radiation, Fitzpatrick (9) has developed a system which divides people into six sun-reactive skin photo types (SPT) (I–VI). In this system, the capacity to tan (the ability to increase the constitutive colour of skin or the degree of melanin pigmentation) is important to help to categorize individuals of any colour or ethnic background. By this method the physician can estimate the relative risk of developing acute and chronic changes related to UV exposure (9). It was proposed as being more useful than just looking at phenotypic characteristics such as hair colour or eye colour, although others proposed that objectively measured skin colour is a better indicator of UV responses of the skin than SPT (10). A study by Carretero-Mangolis & Lim (11) confirms that there is indeed a correlation between MED and SPT, i.e. the higher the SPT, the higher the MED.

In our institute patients with vitiligo are treated with UVB 311 nm (12). UVB therapy is based on the theory that giving a suberythema dose on each individual lesional vitiligo macula is just enough to stimulate the remnant perilesional and follicular melanocytes to multiply, causing outgrowth into that lesion.

It is generally assumed that lesional skin of patients with vitiligo of SPT I–VI would be equally sensitive to UV radiation, owing to the fact that pigment is absent in all of these lesions.

However, from the patients' histories it became clear to us that in patients with dark skin, a decreased UV sensitivity existed as compared with lesional skin from patients with fair skin. Additionally, in inducing a therapeutically effective (suberythematogenic) dose, we noticed that there can be substantial differences in dose delivered to patients of different SPT.

The aim of this study was to determine exactly the UVB sensitivity of vitiligo skin by measuring the MED in lesional and normal skin of different SPT, in subjects who had not had UVB treatment before.

## PATIENTS AND METHODS

### Patients

Patients with SPT II–VI were selected. We included patients from 18 to 55 years of age, with a vitiligo spot on the

mid-dorsal trunk. The selected vitiligo spot had to be big enough to fit our template, i.e.  $\pm 8 \text{ cm}^2$ . People were excluded when there had been sun exposure on the test spot within a period of 3 months prior to our photo tests.

*Minimal erythema dose measurements*

To get well-defined test spots we used a suede template. In this template 16 squares of  $1 \times 1 \text{ cm}$  were cut out so that 16 spots measuring  $1 \text{ cm}^2$  could be irradiated with increasing UV dosages. We only irradiated white patches on mid-dorsal parts of the trunk. We irradiated both lesional and adjacent non-lesional skin of vitiligo patients simultaneously. The distance between lamp and skin was 10 cm in all cases. We used a UV 801 BL therapy unit (TL01) (Waldmann Medical Division, Schwenningen, Germany) which contained 10 narrowband UVB radiators of type TL20W/01 (TL-01), narrow waveband 310–315 nm with maximum at 311 nm (Philips, Eindhoven, The Netherlands). For this investigation the use of the Philips TL 20W/01 was more practical, because it is smaller (60 cm long). Irradiation of eight squares in the lesional and non-lesional skin took place at the same time with increasing doses, for the lowest skin types starting at  $0.30 \text{ J cm}^{-2}$ , ending for the highest SPT at  $2.40 \text{ J cm}^{-2}$ . From our experience of giving UVB 311 nm light therapy we made ranges for every SPT: II,  $0.30\text{--}1.06 \text{ J/cm}^2$ ; III,  $0.36\text{--}1.22 \text{ J/cm}^2$ ; IV,  $0.52\text{--}1.85 \text{ J/cm}^2$ ; V,  $0.62\text{--}1.85 \text{ J/cm}^2$  and VI,  $0.74\text{--}2.45 \text{ J/cm}^2$ . These ranges were divided in eight steps, with increments of  $2 \times 3\sqrt{2}$ .

After 24 h (13) we determined the MED in both the lesional and non-lesional skin. A MED is the lowest radiation exposure

to UV rays sufficient to produce either just perceptible erythema (JPE) on exposed skin after 24 h or an erythema with sharp margins after 24 h. Because the inter-observer error in determining JPE is significantly less than that for sharp margins, the first definition appears to be preferable (14).

The relation between SPT and MED was assessed with linear regression models. Differences in MED levels between vitiligo and normal skin within individuals were analysed with a paired students t-test.

**RESULTS**

We assessed the MED in 33 individuals (8 men, 25 women, mean age 46.6 years) with SPT varying between II and VI.

Mean values of MED for the normal skin gradually increased from  $0.73$  in individuals with SPT II to  $2.20 \text{ J cm}^{-2}$  in patients with SPT VI (Fig. 1). This linear trend was highly significant (average increase in MED values per SPT  $0.34 \text{ J cm}^{-2}$ ;  $p < 0.0001$ ; 95% CI= $0.26\text{--}0.41$ ).

For the vitiligo skin we also found a highly significant linear trend (average increase in MED values per SPT  $0.19 \text{ J cm}^{-2}$ ;  $p < 0.0001$ ; 95% CI= $0.14\text{--}0.24$ ), indicating that the vitiligo skin of individuals with a darker skin can tolerate higher doses of UVB. MED values were on average 35% lower (95% CI= $31\text{--}39\%$ ) in the vitiligo skin compared with the normal skin within the same individual (Figs 1 and 2).

**DISCUSSION**

The optimal dose for treating vitiligo with UV radiation (in particular UVB 311 nm) is slightly below 1 MED (12). This stabilizes the vitiligo and causes cell division and migration of melanocytes. Although there is an ongoing discussion about the existence of a relationship between SPT and MED (11, 13), we definitely saw this relationship.

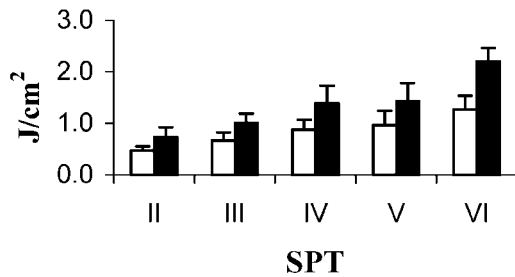


Fig. 1. Minimal erythema dose (mean+SD) vs skin type (SPT) in vitiligo lesional (□) and non-lesional (■) skin.

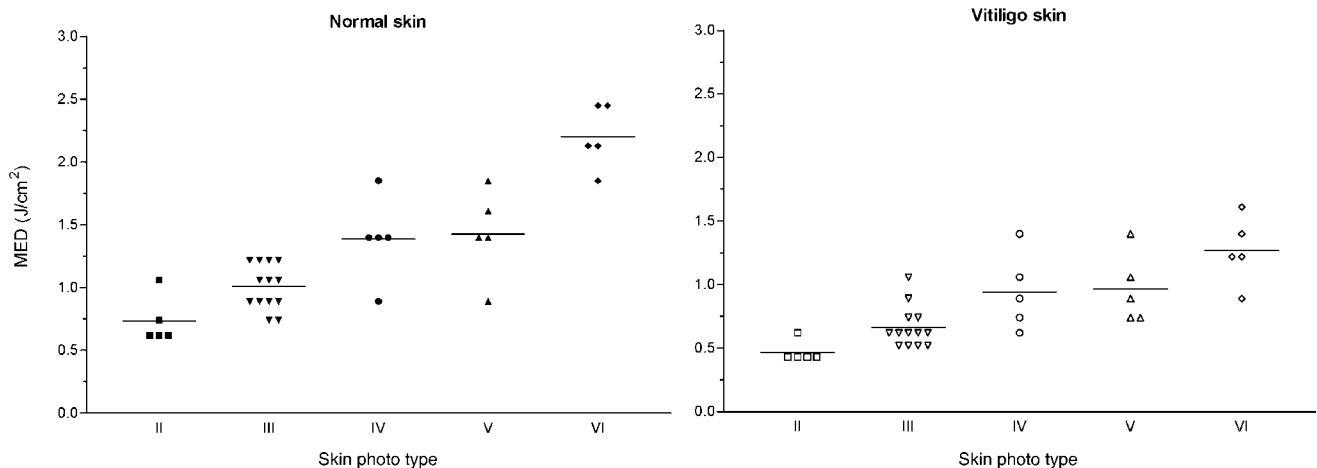


Fig. 2. Scatter plot of minimal erythema dose (MED) per skin type in vitiligo non-lesional vs lesional skin. Horizontal lines indicate the mean value.

Until now we only had information about the relation between MED and SPT from normal skin (9, 10) of different SPT (I–VI). In the present study we saw that there is also a linear relationship between the SPT of the patient and the sensitivity to UVB 311 nm irradiation of the lesional skin.

These observations are very important for optimal UVB treatment. Because the mean MED for each SPT is known via our results, it would be possible to apply the UVB therapy more efficiently. Treatment could be started with a UVB dose slightly under the mean UVB dose fitting the patient's SPT as determined in the present study. With this method, patients would receive optimal therapy without losing time or risking skin burns.

As melanocytes are absent or scarcely present (15) in the lesional skin of a person with vitiligo, this difference in photosensitivity cannot be due melanin. This protection must be based on one or several other mechanisms.

We know that epidermis thickness increases due to UV irradiation; Hoffmann et al. (16) showed that this could result in a MED raise of a factor 3. However, in our MED study the patients' skin had not been exposed to UV radiation for at least 3 months, and the tests were carried out in regions that had not been exposed to sun, so skin thickening cannot be responsible for the observed differences. As there are racial differences between the several skin types, in theory this could be a causal factor which could be responsible for the observed SPT-related MEDs. However, Whitmore & Glavan Sago (17) proved that there was no difference in skin thickness between white and black women; therefore racial differences in skin thickness cannot be the factor that explains our observation.

One mechanism that possibly accounts for the SPT-related differences is the antioxidant status of the skin; it is known that antioxidants provide photoprotection (18). Picardo et al. (19) showed that there are significant differences in antioxidant status in normal skin between people with high (SPT III–V) and low (SPT I–II), e.g. the higher the SPT, the higher the amount of catalase. Possibly the same differences in antioxidant status between the different SPT exist in vitiligo patients, which could account for the differences observed in this study. More research is needed to elucidate our observations.

#### ACKNOWLEDGEMENT

We would like to thank J.B. Reitsma MD PhD, Department of Clinical Epidemiology, University of Amsterdam, for his support in establishing the statistical analysis.

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