

## Determination of minimal erythema dose for narrow band-ultraviolet B radiation in north Indian patients: Comparison of visual and Dermaspectrometer® readings

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### ABSTRACT

**Background:** Minimal erythema dose (MED) for narrow band-ultraviolet B radiation (NB-UVB) varies with race and skin type. The aim was to estimate the MED for NB-UVB and compare visual readings with those from a Dermaspectrometer® in a north Indian patients as the available data is sparse. **Methods:** Forty one patients who visited the dermatology outpatient department were recruited for this study. Skin type was grouped as per Fitzpatrick skin type scale. Patients' upper backs were irradiated after applying a novel template with 8 windows of 2 x 2 cm each, with a test dose ladder of 250-1500 mJ/cm<sup>2</sup> in a Waldmann (700K) TL-01 chamber. MED and erythema index were read after 24 hours, the latter by using Dermaspectrometer®. **Results:** Forty one patients (10 males, 31 females) with mean age of 30.5 (14-65) years were recruited. 23 patients were of skin type 5, 17 of type 4 and one of skin type 3. The estimated MEDs were 1000 mJ/cm<sup>2</sup> in 17, 750 mJ/cm<sup>2</sup> in 19, 1100 mJ/cm<sup>2</sup> in four and 500 mJ/cm<sup>2</sup> in one patient. The median and mode MED was 1000 mJ/cm<sup>2</sup>. There was an exponential rise in the erythema index with increase in irradiation (17.18-26.25/ 250-1500 mJ/cm<sup>2</sup>). Student's t-test applied to detect differences between the visual and Dermaspectrometer® readings was found to be statistically not significant. **Conclusion:** The estimated MED for NB-UVB varied from 500 to 1100 mJ/cm<sup>2</sup>, the median MED being 1000 mJ/cm<sup>2</sup>. The darker skin types did not have low MED while some patients with lighter skin type displayed lower MED. There was no significant difference in MED determined by visual and Dermaspectrometer® readings.

**Key Words:** Dermaspectrometer®, Indian patients, Minimal erythema dose, Narrowband UVB

### INTRODUCTION

Narrow band (TL-01) ultraviolet (UV) lamps are being used increasingly for phototherapy of psoriasis, vitiligo and various other dermatoses. Determining the minimal erythema dose (MED) would help to accurately deliver the required irradiation dose for therapeutic efficacy. Starting doses of UVB are usually based on skin type especially when MED is not determined prior to phototherapy. This is not satisfactory as skin type is a poor predictor of MED and there are many variations in MED within each skin type. It is also apparent that the MED has different definitions

varying from well-defined erythema (light pink) to ill-defined erythema. To circumvent such problems, we used narrowband reflectance spectroscopy to determine MED and compared it with visual observations.

### METHODS

Forty one patients who visited the dermatology OPD were recruited after they had given written informed consent. Skin type, eye color and hair color were recorded. The regional areas from which the person hailed were also noted. Patients' history of photosensitivity, intake of

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systemic antibiotic or anti-inflammatory drugs and collagen vascular disorders were noted and these factors were used as exclusion criteria in this study. The template was made of a thin sheet of leather with 8 windows of 2 x 2 cm with Velcro tapes stitched to the margin for manual closure of windows after each dose. Patients' upper backs were irradiated after fixing this template using a test dose ladder of 250-1500 mJ/cm<sup>2</sup> (250, 500, 750, 1000, 1100, 1200, 1300 and 1500) in the Waldmann (700K) TL-01 full-bodied chamber. The rest of the body was adequately protected from irradiation by using a protective gown and goggles.

MED [Figure 1] and erythema index were read after 24 hours, the latter by using the Dermaspectrometer®. The Dermaspectrometer® (Cortex Technology, Denmark) is a narrow-band reflectance spectrometry instrument that is handheld and battery operated. This instrument's light emitting diodes emit light at two defined wavelengths: 568 nm (green) and 655 nm (red). It measures the absorbed and reflected light at the green and red wavelengths for determination of oxyhemoglobin and melanin levels, respectively. It illuminates an area of 11 mm<sup>2</sup>. The instrument is applied on the erythematous area and this provides easy and safe assessment of skin color by providing a read-out of the erythema / melanin index.

The erythema index and melanin index is based on their differences in the spectral curves of the hemoglobin and melanin. It is suggested that the reflectance of the narrow band light in the red spectrum would yield reasonable estimates of skin color following the equation  $M = \log_{10} (1\% \text{ red reflectance})$ . The degree of the erythema or redness is measured by subtracting the absorbance due to melanin from the absorbance of the green filter, this could be

calculated as  $E = \log_{10} (1\% \text{ green reflectance}) - \log_{10} (1\% \text{ red reflectance})$ .

It has been used to determine the erythema produced by ultraviolet light and patch testing. We used this instrument to compare with visual observations. The erythema / melanin index was measured at baseline and at 24 hours after irradiation over the covered and uncovered site. Only the erythema index (EI) was measured at the test site after irradiation. Statistics used were frequency distribution and descriptives, paired t test and Pearson's coefficient of correlation. Student's t-test was applied to compare the differences between the visual readings to that of the Dermaspectrometer® and Pearson's coefficient of correlation applied to look for correlation between these two readings.

## RESULTS

Forty one patients (10 males, 31 females) with mean age of 30.5 (14-65) years were enrolled. Twenty three patients were of skin type 5, 17 of type 4 and one of skin type 3. All the patients were of Indian origin except one patient with type 3 skin who was from Nepal. MED for NB-UVB varied from 500 to 1100 mJ/cm<sup>2</sup> (average 893 mJ/cm<sup>2</sup>) and the median and mode MED was 1000 mJ/cm<sup>2</sup>. The estimated MED was 1000 mJ/cm<sup>2</sup> in 17, 750 mJ/cm<sup>2</sup> in 19, 1100 mJ/cm<sup>2</sup> in four and 500 mJ/cm<sup>2</sup> in one patient. According to the skin type, the MEDs were 750 mJ/cm<sup>2</sup> in in type 3, 750-1100 mJ/cm<sup>2</sup> in type 4 (median and mode being 1000 mJ/cm<sup>2</sup>) and 500-1100 mJ/cm<sup>2</sup> in type 5 (750 mJ/cm<sup>2</sup>). Dermaspectrometer® readings were taken in 26 patients. The mean erythema index (EI) over the covered site (control) was  $17.96 \pm 2.29$ . The mean EI over the uncovered site was  $18.19 \pm 2.07$ . The mean EI on the visual positive scale was  $20.93 \pm 3.71$  (positive site) ( $P = 0.0002$ ). There was an exponential rise in the erythema index (17.18-26.25) with an increase in the dose of irradiation (250-1500 mJ/cm<sup>2</sup>). Student's t-test applied for comparison between the visual readings to that of erythema index was found to be statistically not significant.

## DISCUSSION

MED determination is essential for rational treatment with UV light. MED readings are helpful for subsequent exposures and increments of UV irradiation. Various Indian studies, predominantly from south India have shown variable results.<sup>[1-3]</sup> Pai *et al.* reported the average MED for narrow band UV-B exposure for type IV to be 600 mJ, (range 515-755 mJ) and type V skin to be 1100 mJ (range 895-1290



**Figure 1: MED to narrow band UVB 0.75 J/cm<sup>2</sup> (circles around the square test sites)**

mJ).<sup>[1]</sup> They also suggested that better therapeutic response could be achieved by starting NB UVB at 360-450 mJ as an initial irradiation dose for type IV skin and 600-825 mJ for type V skin.<sup>[1]</sup> In another study on six volunteers, the MED for NB-UVB ranged between 150-400 mJ for type IV and type V Indian skin.<sup>[2]</sup> In our study, we found MEDs to be 750-1100 mJ/cm<sup>2</sup> (1000 mJ/cm<sup>2</sup>) for type IV and 500-1100 mJ/cm<sup>2</sup> (750 mJ/cm<sup>2</sup>) for type V skin. We found that the median MED for type V skin was lesser than that for type IV skin.

In the above mentioned studies, different kinds of dose ladders have been used, 300-1550 mJ/cm<sup>2</sup> and 50-500 mJ/cm<sup>2</sup> (9 increments by 50 mJ/cm<sup>2</sup> till 500 mJ/cm<sup>2</sup>).<sup>[1,2]</sup> The second study on six volunteers also has a very low cut off<sup>[2]</sup> in which patients with higher MED could have been missed and probably be started at lower dose, thus increasing the amount of time to achieve the required dose. In yet another study, Youn *et al.* used the standard light source (Waldmann UV 801 BL) equipped with 10 TL stand type and used an incremental ladder of 200-1500 mJ/cm<sup>2</sup> (200, 240, 300, 380, 470, 600, 750, 950, 1200 and 1500).<sup>[4]</sup> Hence, taking into account all these variations, we used multiples of 250 till 1000 mJ/cm<sup>2</sup> and then used increments of 100 till 1500 mJ/cm<sup>2</sup>. The lower increments used later were chosen for the sake of safety of the patients to not burn their skin with higher doses of irradiation. Thus, these variations strengthen the cause for more accurate determination and individual patient testing rather than application of blanket guidelines.

The template which we used was locally devised, inexpensive, portable and could be fixed to any site. The only drawback was that the closure and opening of the windows had to be done manually.

The Deraspectrometer<sup>®</sup> has been used to measure ultraviolet radiation-induced erythema, skin and hair color,

laser-treated port-wine stain and erythema index of clinical patch testing.<sup>[5-8]</sup> The Deraspectrometer<sup>®</sup> which we used to determine the erythema is expensive and showed significant inter-individual variations. However, its readings (erythema index) were objective and correlated with visual findings very well. In conclusion, the estimated MED for NB-UVB in our patients varied from 500 to 1100 mJ/cm<sup>2</sup> (average 1000 mJ/cm<sup>2</sup>). Skin type III did not have low MED but some with skin types IV and V displayed lower MEDs. There was no significant difference in MED determined by visual reading and by a Deraspectrometer<sup>®</sup>

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