New light source for narrowband UVB phototherapy puts patients at risk

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Action spectrum studies in psoriasis have established that UV light with wavelengths between 310 and 315 nm can completely clear skin lesions at sub-erythemogenic doses. In contrast, wavelengths from 290 to 300 nm produce a sunburn reaction without any therapeutic benefit (1, 2). These findings led to the development and use of narrowband UVB (NB-UVB) light sources for dermatological therapy.

Since its introduction in 1988, the Philips TL01 fluorescent tube has been used successfully and safely in phototherapy for many skin diseases (3-6). A major advantage was that burning of patients could be effectively controlled compared to existing photochemo-therapy modalities and broad- and small-spectrum UVB treatments.This led to 311 nm irradiation becoming the treatment of choice for conditions such as vitiligo (7, 8) and Psoriasis (13, 14)

In recent years lamps using an alternative '311 nm' light source have become available, offered as a cost-effective replacements for the Philips TL01. However there are some worrying differences between the two.

Figure 1 shows the spectral energy distribution of two 100 W lamps weighted with the erythemal action spectrum, where the weighting factor $S(\lambda)$ is derived from reference 9. The black line is the Philips TL01 while the pink line uses the alternative 311 nm source. The first obvious difference is that the Philips TL01 lamp emits a peak at 311 nm and the other lamp at 313 nm. It is difficult to say whether this makes a difference to therapeutic effectiveness as the optimal action spectrum for psoriasis and vitiligo is not precisely known (10). Moreover, there is little clinical experience with 313 nm.

Comparison of erythemal-weighted irradiance

However, the other lamp does produce a different spectral energy distribution, significantly altering the accumulated dose in both the therapeutic and the non-therapeutic regions. The total effective UV irradiance of the weighted erythemal action spectrum can be calculated by simply adding together the area under the curve, as shown in Table 1.

The alternative '311 nm' source does produce a greater total erythemal-weighted irradiance (46.2 mW/cm^2 compared to 39.1 mW/cm^2). However, less than half (46%) is within the therapeutic region. In comparison, two-thirds (66%) of the erythemal-weighted irradiance from the Philips TL01 lamp is in the therapeutic region. The result is that the Philips TL01 lamp effectively delivers about 20% more energy in the therapeutic wavelength range.

Table 2 indicates the total radiation dose delivered by the other lamp as a percentage of the total radiation dose delivered by Philips TL01 lamp in various frequency bands and for various operating scenarios. So when both lamps are used for the same time, we see that the

alternative light source delivers only 82% as much irradiation in the therapeutic band but almost double (189%) below 310 nm, and 274% in the 290 to 300 nm region.

If the timing for each lamp is adjusted to achieve the same Minimal Erythemal Dose (MED), the higher total erythemal-weighted irradiance of the other lamp means its effectiveness in the therapeutic band decreases to 70%. Yet the aggressive radiation it delivers below 310 nm is still 160% compared to the Philips TL01 lamp.

Of course, the other lamp could be used for a longer time to compensate for lower output in the therapeutic range, but that would lead to even higher irradiance with shorter UVB wavelengths. For example in making a direct comparison of the effectiveness of the two lamps at the 311 nm wavelength, exposure times using the other lamp need to be increased significantly. The result is that the total erythemal-weighted irradiance increases to 144% compared to Philips TL01 lamp and the radiation below 310 nm increases to 230%.

Dangers of non-therapeutic wavelengths

In theory, we would prefer to see no radiation at all in the non-therapeutic wavelength range below 310 nm. Of course in practice that is very difficult to achieve. Regrettably the major contribution of the erythemal output of the alternative '311 nm' light source comes from this lower wavelength region. Moreover these shorter UVB wavelengths are responsible for uncontrollable erythema formation.

Patients who experience severe burns are unlikely to return for further treatment. It is therefore critical that sub-erythemogenic doses are used in clinical settings [13, 14]. Attenuated doses are also preferable from the perspective of tumor induction, as UV-erythema is a major risk factor for skin cancer.

The other lamp's higher total erythemal output level means it must be used for shorter exposure times. Consequently, patients will need more treatment sessions to gain the same therapeutic benefit – in some cases 33% more sessions. This increment on the number of treatments may result in negative late side effects in the long term.

Even using very low doses doesn't change the essence of this reasoning. The Philips TL01 lamp has shown to be efficient at the sub-erythemogenic energy output. In comparison the alternative '311 nm' lamp is essentially the combination of a short wavelength UVB lamp and significantly less irradiance at the therapeutically optimal 311 nm wavelength. On this basis it is more likely to have long term negative effects than the Philips TL01.

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Legends to figures

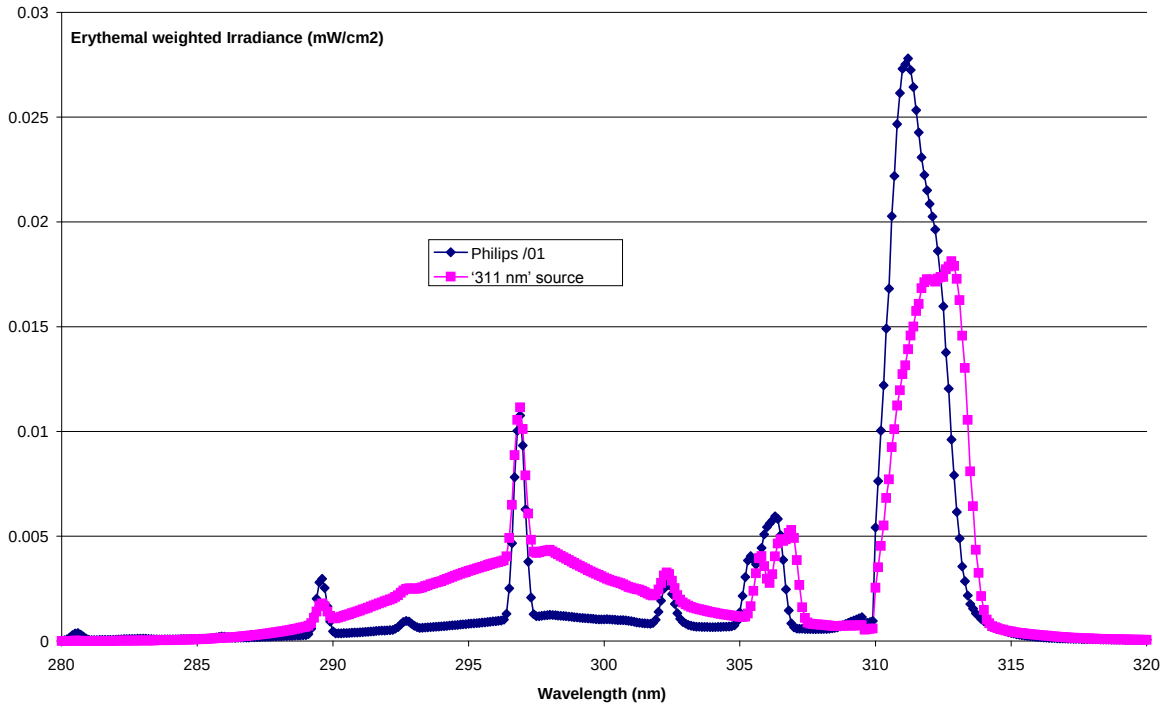

Figure 1. Weighted spectral energy distribution

Table 1. Weighted erythemal irradiance of Philips TL01 and alternative '311 nm' source

	Arimed 311 (mw/cm^2)	**Philips TL01 (mW/cm^2)**
Total output	46.2 (100%)	39.1 (100%)
Output in therapeutic region – 310-320 nm	21.3 (46%)	25.9 (66%)
Output in non-therapeutic region – below 310 nm	24.9 (54%)	13.2 (34%)

Output in non-therapeutic region – below 310 nm	24.9 (54%)	13.2 (34%)
280-290 nm	1.1 (2%)	0.8 (2%)
290-300 nm	14.3 (31%)	5.2 (13%)
300-310 nm	9.5 (21%)	7.2 (18%)

Table 2. Total effective erythemal-weighted irradiance produced by alternative '311 nm' source to achieve comparable results of the Philips TL01

	Same time	**Same MED**	**Same irradiance**

			@ 311 nm
		(irradiance x 0.85)	(irradiance x 1.22)
Total output	118%	100%	144%
Output in therapeutic region – 310-320 nm	82%	70%	100%
Output in non-therapeutic region – below 310 nm	189%	160%	230%
280-290 nm	147%	125%	179%
290-300 nm	274%	232%	333%
300-310 nm	132%	112%	161%