

ORIGINAL ARTICLE

Narrowband UVB phototherapy in children: A New Zealand experience

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ABSTRACT

Background: Phototherapy is effective for many dermatoses in adults, but there is a paucity of data for its use in children.

Objectives: To review the efficacy and tolerability of narrowband UVB phototherapy in children at a tertiary centre in New Zealand, and determine if there were any factors that differentiated responders from non-responders.

Methods: A prospective analysis of children (<16 years old) who had undergone phototherapy over a 15-year period.

Results: 116 children received phototherapy with a total of 144 courses. Mean age was 11.0 years with the majority being European and having skin phototype II. Atopic dermatitis was the most common indication for treatment followed by psoriasis, pityriasis lichenoides, nodular prurigo, morphea, vitiligo, urticaria pigmentosa and erythropoietic porphyria. Treatment was effective in the majority of children (72%). Most received only one course. For responders, the mean number of treatments was 32.4. The mean dose per treatment to achieve clearance was 886 mJ/cm² and the mean maximum treatment dose per treatment was 1328 mJ/cm². All children tolerated treatment well with 36% developing brief, minimally symptomatic, erythema. Only two children experienced exacerbations of their underlying dermatoses.

Conclusions: This study shows that phototherapy is an effective and well-tolerated treatment modality in children.

Key words: atopic dermatitis, narrowband UVB, paediatric, phototherapy, psoriasis, ultraviolet light.

INTRODUCTION

Narrowband UVB (nbUVB) phototherapy is safe and effective for a wide range of dermatoses in adults.^{1–7} For use in children, a paucity of data exists. Prolonged life expectancy, concern over its possible association with skin cancers and difficulties associated with administering phototherapy to children has limited its use in this population.

The available paediatric literature has primarily focused on phototherapy in the treatment of childhood psoriasis.^{8–14} New Zealand has one of the highest prevalence of atopic dermatitis in the world, with 13% of children under the age of 14 being affected.¹⁵ Although topical corticosteroids remain the mainstay of therapy, this treatment modality often fails children with severe disease. nbUVB phototherapy is an appropriate second line therapy.^{2,16}

This study reviews 15-years' experience of nbUVB phototherapy in New Zealand children where the prevalent dermatosis is atopic dermatitis.

MATERIALS AND METHODS

Phototherapy data of children who received nbUVB was prospectively collected from January 1993 to December 2008. All children had been referred from the paediatric dermatology clinic. The records of children aged <16 years of age at the time of treatment were examined to determine basic demographics, diagnosis, number of treatments and courses received, duration to clearance, cumulative dose, highest dose per treatment and basic information regarding outcome and side effects. All children were allowed to continue adjunctive topical and systemic therapy.

Phototherapy was performed using a VS5 Series Phototherapy Booth, (Wayne Electronics Pty. Ltd., Somersby, NSW, Australia) with 56 (TL100/01) nbUVB fluorescent lamps. Therapy was performed under the supervision of a dermatologist and administered by specialist dermatology nurse(s) trained in phototherapy. The emission spectrum has a range of 309–313 nm with a median wavelength of 311 nm. The radiance was checked on an annual basis with a Solar Light PMA 2100 radiometer (Solar Light Inc.,

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Abbreviation:

nbUVB

narrowband UVB

Glenside, PA, USA). The average radiance was 10.0 mW/cm². The power output was 3.5 mW/cm² at a distance of 10 cm from the light tubes as measured by the PMA 2100 photometer.

Initially, all treatments were given three times per week. The initial doses of nbUVB were determined by the patient's skin type (assessed clinically).² From a practical perspective, it was our experience that determining minimum erythema dose and minimum phototoxic dose took too long and was too exhausting for children. At each session, the dose of irradiation was increased by 10% if there had been no erythema. The optimal constant dose was achieved when minimal erythema occurred in the lesions. If symptomatic erythema developed, irradiation dose was reduced by 20%.

All children wore UV-blocking goggles (and occasionally UV-blocking masks) and their genitals were shielded from UV exposure.

Responders were children who had >75% improvement, or complete clearance of their underlying dermatoses. Children who had <75% improvement were classified as non-responders. Initial responders were children who responded in the first course but subsequently failed to respond.

Statistical analysis

Statistical analyses were performed on phototherapy courses rather than patients. The use of phototherapy courses allowed a simplification of analysis into two categories: responders and non-responders. This allowed differences between these two categories to be analysed.

One patient received a significantly higher mean dose per treatment (4,596 mJ/cm²) than the rest and inclusion of this data led to skewing of the analyses, so this data was excluded.

Two broad types of data are present in this study – categorical and continuous data. Categorical data is data that can be sorted into categories for example, gender, ethnicity, skin type, erythema and diagnosis. Continuous data is data that can take on any value within a finite or infinite interval and in this study it refers to cumulative dose, maximum dose and mean dose per treatment.

A box and whisker diagram was plotted to allow a graphical overview of doses for responders and non-responders. *T*-test for independent samples was used on this continuous data to determine statistical differences between responders and non-responders. *T*-test was also used to determine differences between responders and non-responders for age. For categorical data, Chi-squared was used to determine the differences between these two groups for gender, ethnicity, skin type, erythema and diagnoses. To avoid the inclusion of a small number of data points, which might skew the analyses, analyses were restricted on ethnicity to European and Maori, on diagnoses to atopic dermatitis and psoriasis, and on skin type to Type II, III and IV.

The Kolmogorov-Smirnov test was used to determine the difference between responders and non-responders for the number of treatments as this allowed the mean of number

of treatments between the two groups to be compared. Kolmogorov-Smirnov was used because the data in this study did not fit a normal distribution and hence a non-parametric test was chosen.

All statistical analyses were made using STATISTICA for Windows v.8.0.725.0, 2008 (StatSoft Inc., Tulsa, OK, USA).

RESULTS

Over 15 years, 116 children were treated with a total of 144 courses of phototherapy. The mean age was 11.0 years (range, 2.6–15.9 years) with the majority of children being of European origin (75 children or 65%) and many having Fitzpatrick skin phototype II (58 children or 50%). Atopic dermatitis was the most common indication for treatment (61 children or 53%) followed by psoriasis (38 children or 33%) pityriasis lichenoides (four children or 3%), nodular prurigo (four children or 3%), morphea (three children or 3%), vitiligo (two children or 2%), urticaria pigmentosa (two children or 2%) and erythropoietic porphyria (one child).

As a group, the majority of children (100 children or 86%) received only one course of phototherapy (Fig. 1)

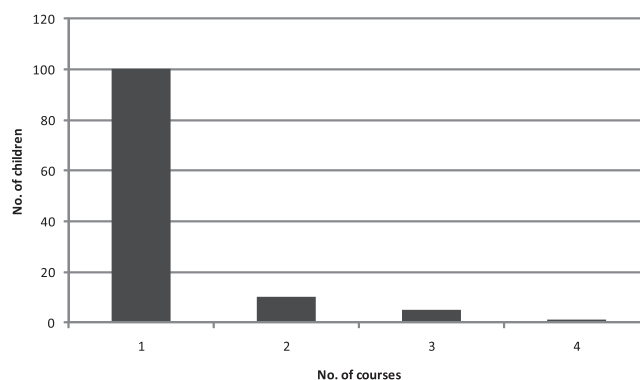


Figure 1 Histogram of number of courses.

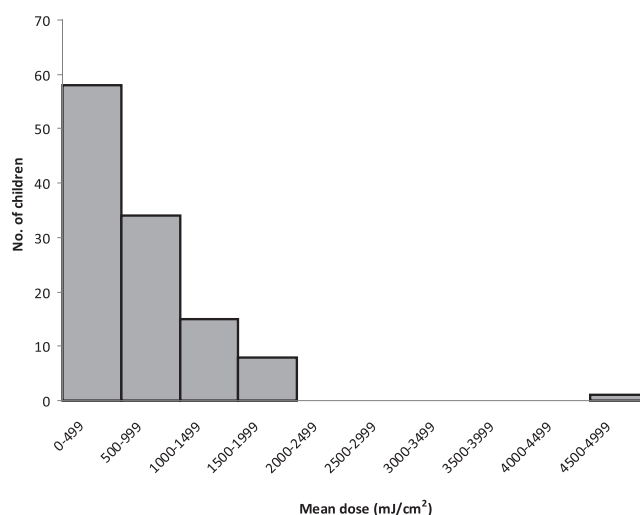


Figure 2 Histogram of mean dose per treatment.

irrespective of diagnosis; one patient received four courses of therapy. That particular child also received the highest mean dose per treatment of 4596 mJ/cm² for her atopic dermatitis (Fig. 2).

There were five children who initially responded well to phototherapy, but failed to respond to a subsequent course(s). Two children (1.7%) got worse with phototherapy and in 10 children (8%) there was no change. Courses were therefore divided to responders and non-responders to allow analysis of variables that differentiated responders from non-responders (Table 1). There were 102 courses in

the responder group and 42 courses in the non-responder group.

Amongst the children that responded, the majority received 21–30 treatments, whereas non-responders received <20 treatments (Table 1). The mean number of treatments, mean dose per treatment, maximum and cumulative dose were all higher amongst responders compared to non-responders. There were more children with mild erythema amongst the responders ($n = 41$ or 35%) compared with non-responders ($n = 5$ or 4.3%) ($P < 0.05$). In no cases was erythema severe enough to warrant discontinuation of therapy.

When analysed according to skin type, mean dose and cumulative dose increased the darker the skin phototype was. Children with skin phototype IV received the highest number of treatments, cumulative dose and mean maximum dose (Table 2).

The box and whisker diagram provides a graphical representation of the doses of responders and non-responders (Fig. 3). The distribution of data is not normal and is skewed towards lower doses. Cumulative dose, maximum dose and mean dose are higher for responders compared with non-responders with higher values, median values and inter-quartile ranges.

Statistical analyses were performed to determine variables that separated responders from non-responders (Table 3). There were no statistically significant difference between responders and non-responders for age, gender,

Table 1 Characteristics of responders and non-responders

Characteristics	Responders	Non-responders
No. of courses	102	42
Mean age (years) (SD)	11.1	11.0
Gender		
Male	54	18
Female	68	24
Skin type		
I	3	4
II	52	20
III	31	5
IV	16	12
V	0	1
Diagnosis		
Atopic dermatitis	47	28
Psoriasis	45	6
Other	10	8
Ethnicity		
European	70	23
Asian	7	2
Maori	20	11
Other	5	6
Number of treatments		
1–10	5	14
11–20	22	9
21–30	37	8
31–40	26	7
>40	12	4
Mean number of treatments	28.7	20.6
Mean dose per treatment (mJ/cm ²)	1 309.8	419.9
Mean of maximum dose (mJ/cm ²)	737.4	721.5
Mean of cumulative dose (mJ/cm ²)	25 085.4	11 549.8
Mild symptomatic erythema		
Present	41	5
Absent	61	37

SD, standard deviation.

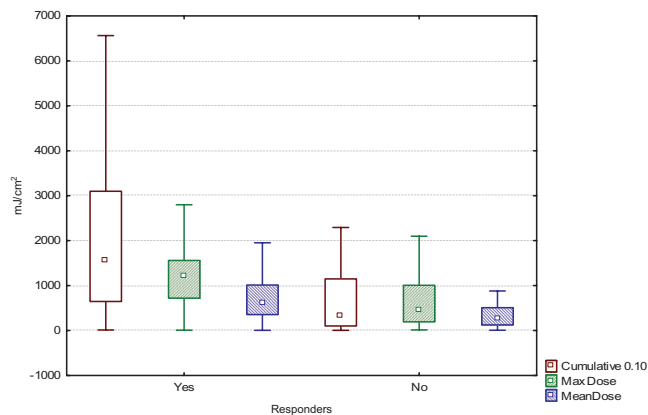


Figure 3 Box and Whisker plot of cumulative, maximum and mean dose. (Cumulative 0.10 = Cumulative dose/10. As cumulative dose is much greater than maximum and mean dose, the value is divided by 10 to allow data to be fitted into a graph).

Table 2 Comparison of dose according to skin phototype

Skin type	No. of children	Mean no. of treatments	Erythema	Mean dose (mJ/cm ²)	Mean of cumulative dose (mJ/cm ²)	Mean of maximum dose (mJ/cm ²)	Recommended maximum dose (mJ/cm ²) ^{7,17,18}
I	6	36.2	3	432.2	15 629.5	738.0	2000
II	58	29.4	24	906.9	26 643.7	1202.3	2000
III	31	29.2	9	826.9	24 139.9	1181.4	3000
IV	20	41.2	7	935.5	38 496.7	1682.9	3000

Table 3 Differences between responders and non-responders

Variable	Chi-square (χ^2) / t value [‡]	Degrees of freedom	P value
Age [†]	0.18	142	0.86
Gender	1.54	1	0.22
Ethnicity (European & Maori)	0.38	1	0.53
Skin type (II, III & IV)	5.76	2	0.06
Diagnoses (Psoriasis & Eczema)	11.72	1	0.001*
Erythema	9.74	1	0.002*
Mean dose per treatment (<3500 mJ) [‡]	3.08	142	0.007*
Maximum dose [‡]	3.55	142	0.001*
Cumulative dose [‡]	2.72	142	0.002*
Number of treatment [‡]	Zadj = 5.58	– (n = 50, 120)	0.001*

*Statistically significant. [†]t-test performed. [‡]Kolmogorov–Smirnov test. Analyses were restricted to mean dose per treatment of <3500 mJ. Zadj, Adjusted Z-value.

ethnicity and skin type. There was statistically significant difference between the diagnosis of psoriasis and eczema amongst responders versus non responders (P value = 0.001); psoriasis responded better to phototherapy than atopic dermatitis. Differences between responders and non-responders for number of treatments, erythema, maximum dose and cumulative dose were also statistically significant (all P values < 0.05). Children who responded to phototherapy received higher number of treatments, maximum dose and cumulative dose.

DISCUSSION

This study has shown that phototherapy is an effective and well tolerated treatment modality in children. Most children only needed a single course. There were no factors that could predict which children were more likely to respond to phototherapy. Children of all ages, gender, ethnicity and skin types responded equally. Phototherapy is well tolerated. In no cases was erythema severe enough to warrant discontinuation of therapy and when it developed, all cases were mild and transient in nature.

Responders had a significantly higher number of treatments, maximum dose and cumulative dose. This difference is not surprising – responders received more treatment as they showed early signs of response. They were also more likely to have had mild, symptomatic erythema for similar reasons. This may indicate that treatment should have continued for longer, and been more aggressive, in apparent non-responders.

The response rate in our study is in agreement with published literature (Tables 4,5).^{8,10–14,19,20} In psoriasis, the mean cumulative and maximum dose of nbUVB was similar in a large Turkish study¹⁰ but higher than two other studies from Croatia and India.^{11,15} In children with atopic dermatitis, this study shared similar results to a large Irish study.¹⁹ However, the dose used in our study was much higher than a smaller, Croatian study.¹⁵ A likely explanation is that the Croatian study used combined UVA and UVB for children with psoriasis and atopic dermatitis, and hence less overall UVB.¹⁵

When analysed to skin type, the doses used in this study was much lower than international recommendations (Table 2).^{7,17,18} We postulate this to be due to the higher ambient UV radiation present in the NZ atmosphere acting synergistically with narrowband UVB from phototherapy.

When compared to children with psoriasis those with atopic dermatitis had a lower response rate, as described in earlier reports.^{20,21} This could reflect the nature of the underlying disease where atopic dermatitis is characterised by frequent relapses and remissions.

Our study is limited in generalisability to populations of European ethnicity with skin phototype II and III. In addition, all children were allowed to continue topical and systemic therapies, which could potentially bias the results. However in our opinion, this is likely to have a small impact as they had mostly failed previous treatments. We were unable to comment on the impact of phototherapy for other dermatoses as the numbers of children was too small to provide thorough analysis.

Photocarcinogenicity of nbUVB could not be assessed in this study as the aim of this study was to assess efficacy and tolerability. However no cases of skin cancer have been reported in the study group to date; the data collected will form the basis for a follow-up study to address this issue.

In addition, this study represents the experience of phototherapy in a paediatric population in one centre in New Zealand. Previous studies have shown that variability exists in emissions of phototherapy booths in spite of regular calibrations.^{22–24} This variability could cause differences in outcomes and doses between different centres.

Nonetheless, the strengths of this study include its size (allowing statistical analysis to be performed), completeness of data and long duration of data collection (15-year period).

In conclusion, nbUVB phototherapy is effective and well-tolerated in children. Most children responded after one course and although children with psoriasis responded better, no patient-related factors predicted response to therapy.

Table 4 Literature review of phototherapy for psoriasis in children

Study	Country	Modality	No. of patients	Mean age in years	Mean no. of treatment	Mean cumulative dose in mJ/cm ²	Mean of max dose per treatment in mJ/cm ²	Response
Ersoy-Evans <i>et al.</i> ¹⁰	Turkey	nbUVB	28	12 ± 2.5	25.8 ± 10.6	20 000 (3 000–85 000)	1000 (300–6000)	92.9% (<i>n</i> = 26)
Jury <i>et al.</i> ¹²	Scotland	nbUVB	55	Median 12 (4–16)	Median 17.5 (9–55)	NR	NR	65% (<i>n</i> = 25) had clearance or minimal residual disease. Data missing for 10 patients
Pasic <i>et al.</i> ¹³	Croatia	UVA + nbUVB	20	9.5 (6–14)	19 (10–59)	6 610 (2 400–24 500)	340 (30–500)	45% of patients had excellent response (<i>n</i> = 9), 20% good (<i>n</i> = 4), 20% moderate (<i>n</i> = 4) and 15% no improvement (<i>n</i> = 5).
Zamberk <i>et al.</i> ¹⁴	Spain	nbUVB	20	13 (5–17)	Median 28 (10–59)	Median 40 841 (5 992–144 057)	3000 (873–3000)	52.17% of patients had >90% improvement in PASI.
Jain <i>et al.</i> ¹¹	India	nbUVB + Mineral oil	18	(5–14)	20.56 ± 3.06	2 956 ± 1 070	297 ± 100	End point was clearance which was achieved in all 18 patients.
Current study	New Zealand	nbUVB alone	18	(5–14)	25.78 ± 3.14	4 088 ± 1 236	395 ± 115	90% response
		nbUVB	58	11.5 (8.5–15.5) and median of 11.2	27.8 (4–76) and median of 25.5	20 370 (161.5–89 091) and median 13 115	1388 (15–2996) and median 490	

NR, Not recorded; nbUVB, Narrow-band ultraviolet B; PASI, Psoriasis Area and Severity Index.

Table 5 Literature review of phototherapy for atopic dermatitis in children

Study	Country	Modality	No. of children	Mean age in years [†]	Mean no. of treatments [†]	Mean cumulative dose in mJ/cm ²	Mean of max dose per treatment in mJ/cm ²	Response
Jury <i>et al.</i> ¹²	Scotland	nbUVB	25	Median 12 (4–16)	NR	NR	NR	68% (<i>n</i> = 17) clearance or minimal residual disease. 16% (<i>n</i> = 4) no response. Data is missing for 4 children.
Pasic <i>et al.</i> ¹³	Croatia	UVA + nbUVB	21	11.5 (4–15)	18 (9–71)	6 140 (1 300–10 420)	3600 (1000–6000)	Excellent in 45.4% (<i>n</i> = 10) children, Good 22.7% (<i>n</i> = 5) children, Moderate improvement in 31.8% (<i>n</i> = 7) children
Clayton <i>et al.</i> ¹⁹	UK	nbUVB	50	Median 12 (4–16)	Median 30 (10–55)	Median 29.339 (8.539–45.88)	NR	Complete clearance in 40% (<i>n</i> = 20), Good improvement 20% (<i>n</i> = 10), Moderate improvement 26% (<i>n</i> = 10), No improvement 14% (<i>n</i> = 7).
Current study	New Zealand	nbUVB	61	10.5 (2.6–15.8) and median of 10.3	33.4 (1–101) and median of 30	29 706 (50–271 162) and median of 15 542	1220 (50–3996) and median of 1160	71% response
		nbUVB	61	10.5 (2.6–15.8) and median of 10.3	33.4 (1–101) and median of 30	29 706 (50–271 162) and median of 15 542	1220 (50–3996) and median of 1160	

[†]Values are in mean unless specified. NR, Not recorded; nbUVB, Narrow-band ultraviolet B.

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