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Narrowband ultraviolet B phototherapy improves quality of life of psoriasis and atopic dermatitis patients up to three months: results from an observational multi-center study

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ABSTRACT

Background/purpose: Narrowband UVB phototherapy is a common treatment modality in psoriasis and atopic dermatitis, but evidence of its actual effect in clinical setting is sparse. Our aim was to assess the effectiveness and costs of narrowband UVB phototherapy in psoriasis and atopic dermatitis in clinical setting.

Methods: We observed 207 psoriasis patients and 144 atopic dermatitis patients in eight centers. SAPASI, PO-SCORAD and VAS measures were used at baseline, at the end and three months after the narrowband UVB phototherapy course. Quality of life was measured using DLQI and costs were assessed using a questionnaire.

Results: Both in psoriasis and in atopic dermatitis the DLQI and SAPASI/PO-SCORAD improved significantly and the results remained improved for at least three months in both groups. Alleviation of pruritus correlated to better quality of life in both patient groups. We reported slight redness and burning side-effects which were due to lack of MED testing. Self-administered tools proved to be useful in

evaluating pruritus and severity of the disease in psoriasis and atopic dermatitis. Mean patient costs were 310 € and 21 hours of time, and mean costs for the healthcare provider were 810 €.

Conclusion: In psoriasis, narrowband UVB is a very efficient treatment in clinical setting, whereas in atopic dermatitis more studies are needed to determine the best dosage.

Key words: PO-SCORAD, SAPASI, DLQI, PASI, SCORAD

INTRODUCTION

Psoriasis and atopic dermatitis (AD) are skin diseases that deteriorate the patient's health-related quality of life (HRQoL) (1-3). Both skin diseases improve with narrowband ultraviolet B (NB-UVB) phototherapy (4). In a controlled setting, NB-UVB was shown to improve also HRQoL of psoriasis patients (5). NB-UVB therapy is regarded suitable for psoriasis patients with 10% or more body surface area affected by psoriasis and/or if the condition has not responded to topical treatment (6-8). Outcomes of NB-UVB phototherapy in AD are less studied. NB-UVB was shown to improve the HRQoL of children with AD (2), and in twelve AD patients at least 50% reduction was found in the Scoring of Atopic Dermatitis (SCORAD) questionnaire (9).

Alleviation of a skin disease can be assessed using various scoring systems, which are mostly aimed for professionals, such as the Psoriasis Area and Severity Index (PASI) and SCORAD (10,11). Nowadays patients are expected to take more responsibility of their care, and various patient-oriented measures, such as the Self-Administrated PASI (SAPASI) (12,13) and the Patient-Oriented SCORAD (PO-SCORAD) have been developed (14). The self-administrated measures could also empower patients. Dermatology Life Quality Index (DLQI) is an established measure of HRQoL (15). Both patients and professionals may take use of it. The DLQI score ranges from 0 to 30 and scores over 10 indicate problems in HRQoL.

Outcomes of randomized and strictly guided studies might differ from those achieved in clinical practice. Therefore, little is known about how NB-UVB works in clinical context and observational clinical studies are needed. The Finnish Photo-Dermatology Section updated the national guidelines of NB-UVB phototherapy in 2012. These include a dosing schedule for NB-UVB treatment of AD patients, and two tentative dosing schedules for psoriasis patients with either skin photo-type II or III– IV (16).

The costs of phototherapy can be significant for the healthcare sector and patients. The annual cost of UVB-phototherapy for the healthcare provider has been estimated to be between USD 3000–4800, including outpatient visits and phototherapy (17,18). With lower phototherapy unit costs, and without office visit costs, phototherapy has been estimated to cost EUR 1105 annually (19). Indirect costs, such as time and travel costs, can be significant for the patient. In a Dutch study, the indirect costs were estimated to be 75% of phototherapy costs (20). In a U.S. study, travel costs of a three-month phototherapy course were estimated to be USD 461–2306 depending on the distance, and total costs including phototherapy, copayments and lost wages USD 1871–4864 (21). Phototherapy costs after reimbursement vary between countries due to different social systems and insurances.

Our observational multi-center study was aimed to verify how the ordinary NB-UVB phototherapy in public out-patient dermatologic clinics impacts psoriasis and AD with specific emphasis on HRQoL. Since there is little data about the costs of NB-UVB in Finland, we calculated the costs for the healthcare provider and patients.

METHODS

This study was organized as a multi-center study and the protocol was approved by the Ethics Committee of Tampere University Hospital (N:o R12118). All five university hospitals of Finland and three central hospitals from Southern Finland participated the study (Supplement 1). The data was collected in 2012–2014.

Patients and the narrowband UVB phototherapy course

Each clinic was asked to recruit at least 25 psoriasis and 25 AD patients taking advantage of arriving referrals. Patients in the need of NB-UVB phototherapy were considered eligible. Volunteering patients gave their informed consent. Subjects being pregnant or under 18 years old were excluded, and as a rule, patients with photosensitivity or photosensitizing drugs did not receive phototherapy. No further instructions were given on how to implement the phototherapy; each clinic was expected to conduct it using their best knowledge and the national guidelines. In our national NB-UVB guidelines, the proposed initial dose for AD is 0.20 J/cm^2 with 10% increments. For psoriasis patients with Fitzpatrick's skin photo-type II, the initial dose is 0.20 J/cm^2 with 20% increments, and for psoriasis patients with photo-types III-IV, 0.30 J/cm^2 with 20% increments. During phototherapy, patients could use their routine systemic or topical medications, which were recorded in the files by the staff together with UVB doses and possible side effects.

The phototherapies were administered using Waldmann UV 7002 cabin equipped with 42 TL-01 tubes (Schulze & Böhm, Brühl, Germany) in four hospitals, and Waldmann UV 7001 cabin equipped with 20 TL-01 tubes (Waldmann, Villingen-Schwenningen, Germany) in four hospitals. In Päijät-Häme Central Hospital the cumulative NB-UVB doses were also measured using personal dosimeters (VioSpor blue line Type III, BioSense, Bornheim, Germany). The meters detect a dose ranging from 1.5 to 90 Standard Erythema Dose (SED) and are suitable for measurements of artificial lamps with different spectral compositions, such as TL-01 (22). One SED is equivalent to an erythemal effective radiant exposure of 10 mJ/cm^2 CIE (23). The dosimeters were attached to the patients' wrists (24). A previously measured lamp spectrum was used for the NB-UVB dose calculations (25).

Assessment of disease activity and HRQoL

Patients do not routinely score their disease severity or HRQoL even if it might be useful, but we asked them to do so. The psoriasis patients filled in the SAPASI (12,13) and AD patients the PO-SCORAD (14) measures. Pruritus and disease severity were assessed globally using the Visual Analogue Scales (VAS) (26). HRQoL was assessed using DLQI, and the change in DLQI was the principal outcome measure (15,27). All measures were filled in three times: at baseline, at the end of the NB-UVB course, and three months after the course.

Assessment of phototherapy costs

Direct costs for the patient and the healthcare provider were assessed, but not costs of productivity losses for the employer. A questionnaire was used to assess time and travel costs. Travel costs were calculated using distances reported by the patients, between their home and the phototherapy unit, together with the number of visits related to phototherapy. For one-way distances less than 12.5 km, a regional bus fee of 2.5 € was applied. For distances beyond 12.5 km, a Social Insurance Institution of Finland reimbursement cost of 0.20 €/km was used.

Patients reported the average time needed for travelling and administering phototherapy. Time was not transformed to monetary losses, which vary depending on employment status. For example, employees and entrepreneurs suffer different time costs since employees can generally use their working time for health care visits, whereas entrepreneurs suffer monetary costs for their lost time personally.

The copayment charge for an outpatient visit to a tertiary level hospital in 2012 was 27.50 €. For phototherapy, the charge was 7.50 € per visit. Total visit costs were calculated assuming only one dermatologist's appointment, prior the phototherapy course, which is the typical situation. Medication costs were not included, because these are compensated by a separate national insurance, which was not the focus of our study.

In the public sector, funding of phototherapy is based on taxing of municipalities, and the small copayment paid by the patient. The Finnish National Institute for Health and Welfare has published the unit costs for healthcare for 2011. Accordingly, the average dermatologist's appointment fee at a tertiary hospital was 199 € and a 30-minute nurse appointment was 34 €., ultimately charged from the municipalities.

Sample size calculation

The minimum size of the patient cohorts was calculated assuming that a clinically significant difference in DLQI is 5 points, with an α-value of 0.05 and a β-value of 0.90 (28). An assumed SD of 5.5 was used (27). Accordingly, it was considered necessary that at least 25 psoriasis patients and 25 AD patients per hospital should complete the study, in order to compare results between the hospitals.

Statistics

Statistical comparisons between psoriasis patients and AD patients were made using the t-test, chi-square test, or Fisher-Freeman-Halton test. Mean changes in DLQI and disease activity during the NB-UVB phototherapy were assessed using the paired t-test with Hochberg's approach for multiple comparison. The data is presented using mean ± SD, unless stated otherwise. Stata 15.0 (StataCorp LP; College Station, Texas, USA) statistical package was used for the analysis.

RESULTS

Patients

A total of 207 psoriasis patients and 144 AD patients completed the study. The majority of psoriasis patients were males (n=119, 57%), but the majority of AD patients were females (n=95, 66%) ($p<0.001$). The mean age of psoriasis patients was 51 years (range 18–77) and AD patients 34 years (range 18–79) ($p<0.001$). The Fitzpatrick's skin photo-types I to IV were presented in frequency of 7/64/115/21 for psoriasis and 6/58/71/9 for AD patients ($p=0.22$). There were seven patients with psoriatic arthritis, and 19 patients were taking acitretin, one methotrexate, one etanercept and one prednisolone. Seven AD patients were taking prednisolone. The minimum desired number of participants of 25 was gained in only some of the hospitals, which made it impossible to compare the results (Supplement 1).

Disease activity after NB-UVB phototherapy

SAPASI depicting psoriasis severity decreased from 11.7 ± 7.4 by 8.6 units during the NB-UVB course ($p<0.001$). PO-SCORAD in AD patients decreased from the initial value of 40.4 ± 14.3 by 18.9 units ($p<0.001$). At the end of the course 29 (14%) of psoriasis patients were completely cleared, whereas only two (1.4%) of AD patients did so. A 75% clearance of SAPASI was observed in 109 (53%) of psoriasis patients. Respectively 25 (17%) of AD patients achieved 75% improvement using PO-SCORAD (Table 1). VAS depicting global disease severity and pruritus decreased statistically significantly in both patient groups ($p<0.001$).

Quality of life after NB-UVB phototherapy

The main outcome measure, DLQI, improved in both patient groups highly significantly during NB-UVB (Fig. 1). In psoriasis patients DLQI improved from its initial value of 10.1 ± 6.5 by 6.3 ($p<0.001$), and in AD patients from 12.9 ± 6.0 by 8.1 ($p<0.001$) (Table 1).

The initial SAPASI and PO-SCORAD showed moderate correlations to initial DLQI, r=0.47 (95% CI 0.35 to 0.58, $p<0.001$), and r=0.43 (95% CI 0.28 to 0.56, $p<0.001$), respectively. Initial global disease severity VAS correlated with DLQI at the onset of the study in both patient groups (in psoriasis r=0.54, 95% CI 0.44 to 0.63, $p<0.001$ and in AD r=0.32, 95% CI 0.16 to 0.46, $p<0.001$). The most important determinant of HRQoL was pruritus. In both patient groups the initial pruritus VAS correlated highly significantly with the initial DLQI values (in psoriasis r=0.58, 95% CI 0.49 to 0.66, $p<0.001$; and in AD r=0.45, 95% CI 0.29 to 0.59, $p<0.001$) (Table 1).

Disease activity and quality of life 3 months after NB-UVB phototherapy

Three months after the NB-UVB course, SAPASI was still decreased from the baseline value by 4.9 units ($p<0.001$) and PO-SCORAD by 16.5 units ($p<0.001$). VAS depicting global disease severity and pruritus were still significantly decreased in both patient groups ($p<0.001$). DLQI was still decreased in psoriasis patients by 3.8 units ($p<0.001$) and in AD patients by 8.0 units ($p<0.001$, Fig. 1).

NB-UVB phototherapy course

During the NB-UVB course, psoriasis patients received a cumulative UVB dose of 16.4 ± 8.3 J/cm^2 (96.5 ± 48.4 SED) and AD patients 12.2 ± 5.5 J/cm^2 (71.8 ± 32.4 SED). The number of NB-UVB exposures was 18 ± 4 in psoriasis patients and 17 ± 4 in AD patients. The NB-UVB exposures were typically given three times a week. The duration of phototherapy was 7.7 ± 3.4 weeks in psoriasis and 7.3 ± 2.5 in AD patients (Table 2). We analyzed the initial UVB doses in Päijät-Häme Central Hospital. The mean initial dose was 0.21 ± 0.04 J/cm^2 in psoriasis patients (n= 28), and 0.19 ± 0.04 J/cm^2 in AD patients (n=27), being in agreement with the national guidelines. According to the patient records, some erythema was recorded in 66% of psoriasis patients, and severe erythema or skin burn in 8%. Among AD patients 61% experienced some erythema during the NB-UVB course, whereas definite burns were seen in 13.9% (Table 2). In addition, eight psoriasis patients reported tingling and burning, seven pruritus, three dryness, two headache, one blistering, one tiredness and one fever. In AD patients, nine reported dryness, eight pruritus, four tingling and burning, two herpes simplex and one tiredness.

Personal UV dosimeters

The mean cumulative UVB dose measured using personal dosimeters in Päijät-Häme Central Hospital was 47.3 ± 20.9 SED in psoriasis patients (n=18) and 47.1 ± 21.6 SED in AD patients (n=13). According to the internal dosimeter of the Waldmann cabin, the corresponding physical non-weighted doses were 13.9 ± 6.1 J/cm^2 in psoriasis patients (n=18) and 12.7 ± 4.3 J/cm^2 in AD patients (n=13). Using a previously measured lamp spectrum, we calculated that these doses correspond to 81.8 SED and 74.7 SED, respectively. The calculated dose is thus 42% higher in psoriasis patients, and 37% higher in AD patients, than the dose measured using dosimeters.

Phototherapy costs for the patients

The mean one-way distance to the phototherapy unit was 15.0 km (95% CI 12.6 to 17.3 km, range 0.0 to 250 km). The mean cumulative travel distance per patient was 569 km (95% CI 463 to 675km, range 0.0 to 14000 km), which yielded a mean travel cost of 149 € (95% CI 129 to 169 €, range 40 to 2800 €). The mean time required for one phototherapy visit including travel time was 66 min (95% CI 61 to 72 min, range 5 to 690 min), which yielded a mean total phototherapy course time of 21 h (95% CI 19 h to 23 h, range 2 h to 242 h). The patients' share of visit costs were on average 162 € (95% CI 159 to 166 €). The

mean total patient costs including travel and phototherapy costs were 310 € (95% CI 289 to 331 €, range 120 to 3030 €).

Phototherapy costs for the healthcare provider

The societal costs of phototherapy including the dermatologist's appointment, and phototherapy sessions administered by nurse, were on average 810 € (95% CI 795 to 825 €).

DISCUSSION

To our knowledge, our study is the first large scale clinically oriented study to show how NB-UVB phototherapy functions in the normal out-patient treatment context in psoriasis and AD. Using several outcome measures, we showed that NB-UVB phototherapy is an efficient regime in clinical use and improves the HRQoL of psoriasis and AD patients highly significantly using DLQI. This was also the primary outcome measure in this study. Improvement was maintained for at least three months in both groups.

Consistent with our study, psoriasis seems to be cleared more efficiently than AD in strictly steered intervention studies. Dawe at al. have shown even 100% clearance in psoriasis using NB-UVB, whereas others have shown for AD only moderate responses (29-31). Noteworthy the SAPASI and PO-SCORAD are not comparable. PASI and SAPASI measure visible signs, but SCORAD and PO-SCORAD involve subjective symptoms e.g. pruritus (12-14).

The global measures used in our study: the "global disease severity VAS", the "pruritus VAS" and DLQI measure the outcome globally and show a highly significant improvement. The results showed that NB-UVB phototherapy works also clinically expectedly. A clearance of 75% or more using SAPASI and PO-SCORAD was found in 50% of psoriasis patients, but only in 16% of AD patients. SAPASI and PO-SCORAD showed highly significant change in disease severity statistically. To our surprise, pruritus was equally frequent in both patient groups, although pruritus has earlier been shown to affect the HRQoL more in AD patients than in psoriasis patients (32).

NB-UVB phototherapy is indicated when topical treatments are not sufficient. Therefore, the severity of the skin condition is an important denominator when assessing the outcome. In our study the average severities of the skin conditions were either moderately severe or severe defined as DLQI > 10, SAPASI > 10 or PO-SCORAD > 40 (Table 1). The patients were thus high need patients and the outcome of NB-UVB can be judged as optimal in agreement with Patrizi et al. (33).

In this multi-center study, the mean cumulative NB-UVB dose was 16.4 J/cm^2 in psoriasis patients and 12.2 J/cm^2 in AD patients. A subset of patients used personal UV dosimeters, which measured a mean UVB dose of 47 SED in psoriasis and similarly 47 SED in AD. We have earlier assessed the UVB doses of a 2-week heliotherapy with similar dosimeters and saw a mean cumulative dose of 30 SED in psoriasis and 43 SED in AD patients (34). During a high UV season even higher UVB doses, such as 60 and 109 SED, have been demonstrated in heliotherapy (35). Thus, the cumulative UVB dose during NB-UVB phototherapy compares to that of a 2-week heliotherapy.

We were surprised of high frequency of erythema at some stages of therapy in 66% of psoriasis and 61% of AD patients. Definite burns were seen in 8% and 9% respectively. Mild erythema reactions were seen in 73% of psoriasis patients receiving NB-UVB in a strictly controlled randomized study, where the dosing was based on preceding Minimal Erythema Dose (MED) testing (36). However, the increments in that study were 30-40% initially differing from our moderate increments of 10–25%, and the treatment

was given twice a week. Diffey (2004) has shown using modeling that clearance of psoriasis is achieved faster using higher dosing (36). According to other studies, NB-UVB phototherapy functions at its best close to MED (31). To our knowledge, no such data is available for phototherapy of AD, and further studying is warranted.

MED testing is rarely performed preceding phototherapy in our country, and photo-testing devices may also be lacking on the site. Defining the skin photo-type without MED testing is a challenge (16,38-40). Therefore, the photo-types may not have been classified properly in the clinics explaining erythema reactions. In addition, there were skin photo-type I participants, which is a deviation of our national recommendation and must be discussed in our clinics. International guidelines suggest MED testing and using 70% of the MED as an initial dose (41). Increasing the use of MED testing could decrease erythema reactions. There are also technical tools available to predict UV dosing objectively (42). Due to increasing number of new medicines, the use of phototherapy has decreased and perhaps less emphasis is put on maintaining expertise.

The self-administered assessment tools fulfilled their task in this study. We were especially satisfied with the global VAS measures and DLQI showing respective outcome as the more laborious SAPASI and PO-SCORAD. To empower patients, the measures should be easy to calculate and interpret. Further studies with modifications of VAS are warranted in this purpose.

A 2-week heliotherapy has been shown to improve clinical signs and HRQoL of psoriasis and AD, and the improved HRQoL persisted in both patient groups for up to three months. Three months after heliotherapy, SAPASI remained decreased by 36% and PO-SCORAD by 40% (34). Autio et al. (2002) demonstrated a 45% decrease in SCORAD index 3 months after a 2-week heliotherapy (43). These results are comparable with the 42% SAPASI decrease and 41% PO-SCORAD decrease seen in the present study.

The costs of NB-UVB phototherapy were lower than in previous studies (17-19,44), probably because we included only one dermatologist's appointment to the calculations. Also, we did not register potential laboratory, pathology or hospitalization costs. Thus, our cost analysis represents the cost of an ideal NB-UVB phototherapy course and represents at its best the minimum cost.

The advantage of our study is that this was a real-life follow-up study, not just register data or a random questionnaire. A limitation of our study is that only few departments recruited the desired 25 patients per group. The low figures (Supplement 1) did not mean that there was a shortage of patients, but rather that there was not enough staff or time to complete the study in a busy clinic. In addition, the time cost was not transformed to monetary costs, and earlier studies have shown that the burden of phototherapy falls on the patient and employee, who both may pay marked time-related cost (45,46).

We were able to show that NB-UVB phototherapy works well in a normal clinical setting and both psoriasis and AD patients showed highly significant alleviation of their skin conditions and improvement of their HRQoL. The improved situation, as seen in disease scores, global measures and DLQI, was sustained in both patient groups for at least three months confirming that earlier research outcomes coincide with clinical outcomes. The direct costs of NB-UVB phototherapy are reasonable or even cheap as regards severity of the skin conditions, but the invisible indirect costs may alter this.

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REFERENCES

1. Rapp S R, Feldman S R, Exum M L, Fleischer A B, Reboussin D M. Psoriasis causes as much disability as other major medical diseases. J Am Acad Dermatol 1999: 41: 401-407.
2. Darne S, Leech S N, Taylor A E M. Narrowband ultraviolet B phototherapy in children with moderate-to-severe eczema: a comparative cohort study. Br J Dermatol 2015: 170: 150-156.
3. Mrowietz U, Chouela E N, Mallbris L, et al. Pruritus and quality of life in moderate to severe plaque psoriasis: post hoc explorative analysis from the PRISTINE study. J Eur Acad Dermatol Venereol 2015: 29: 1114-1120.
4. Gerritsen F M, Brouwer M W D, Limpens J, Spuls P I. Photo(chemo)therapy in the management of atopic dermatitis: an updated systematic review with implications for practice and research. Br J Dermatol 2014: 170: 501-513.
5. Al Robaee A A and Alzolibani A A. Narrowband ultraviolet B phototherapy improves the quality of life in patients with psoriasis. Saudi Med J 2011: 32: 603-606.
6. Pathirana D, Ormerod A D, Saiag P, et al. European S3-guidelines on the systemic treatment of psoriasis vulgaris. J Eur Acad Dermatol Venereol 2009: 23: 1-70.
7. Menter A, Korman N J, Elmets C A, et al. Guidelines of care for the management of psoriasis and psoriatic arthritis: section 5. Guidelines of care for the treatment of psoriasis with phototherapy and photochemotherapy. J Am Acad Dermatol 2010: 62: 114-135.
8. Mehta D and Lim H W. Ultraviolet B photherapy for psoriasis: review of practical guidelines. Am J Clin Dermatol 2016: 17: 125-133.
9. Tintle S, Shemer A, Suarez-Farinas M, et al. Reversal of atopic dermatitis with narrow-band UVB phototherapy and biomarkers for therapeutic response. J Allergy Clin Immunol 2011: 123: 583-593.
10. Fredriksson T and Pettersson U. Severe psoriasis – oral therapy with a new retinoid. Dermatologica 1978: 157: 238-244.
11. European Task Force on Atopic Dermatitis. Severity scoring of atopic dermatitis: the SCORAD index. Dermatology 1993: 186: 23-31.
12. Fleischer A B J, Rapp S R, Reboussin D M, Vanarthos J C, Feldman SR. Patient measurement of psoriasis disease severity with a structured instrument. J Invest Dermatol 1994: 102: 967-969.
13. Feldman S R, Fleischer A B, Reboussin D M, et al. The Self-Administered Psoriasis Area and Severity Index is valid and reliable. J Invest Dermatol 1996: 106: 183-186.
14. Stalder J, Barbarot S, Wollenberg A, et al. Patient-Oriented SCORAD (PO-SCORAD): a new self-assessment scale in atopic dermatitis validated in Europe. Allergy 2011: 66: 1114-1121.
15. Finlay A Y and Khan G K. Dermatology Life Quality Index (DLQI) – a simple practical measure for routine clinical use. Clin Exp Dermatol 1994: 19: 210-216.
16. Fitzpatrick T B. The validity and practicality of sun-reactive skin types I through IV. Arch Dermatol 1988: 124: 869-871.
17. Miller D W and Feldman S R. Cost-effectiveness of moderate-to-severe psoriasis treatment. Expert Opin Pharmacother 2006: 7: 157-167.
18. Beyer V and Wolverton S E. Recent trends in systemic psoriasis treatment costs. Arch Dermatol 2010: 146: 46-54.
19. Driessen R J, Bisschops L A, Adang E M, Evers A W, Van De Kerkhof P C, De Jong E M. The economic impact of high-need psoriasis in daily clinical practice before and after the introduction of biologics. Br J Dermatol 2010: 162: 1324-1329.
20. de Rie M A, de Hoop D, Jonsson L, Bakkers E J, Sorensen M. Pharmacoeconomic evaluation of calcipotriol (Daivonex/Dovonex) and UVB phototherapy in the treatment of psoriasis: a Markov model for The Netherlands. Dermatology 2001: 202: 38-43.
21. Yentzer B A, Gustafson C J, Feldman S R. Explicit and implicit copayments for phototherapy: examining the cost of commuting. Dermatol Online J 2013: 19: 18563.
22. Quintern L E, Furusawa Y, Fukutsu K, Holtschmidt H. Characterization and application of UV detector spore films: the sensitivity curve of a new detector system provides good similarity to

the action spectrum for UV-induced erythema in human skin. J Photochem Photobiol B 1997: 37: 158-166.
23. Erythemal reference action spectrum and standard erythemal dose. Commission Internationale de l'E´clairage, 1999.
24. Thieden E, Agren M S, Wulf H C. The wrist is a reliable body site for personal dosimetry of ultraviolet radiation. Photodermatol Photoimmunol Photomed 2000: 16: 57-61.
25. Ylianttila L, Huurto L, Visuri R, Jokela K. Development of quality assurance methods for ultraviolet phototherapy devices. Finnish Medicines Agency. Publication series 4/2005. Available from: www.fimea.fi/documents/160140/753095/19694_julkaisut_4_2005_UV_julkaisu_verkko_v2-rd.pdf.pdf.
26. Shikiar R, Bresnahan B W, Stone S P, Thompson C, Koo J, Revicki D A. Validity and reliability of patient-reported outcomes used in psoriasis: results from two randomized clinical trials. Health Qual Life Outcomes 2003: 1: 53.
27. Basra M K A, Fenech R, Gatt R M, Salek M S, Finlay A Y. The Dermatology Life Quality Index 1994-2007: a comprehensive review of validation data and clinical results. Br J Dermatol 2008: 159: 997-1035.
28. Katugampola R P, Lewis V J, Finlay A Y. The dermatology Life Quality Index: assessing the efficacy of biological therapies for psoriasis. Br J Dermatol 2007: 165: 945-995.
29. Hudson-Peacock M J, Diffey B L, Farr P M. Narrow-band UVB phototherapy for severe atopic dermatitis. Br J Dermatol 1996: 135: 332.
30. Dawe R S, Cameron H, Yule S, et al. A randomized controlled trial of narrowband ultraviolet B vs. bath-psoralen plus ultraviolet A photochemotherapy for psoriasis. Br J Dermatol 2003: 148: 1194-1204.
31. Berneburg M, Rocken M, Benedix F. Phototherapy with narrowband vs broadband UVB. Acta Derm Venereol 2005: 85: 98-108.
32. Ito K, Imafuku S, Nakayama J. Therapeutic preferences are different in psoriatic and atopic dermatitis patients: a questionnaire-based study. J Dermatol 2013: 40: 292-294.
33. Patrizi A, Raone B, Ravaioli G M. Management of atopic dermatitis: safety and efficacy of phototherapy. Clin Cosm Invest Dermatol 2015: 8: 511-520.
34. Karppinen T, Laine J-P, Kautiainen H, Pasternack R, Reunala T, Snellman E. Empowering heliotherapy in psoriasis and atopic dermatitis: an observational study of 186 subjects. Acta Derm Venereol 2017: 97: 255-257.
35. Vähävihu K, Ylianttila L, Salmelin R, et al. Heliotherapy improves vitamin D balance and atopic dermatitis. Br J Dermatol 2008: 158: 1323-1328.
36. Gordon P M, Diffey B L, Mattews J N S, Farr P M. A randomized comparison of narrow-band TL-01 phototherapy and PUVA photochemotherapy for psoriasis. J Am Acad Dermatol 1999: 1: 728-732.
37. Diffey B L. Towards optimal regimens for the UVB phototherapy of psoriasis: a mathematical model. Acta Derm Venereol 2004: 84: 259-264.
38. Hemmiki K and Snellman E. How fast are UV-dimers repaired in human skin DNA in situ? J Invest Dermatol 2002: 119: 700-702.
39. Hemminki K, Xu G, Kause L, Koulu L M, Zhao C, Jansen C T. Demonstration of UV-dimers in human skin DNA in situ 3 weeks after exposure. Carcinogenesis 2002: 23: 605-609.
40. Snellman E, Xu G, Pasanen P, Laihia J, Hemminki K. Correlation analysis of production and photoisomerization of epidermal urocanic acid versus induction and repair of DNA photoproducts in the human skin in situ. J Invest Dermatol 2002: 118: 893-895.
41. Nast A, Boehncke H, Mrowietz U, et al. German S3-guidelines on the treatment of psoriasis vulgaris (short version). Arch Dermatol Res 2012: 304: 87-113.
42. Wulf H C. Method and an apparatus for determining an individual's ability to stand exposure to ultraviolet radiation. US Patent 1989 4: 882 598 1-38.

43. Autio P, Komulainen P, Larni H M. Heliotherapy in atopic dermatitis: a prospective study on climatotherapy using SCORAD index. Acta Derm Venetol 2002: 82: 436-440.
44. Mustonen A, Leino M, Mattila K, Koulu L, Tuominen R. Treatment costs of psoriasis in a tertiary-level clinic. BMC Health Serv Res 2014: 14: 344.
45. Mustonen A, Mattila K, Leino M, Koulu L, Tuominen R. Psoriasis causes significant economic burden to patients. Dermatol Ther 2014: 4: 115-124.
46. Mustonen A, Mattila K, Leino M, Koulu L, Tuominen R. How much of the productivity losses among psoriasis patients are due to psoriasis. BMC Health Ser Res 2015: 15: 87.

	Baseline	Change from baseline	
	Mean (SD)	Δ After phototherapy Mean (95% CI)	Δ 3 months after phototherapy Mean (95% CI)
Psoriasis			
DLQI	10.1 (6.5)	-6.3 (-7.0 to -5.5)***	-3.8 (-4.6 to -2.9)***
SAPASI	11.7 (7.4)	-8.6 (-9.6 to -7.6)***	-4.9 (-6.0 to -3.8)***
VAS pruritus	4.4 (2.7)	-2.9 (-3.3 to -2.5)***	-1.4 (-1.9 to -1.0)***
VAS global	5.8 (2.2)	-3.3 (-3.7 to -3.0)***	-2.1 (-2.4 to -1.7)***
Atopic dermatitis			
DLQI	12.9 (6.0)	-8.1 (-9.0 to -7.1)***	-8.0 (-9.3 to -6.8)***
PO SCORAD	40.4 (14.3)	-18.9 (-21.4 to -16.4)***	-16.5 (-20.0 to -12.9)***
VAS pruritus	5.2 (2.4)	-3.1 (-3.6 to -2.7)***	-2.5 (-3.1 to -1.9)***
VAS global	5.1 (2.1)	-2.9 (-3.3 to -2.5)***	-2.6 (-3.1 to -2.0)***

	Psoriasis (n = 207)	Atopic dermatitis (n = 144)	p -value
Initial NB-UVB radiation dose (J/cm^2)	0.21 ± 0.04*	0.19 ± 0.04**	0.137
Cumulative NB-UVB radiation dose (J/cm^2)	16.4 ± 8.3 (3.5 – 48.5)	12.2 ± 5.5 (3.0 – 29.1)	< 0.001
Number of exposures	18 ± 4 (7 – 30)	17 ± 4 (8 – 30)	0.028
Duration of phototherapy (weeks)	7.7 ± 3.4	7.3 ± 2.5	0.119
Exposures per week 2/3/4	48/157/1	42/100/0	0.26
Patients with erythema	136	88	0.44
Patients with skin burn	17	13	0.92
* Based on 28 psoriasis patients in Päijät-Häme Central Hospital			
** Based on 27 AD patients in Päijät-Häme Central Hospital