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Original Research

Photometric and clinical assessment of localized UVB phototherapy systems for the high-dosage treatment of stable plaque psoriasis

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BACKGROUND: **Ultraviolet-B (UVB) light sources are widely used for the safe and effective treatment of inflammatory skin conditions. The recent commercial introduction of fiber-coupled UVB phototherapy systems facilitates the selective exposure and treatment of localized psoriasis plaques while permitting the safe use of high-dosage treatments.**
OBJECTIVE: **In this study, the performance characteristics and clinical outcome of psoriasis treatments were assessed when using two technologically distinct sources of high-intensity, fiber-optically delivered therapeutic UVB.**
METHODS: **A pulsed, monochromatic 308 nm excimer laser and a continuous-wave, incoherent UVB light source were compared using photosensitive recording papers, images captured with a CCD camera, and on the healthy and lesional skin of ten psoriasis patients.**
RESULTS: **Beam profile analyses and minimal erythema dose (MED) test spots revealed distinct energy distribution patterns from the two devices. The Guassian-type laser beam energy distribution complicated MED determinations, whereas skin exposed to light from the incoherent UVB system developed a more uniform erythema. Both systems cleared the treated psoriasis plaques equivalently, requiring no more than two to five weeks of high-dose treatments.**
CONCLUSION: **When used at equally erythemogenic high doses, both systems produced rapid plaque clearance with minimal side effects. Unlike conventional phototherapy, localized UVB minimizes exposure to the healthy skin, making it suitable for patients with mild to moderate psoriasis, individuals with recalcitrant plaques and for the successful treatment of lesions occurring on most body sites.** *J Cosmetic & Laser Ther* 2003; **5**: 101–106

Introduction

Although UVB phototherapy is safe and highly beneficial for psoriasis, its use has not traditionally extended to the vast majority of patients with mild to moderate disease. For patients with localized plaque-type psoriasis, it is undesirable to expose large portions of their body to potentially damaging UVB. These patients often rely on topical medications that are cumbersome, messy, less efficacious, and sometimes accompanied by undesirable side effects.[1]

The recent development of targeted UVB phototherapy systems addresses a previously unmet need within the dermatology community. These devices selectively deliver therapeutic light through flexible fiber-optic light guides to

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diseased skin. Reports in the medical literature have documented the successful use of lesion-targeted phototherapy for the treatment of various UV-responsive dermatoses.[2–7] For psoriasis patients and their physicians, the advantages of localized phototherapy are numerous. Fiber-delivered UVB can be used to treat virtually all body surface areas including the intertriginous sites.[8] A focused spot of manually directed phototherapeutic light limits UVB exposure to the desired locations while sparing the healthy skin. Consequently, targeted phototherapy systems are expected to be safer than traditional lightboxes. Furthermore, since thick and scaly psoriasis plaques tolerate higher UVB exposure doses than the normal skin, clearances can be achieved in substantially fewer treatment sessions relative to conventional lightbox phototherapy.[3,5,9–11]

Despite an extensive body of medical literature demonstrating the safety and effectiveness of UVB phototherapy for the treatment of psoriasis,[12–14] dermatologists have infrequently administered high-dosage[15] or fiber-delivered treatments. Until recently, lesion-targeted UVB treatment systems were largely unavailable to the medical community. The introduction of high-intensity, incoherent UVB light sources and 308 nm excimer lasers provides a valuable addition to the armamentarium of phototherapy equipment. For the first time, highly effective and safe UVB phototherapy has become an appropriate treatment option for patients with limited skin disease. This study was designed to characterize and compare the performance of fiber-coupled incoherent UVB and excimer laser light sources for high dose monotherapy of stable plaque-type psoriasis.

Methods

The two phototherapy systems evaluated in this study were an incoherent, continuous-wave UVB light source (BClear™, Lumenis Inc., Santa Clara, CA) with a peak irradiance that falls between 311 and 315 nm, and a 308-nm excimer laser device (Xtrac™, PhotoMedex, Radnor, PA) that generates repeating 20–40 ns pulses. The spectral irradiances of these two systems are shown (Figure 1). Spatial beam profiles from the two systems were evaluated using type PS oscillograph recording papers, a CCD camera with image recording equipment and MED test spot responses on healthy, untanned skin.

Ten adult patients with skin phototypes II–V were screened and sequentially enrolled in an unblinded, prospective study to compare the safety and effectiveness of the targeted UVB phototherapy systems for the treatment of stable plaque-type psoriasis. All evaluations and treatments were conducted at the Center for Dermatology and Laser Surgery, Sacramento, CA after obtaining informed consent. Treatments began after first determining the MED for both devices on each patient's lower back or upper buttocks. MED test spots consisted of six incremental doses from each device and were read 20–28 hours following exposure. Initial treatment fluences were two to five multiples of the MED depending on the condition and anatomical location of the psoriasis plaque. Patients returned one to three times per week for up to 16 treatments. Plaques that achieved at least 75% improvement before the twelfth session received up to four additional maintenance treatments. Emollients were frequently applied to the plaques immediately prior to treatment for improved transmission of UVB.

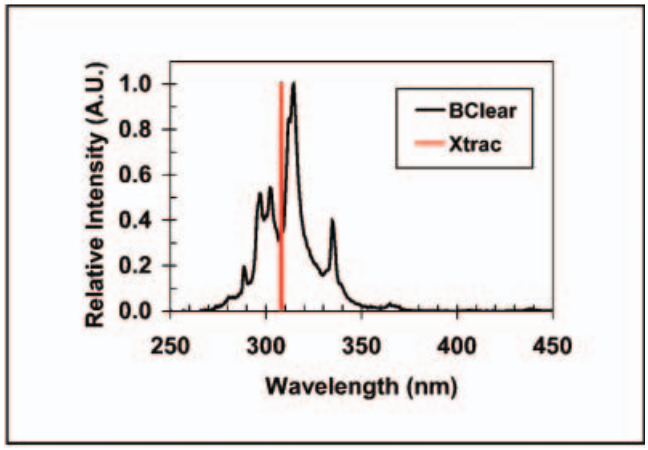

Figure 1
Spectral irradiance of the BClear and Xtrac systems. The relative intensity in arbitrary units (A.U.) of BClear light at each wavelength between 250 and 450 nm is normalized to the peak emission at 314 nm. Xtrac irradiance is monochromatic at 308 nm.

For each enrolled patient, plaques, often occurring at bilaterally symmetrical body sites and, judged to be similar at baseline were designated to receive an equally erythemogenic dose from either the BClear or the Xtrac. Lower doses were sometimes used when the plaques thinned, but treatments were always administered at an equally erythemogenic dose from the two devices. Every patient also had an untreated control plaque that was observed throughout the course of the study. At baseline and prior to each treatment session, plaques were photographed and evaluated for erythema, induration and scale using 0–4 -point scales. A modified, psoriasis severity index (PSI), equal to the sum of these individual scores, and photographs were used to track and record disease progress at each site. Patients did not receive additional medications and were advised regarding sun avoidance and protection. Adverse events and patient satisfaction were also noted throughout the course of the study.

Results

The irradiated spot shapes and sizes from the targeted UVB phototherapy systems were compared using UV sensitive oscillograph recording papers. For each of the radiant exposure doses tested, photodeveloped papers revealed that BClear light is emitted across a 16×16-mm square handpiece tip and the Xtrac laser beam measures roughly 18×18-mm in diameter at the treatment plane (Figure 2). While the BClear system exhibited a uniform output, the peak energy intensity of the Xtrac appeared to reside in the center of the laser beam and decrease toward the edges.

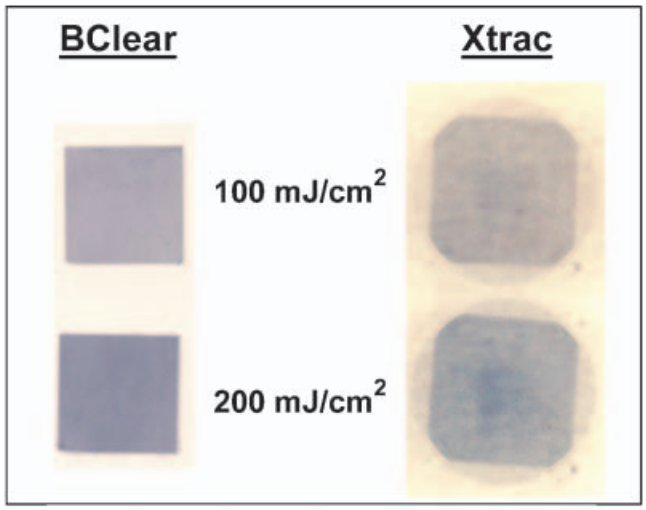

Figure 2
Beam profile analysis of light emitted at the BClear and Xtrac handpiece tips. Photosensitive Type PS oscillograph recording paper documents the beam profiles of BClear or Xtrac light at the indicated fluences. The handpiece tips were positioned flat and held in direct contact with the sheets of paper during exposure. The scanned images are the actual tip sizes.

A more sensitive, semi-quantitative three-dimensional beam profile recording was made using a CCD camera and image capturing board. The fiber-coupled BClear output resembled a top-hat beam profile with few irregularities while the Xtrac laser beam approximated a Gaussian-curve energy distribution with peak intensity in the middle of the beam roughly 1.3 to 1.8 times greater than the intensity at the borders (Figure 3). In accordance with other reports from the medical literature, the non-uniform laser beam made 24-hour MED test spots difficult to interpret with a central macule of more intense erythema (Figure 4).[10,11] With the BClear, the lowest dose test spot to exhibit well-demarcated, minimal erythema was easy to discern. On the unaffected skin of the ten enrolled participants the MED for BClear UVB was 186 ± 50 mJ/cm^2 and for the 308 nm excimer laser the MED was 235 ± 58 mJ/cm^2 (mean $\pm$ SD). Psoriasis treatments were generally well tolerated with only minor adverse reactions comparable to moderate sunburns. Side effects included erythema, occasional blisters, epidermal erosions and transient hyperpigmentation. In some instances, MED test spot ambiguities led to an overly aggressive initial dosing of plaques with the Xtrac laser. Blisters and erosions were seen with a four-fold higher incidence when compared to the BClear system (data not shown). Other adverse reactions presented with similar frequency and severity from the two UVB phototherapy devices.

For the treated plaques, the rate of disease symptom improvement was indistinguishable whether using the (MED dose normalized) incoherent UVB system or the laser device (Figure 5). The total number of treatments administered to the ten enrolled subjects was 12.0 ± 2.3 (mean $\pm$ SD). Psoriasis improvement was often evident after one or two treatments and was particularly apparent on plaques that were less severe at baseline (Figure 6). In most cases, a 50% reduction in PSI scores was achieved

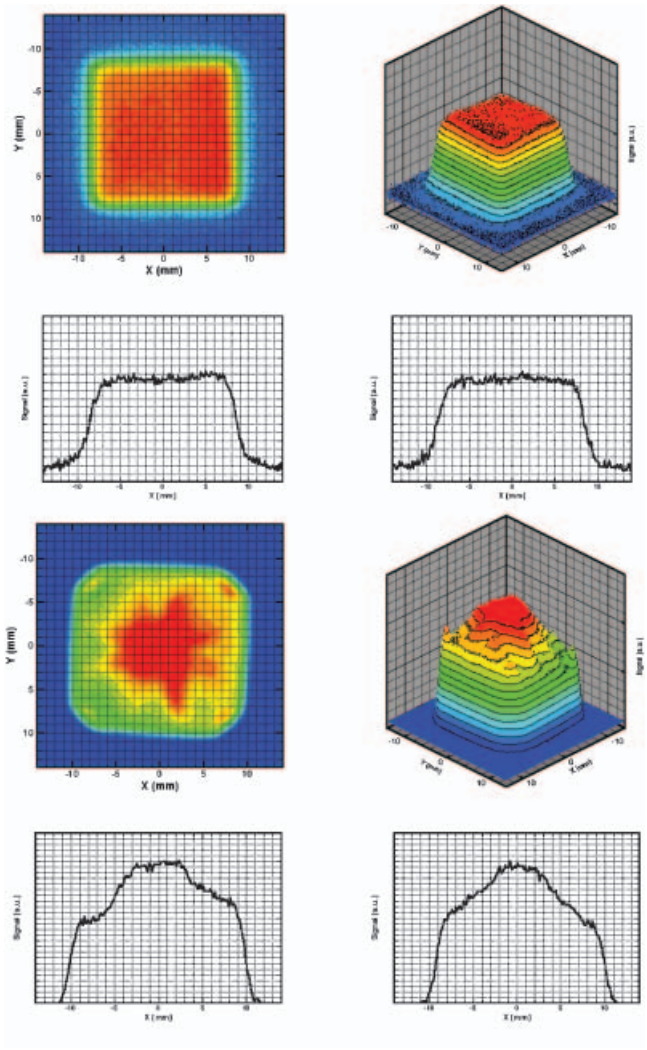

Figure 3
Spatial profile images of the treatment beams from the BClear (top) and Xtrac (bottom). A diffusion screen was placed at the treatment plane and the emitted beams were recorded using a CCD camera and image capturing board.

within 2–5 weeks of initiating treatments. Plaques cleared from all anatomical locations treated including the elbows, knees, legs, trunk, and hands (Figure 7). Eight of ten patients exhibited substantial plaque clearance. At the two-month post-treatment follow-up examination, all treated plaques that achieved clearance remained in remission and those that had improved without clearance remained stable without relapse. The remaining two patients who did not respond favorably to UVB treatment each had unstable or treatment unresponsive disease and developed new lesions during the course of the investigation.

Discussion

Fiber-delivered incoherent light and excimer laser systems provide safe and effective high-dosage UVB phototherapy treatments for localized plaque psoriasis. With localized UVB, a greater percentage of psoriasis patients achieve substantial improvement and fewer treatments are required than using non-targeted light sources.[16] The clinical

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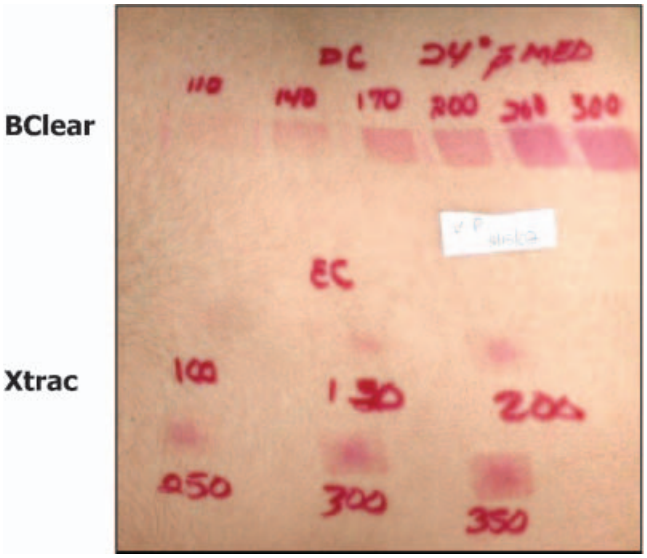

Figure 4
Photograph of MED test spots on the back 24 hours following exposure. BClear test spots are documented on the top and Xtrac test spots are on the bottom of the photograph. The radiant exposure doses tested (in mJ/cm^2) are indicated in red ink.

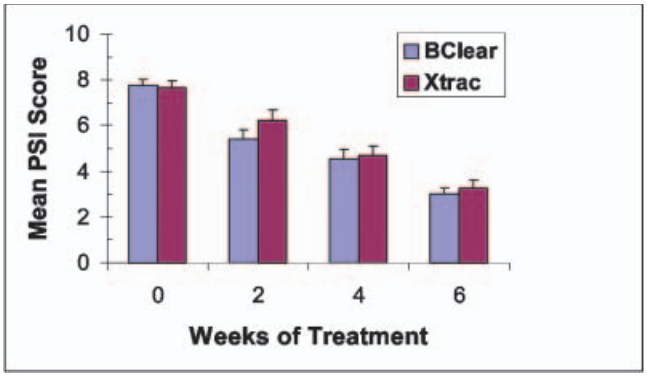

Figure 5
Time course of psoriasis plaque clearance using high-dosage localized UVB phototherapy. The psoriasis severity index (PSI; mean ± SEM) scores for all plaques of responding patients were calculated at baseline and following the indicated weeks of treatment using the BClear and the Xtrac devices.

performance of the BClear and Xtrac phototherapy devices was equivalent with regard to the rate and extent of plaque clearance. Individual treatment doses as large as 5 MED multiples were well tolerated with only minimal complications. Side effects were temporary and included erythema, blisters, epidermal erosions and hyperpigmentation. Patients encountered no discomfort during treatments and were generally satisfied with their outcomes. As with conventional lightbox treatments, localized UVB phototherapy can induce psoriasis remissions that extend for several months to years.[5,8,11,17,18]

Although UVB excimer lasers generate rapid pulses of short duration, DNA damage, T-cell apoptosis and psoriasis clearance each occur independently of pulse frequency and intensity.[19,20] These biological activities are strictly dependent on radiant exposure and wavelength.[21]

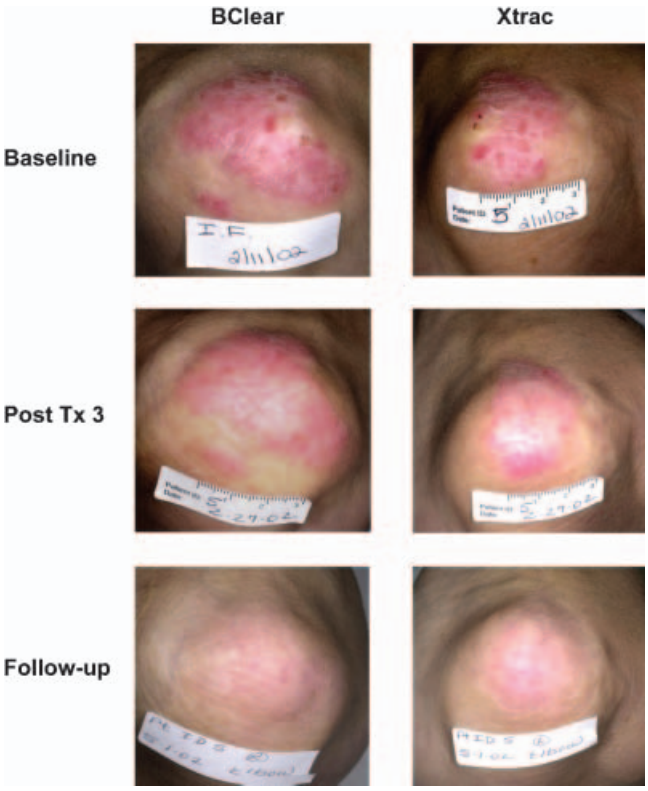

Figure 6
Elbow plaques at baseline, after three localized high-dosage UVB treatments administered with the indicated devices and at the one-month follow-up examination.

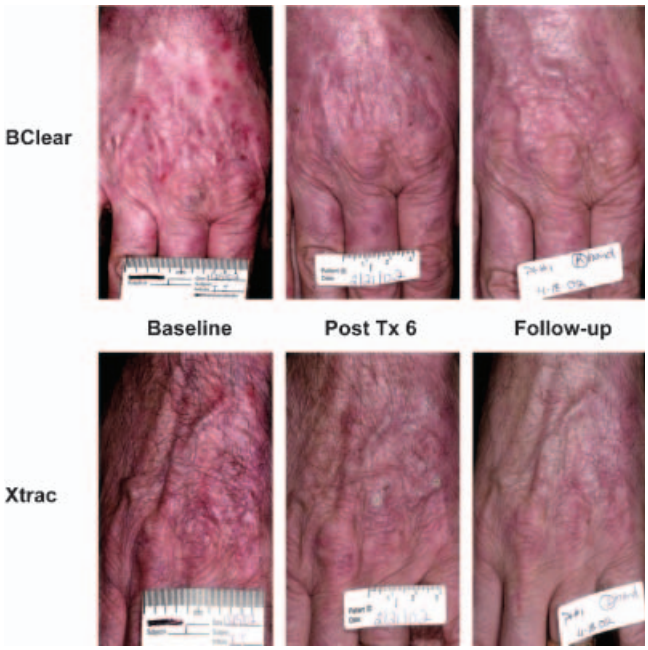

Figure 7
Hand psoriasis before treatment, after six targeted high-dosage UVB treatments administered with the indicated devices and at the two-month post-treatment follow-up examination.

Taking into account the action spectrum for the phototherapy of psoriasis, the BClear spectral irradiance is calculated to be slightly more effective at clearing psoriasis than an equivalent

exposure dose from monochromatic 308 nm sources (data not shown). Furthermore, the peak BClear output at 311–315 nm is predicted to penetrate more deeply into the skin than Xtrac emitted light.[22,23] In clinical practice, MED normalized radiant exposures led to equivalent clearances from the two localized UVB treatment devices.

In order to maximize therapeutic effectiveness and minimize the risk of side effects, the irradiance of phototherapy systems should be evenly distributed across all exposed surface areas.[24] The consequences of an irregular energy distribution pattern of emitted UVB light are increased side effects and reduced efficacy. The ''hot-spot'' in the center of the Xtrac laser beam resulted in the formation of numerous blisters and epidermal erosions on treatment naïve high-dosage targeted plaques. Although the skin healed without scarring, these complications are undesirable to patients and may require the postponement or additional care during subsequent treatment visits. Scanning the target plaques with multiple fractional dose passes can be used to enhance the uniformity of treatment dosimetry. One to three treatments per week were sufficient to substantially improve the vast majority of treated patients regardless of the targeted UVB phototherapy system used. Disease clearance occurred most quickly when thin plaques were treated at high fluences, often requiring no more than four to eight treatments. These observations are consistent with the experiences of other investigators.[3,5,9]

Lesion-targeted delivery of high-dosage phototherapy accelerates the clearance of plaque psoriasis, thus requiring substantially fewer treatments than conventional phototherapy. Other advantages of localized UVB phototherapy include convenience and improved patient compliance. In this regard, patients are not required to undress or take special precautions to limit exposure to the healthy skin. These innovative, localized treatment devices are suitable for the vast majority of psoriasis patients who have skin disease limited to no more than 10–20% of their body surface area. Patients with plaques recalcitrant to low-dosage exposures and those with lesions in the skin folds are also likely to benefit.[5,8] The BClear and Xtrac devices have also received U.S. FDA clearance to market for the treatment of vitiligo and atopic dermatitis.

The promising clinical results and large number of responsive skin conditions for localized UVB may help reverse the trend toward declining utilization of phototherapy in the U.S.[25] Phototherapy used in conjunction with topical agents frequently results in rapid, long lasting and enhanced psoriasis clearing that is dose sparing.[1] Preliminary evidence suggests that plaques continuing to receive topical medications can be fully cleared after two or three BClear treatments (data not shown). Clinical investigations are currently underway to establish the optimal treatment parameters for skin disease patients receiving high-intensity UVB in combination with other therapies.

References

1. Lebwohl M Ali S. Treatment of psoriasis. Part 1. Topical therapy and phototherapy. *J Am Acad Dermatol* 2001; **45**: 487–98.
2. Plewig G Hofmann C Braun-Falco O et al. A new apparatus for the delivery of high intensity UVA and UVA + UVB irradiation, and some dermatological applications. *Br J Dermatol* 1978; **98**: 15–24.
3. Bonis B Kemeny L Dobozy et al. 308 nm UVB excimer laser for psoriasis. *Lancet* 1997; **350**: 1522.
4. Lotti TM Menchini G Andreassi L. UV-B radiation microphototherapy. An elective treatment for segmental vitiligo. *J Eur Acad Dermatol Venereol* 1999; **13**: 102–8.
5. Asawanonda P Anderson RR Chang Y Taylor CR. 308-nm excimer laser for the treatment of psoriasis: a dose-response study. *Arch Dermatol* 2000; **136**: 619–24.
6. Baltas E Nagy P Bonis B et al. Repigmentation of localized vitiligo with the xenon chloride laser. *Br J Dermatol* 2001; **144**: 1266–7.
7. Friedman PM Geronemus RG. Use of the 308-nm excimer laser for postresurfacing leukoderma. *Arch Dermatol* 2001; **137**: 824–5.
8. Mafong EA Friedman PM Kauvar AN et al. Treatment of inverse psoriasis with the 308 nm excimer laser. *Dermatol Surg* 2002; **28**: 530–2.
9. Feldman SR Mellen BG Housman TS et al. Efficacy of the 308-nm excimer laser for treatment of psoriasis: results of a multicenter study. *J Am Acad Dermatol* 2002; **46**: 900–6.
10. Trehan M Taylor CR. High-dose 308-nm excimer laser for the treatment of psoriasis. *J Am Acad Dermatol* 2002; **46**: 732–7.
11. Trehan M Taylor CR. Medium-dose 308-nm excimer laser for the treatment of psoriasis. *J Am Acad Dermatol* 2002; **47**: 701–8.
12. Adrian RM Parrish JA Momtaz TK Karlin MJ. Outpatient phototherapy for psoriasis. *Arch Dermatol* 1981; **117**: 623–6.
13. Pittelkow MR Perry HO Muller SA et al. Skin cancer in patients with psoriasis treated with coal tar. A 25-year follow-up study. *Arch Dermatol* 1981; **117**: 465–8.
14. Larko O Swanbeck G. Is UVB treatment of psoriasis safe? A study of extensively UVB-treated psoriasis patients compared with a matched control group. *Acta Derm Venereol* 1982; **62**: 507–12.
15. Speight EL Farr PM. Erythemal and therapeutic response of psoriasis to PUVA using high-dose UVA. *Br J Dermatol* 1994; **131**: 667–72.
16. Rodewald EJ Housman TS Mellen BG Feldman SR. The efficacy of 308 nm laser treatment of psoriasis compared to historical controls. *Dermatol Online J* 2001; **7**: 4.
17. Koo J Lebwohl M. Duration of remission of psoriasis therapies. *J Am Acad Dermatol* 1999; **41**: 51–9.
18. Kemeny L Bonis B Dobozy A et al. 308-nm excimer laser therapy for psoriasis. *Arch Dermatol* 2001; **137**: 95–96.
19. Novak Z Bonis B Baltas E et al. Xenon chloride ultraviolet B laser is more effective in treating psoriasis and in inducing T-cell apoptosis than narrow-band ultraviolet B. *J Photochem Photobiol B* 2002; **67**: 32–8.
20. Chilbert MA Peak MJ Peak JG et al. Effects of intensity and fluence upon DNA single-strand breaks induced by excimer laser radiation. *Photochem Photobiol* 1988; **47**: 523–5.
21. Parrish JA Jaenicke KF. Action spectrum for phototherapy of psoriasis. *J Invest Dermatol* 1981; **76**: 359–62.

22. Anderson RR Parrish JA. The optics of human skin. *J Invest Dermatol* 1981; **77**: 13–9.
23. Bruls WA Slaper H van der Leun JC Berrens L. Transmission of human epidermis and stratum corneum as a function of thickness in the ultraviolet and visible wavelengths. *Photochem Photobiol* 1984; **40**: 485–94.
24. Snow JL Muller SA. Surface dosimetry in phototherapy: comparison of three ultraviolet B lamps used in the treatment of psoriasis. *Br J Dermatol* 1996; **135**: 949–54.
25. Housman TS Rohrback JM Fleischer AB, Jr Feldman SR. Phototherapy utilization for psoriasis is declining in the United States. *J Am Acad Dermatol* 2002; **46**: 557–9.