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CONSENSUS STATEMENT

Narrowband UV-B, Monochromatic Excimer Laser, and Photodynamic Therapy in Psoriasis: A Consensus Statement of the Spanish Psoriasis Group

J.M. Carrascosa,[a,*] J.L. López-Estebaranz,[b] G. Carretero,[c] E. Daudén,[d] C. Ferrándiz,[a] D. Vidal,[e] I. Belinchón,[f] M. Sánchez-Regaña,[g] L. Puig,[h] Psoriasis Group of the Spanish Academy of Dermatology and Venereology

[a]*Servicio de Dermatología, Hospital Universitari Germans Trias i Pujol, Universitat Autònoma de Barcelona (UAB), Badalona, Spain*
[b]*Servicio de Dermatología, Hospital Fundación de Alcorcón, Alcorcón, Madrid, Spain*
[c]*Unidad de Dermatología, Hospital General Universitario de Gran Canaria Dr. Negrín, Las Palmas de Gran Canaria, Spain*
[d]*Servicio de Dermatología, Hospital Universitario de La Princesa, Madrid, Spain*
[e]*Servicio de Dermatología, Hospital Sant Joan Despí Moisés Broggi, Sant Joan Despí, Barcelona, Spain*
[f]*Sección de Dermatología, Hospital General Universitario de Alicante, Alicante, Spain*
[g]*Servicio de Dermatología, Hospital Universitario Sagrado Corazón, Barcelona, Spain*
[h]*Servicio de Dermatología, Hospital de la Santa Creu i Sant Pau, Universidad Autónoma de Barcelona, Barcelona, Spain*

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Abstract Novel treatment strategies and new information concerning the management of moderate to severe psoriasis justify a reassessment of the role of the classic therapies in this setting. This consensus statement evaluates narrowband UV-B therapy, which is currently considered the phototherapy option of choice in psoriasis because of its risk-to-benefit ratio. The role of excimer laser and photodynamic therapies are also discussed. These targeted therapies are still only available in a small number of centers in Spain and are used principally in the treatment of localized and recalcitrant forms of psoriasis. We discuss the efficacy and safety of phototherapy as well as treatment regimens, combination therapy, and clinical considerations relating to the characteristics of the patient or the disease.

*Corresponding author.
E-mail address: jmcarrascosac@hotmail.com (J.M. Carrascosa).

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PALABRAS CLAVE
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Excímero

Documento de consenso de fototerapia en psoriasis del Grupo Español de Psoriasis: ultravioleta B de banda estrecha (UVBBE), láser y fuentes monocromáticas de excímeros y terapia fotodinámica

Resumen Los nuevos conocimientos y estrategias terapéuticas y de manejo de la psoriasis moderada y grave justifican la reevaluación del papel de los tratamientos clásicos en el manejo de estas formas de la enfermedad. En el presente documento se lleva a cabo la evaluación de la terapia ultravioleta B de banda estrecha (UVBBE) considerada en la actualidad, por su relación entre riesgo y beneficio, como la de primera elección en la fototerapia de la psoriasis. Por otra parte, se ha revisado y evaluado la terapia con sistemas y láseres de excímeros y la terapia fotodinámica en la psoriasis. El uso de estas terapias localizadas, aún limitado a pocos centros a escala nacional, constituye una alternativa terapéutica fundamentalmente en formas limitadas y recalcitrantes de psoriasis. En el siguiente documento se evalúan el perfil de eficacia, la seguridad, los esquemas terapéuticos, el tratamiento combinado y diversas consideraciones clínicas en función del perfil del paciente o de las características de la enfermedad.

Introduction

In recent years, there has been a qualitative improvement in the management of moderate to severe psoriasis as a result not only of the introduction of new types of therapy, such as the biologic drugs, but also of the creation of specialized working groups and more standardization and rigor in patient follow-up accompanied by improvements in the design and assessment of treatment studies.[1] In this context, it is useful to reassess the role of the classic therapies in the management of the moderate to severe forms of this skin disease.

This consensus document evaluates narrowband UV-B therapy, which is currently considered the phototherapy option of choice in psoriasis because of its risk-to-benefit ratio. We also review the advantages and drawbacks of other phototherapies that have only recently been used to treat psoriasis, such as laser and nonlaser excimer light systems and photodynamic therapy.

In addition, we provide an update on the efficacy of each of these therapeutic options, the indications and contraindications for their use, patient selection, combination therapy, and clinical considerations relating to the characteristics of the patient and the disease.

Method

This consensus statement was drafted by a group of dermatologists with particular expertise in the use of phototherapy to treat moderate to severe psoriasis. All are members of the Spanish Psoriasis Group of the Spanish Academy of Dermatology and Venereology (AEDV). The process for drafting the document included a review of earlier guidelines drawn up by the same group, a comprehensive review of the literature in the MEDLINE database and the Cochrane Library, and an analysis of the clinical experience of the members of the Spanish Psoriasis Group. This first draft was then reviewed by all the members of the group and amended when consensus was reached. Insofar as was possible, the resulting conclusions and recommendations were then classified according to established criteria (Table 1).[2] The results of future studies may make it necessary to reconsider the conclusions and recommendations in this statement. The present document was drawn up to help dermatologists in the management of moderate to severe psoriasis and is not intended to serve as a strict treatment guideline. Decisions concerning treatment must always be taken on a case-by-case basis with the sole aim of benefitting the patient.

Narrowband UV-B Therapy

Introduction

Narrowband UV-B therapy is based on the use of UV-B radiation restricted to a narrow spectral emission band around 311 nm, the wavelength that has been shown by experimental studies to be the most effective in the treatment of psoriasis. Narrowband UV-B devices eliminate

Table 1 Levels of Evidence

1. The therapy is supported by a meta-analysis that includes at least 1 double-blind randomized trial of high quality (sample size calculation, flow diagram, intention-to-treat analysis, and a sufficiently large sample size) with clear results, or several high quality studies with consistent results.
2. The therapy is supported by a high quality study or several of lower quality or nonrandomized studies, case-control, or cohort studies with consistent results.
3. The therapy is supported by a lower quality study or by noncomparative studies with consistent results.
4. Scant or unsystematic empirical evidence (includes expert opinion articles).

Table 2 Summary of Information on the Use of Narrowband UV-B Therapy

1. Indication: moderate to severe plaque psoriasis not controlled by topical therapies
2. Approval: over 20 years of clinical experience
3. Regimen: initial dose according to skin phototype or the MED (between 35% and 70% of the MED). Subsequent dose increases of 10% to 40% using erythema as a reference
4. Response: appears after 2-3 weeks (8-10 sessions)
5. Short-term efficacy: only a few studies have used the PASI. PASI 75 in 40%-80% around week 8
6. Long-term efficacy: not designed for long-term use
7. Contraindications: photosensitivity disorders triggered by UV-B radiation. Diseases associated with defective DNA repair, such as xeroderma pigmentosum. The desirability of treatment should be carefully evaluated in patients with a history of melanoma, multiple dysplastic nevi, or nonmelanoma skin cancer
8. Adverse reactions: erythema, usually well tolerated, occurs in up to 20%-50% of patients at some time during treatment depending on the regimen used (dose should be reduced). Xerosis and pruritus. Actinic damage in the long term. Potential increase in risk of cancer—although this has not been demonstrated—in patients who receive high cumulative doses
9. Baseline monitoring: skin examination to rule out the presence of malignant or premalignant lesions. A specific medical history targeting episodes of photosensitivity. Assessment of the medications the patient is taking
10. Ongoing monitoring: regular assessment (every 2 to 3 weeks) of tolerance and efficacy. Complete skin examination in patients with more than 200 treatments
11. Other considerations
    - Can be administered to children, but particular care should be taken to limit the cumulative dose
    - Can be administered to pregnant women and nursing mothers
    - Is a first-line treatment in patients with chronic moderate to severe psoriasis and in patients with a history of visceral or hematologic tumors
    - A higher incidence of erythema has been reported in older and obese patients. In such patients, use caution when increasing the dose
    - The drug of choice for combination treatmen is acitretin, in general at a dose of 10 to 25 mg/d. Since no evidence on the safety of combining this type of phototherapy with biologic agents is currently available, this option should be used sparingly in isolated cases and for short periods
    - No effect on joint disease. Other treatments should be used to address this problem when necessary
    - There is little evidence to support the use of narrowband UV-B therapy in the treatment of localized forms of psoriasis, although it may be a good alternative if the device used is specifically designed for the purpose

Abbreviations: MED, minimal erythema dose; PASI, Psoriasis Area Severity Index.

wavelengths below 300 nm, which have considerable erythemogenic potential but are not therapeutic.[3,4]

The complex mechanism of action of phototherapy involves the inhibition of epidermal proliferation combined with an anti-inflammatory effect secondary to lymphocyte apoptosis, in addition to diverse immunomodulatory effects that include inhibition of the activity of antigen-presenting cells, a shift from a type 1 helper T (T_H1) phenotype to a T_H2 phenotype, and the induction of regulatory T cells.[5,6] Recent studies have shown that narrowband UV-B therapy also inhibits the T_H17 cell subpopulation and has antiangiogenic effects.[7]

Short-Term Efficacy

Narrowband UV-B therapy is of proven efficacy in the short-term treatment of moderate and extensive plaque psoriasis.[8-11]

More effective and less erythemogenic than broadband UV-B therapy (evidence level 2),[12] narrowband UV-B also offers the possibility of a response similar to that obtained with psoralen-UV-A (PUVA) therapy in most patients, although it is less effective in certain areas (the legs, for example) and in patients with a higher Psoriasis Area Severity Index (PASI). Periods of remission are in general shorter after narrowband UV-B than after PUVA (evidence level 2).[13,14]

Since many of the studies of narrowband UV-B therapy were carried out in the 1990s, very few of them used the efficacy parameters, such as the PASI or the affected body surface area, which are needed to facilitate comparison with other therapies. In general, a satisfactory response, that is, a reduction of between 75% and 90% in the PASI (PASI 75 to PASI 90) can be expected in 40% to 80% of patients following treatment (6-8 weeks with 18-24 sessions administered 3 times a week) (Table 2).[15-17] Response usually appears during the second week (after 6-8 sessions) and peaks between weeks 6 and 8 (after 20-24 sessions). Owing to the study design limitations mentioned above, it was impossible to calculate the parameters usually used in meta-analyses, such as the number needed to treat, which in this case would be the number of patients that had to be treated to achieve a satisfactory outcome (a PASI 75 for example). However, in an estimate based on controlled trials and using results from other studies as the placebo group for reference, it was estimated that the number needed to treat with narrowband UV-B therapy would be between 1.1 and 2.3 with a placebo response of 3% and between 1.4 and 4.4 at the upper limit of a placebo response of 19%.[18,19]

Table 3 Situations in Which the Risk-to-Benefit Ratio of Narrowband UV-B Therapy Should Be Evaluated Before Starting Treatment

Age under 10 y
History of nonmelanoma skin cancer
History of melanoma
Presence of premalignant skin lesions
Concomitant immunosuppressive therapy
Skin phototype I
Obesity (greater likelihood of erythema)
Concomitant therapy that may be associated with phototoxic or photoallergic reactions

Long-Term Efficacy

Narrowband UV-B therapy is not indicated for the long-term control of psoriasis. Treatment should be discontinued once a complete or almost complete response is obtained. Some 30% to 60% of patients will experience a relapse within 12 weeks of completion of the treatment cycle, and the benefits will persist beyond 6 months in only 10% to 25% of patients.[14,20]

The routine use of maintenance regimens is not indicated. While some authors have suggested that such regimens could slightly improve the likelihood of a longer period of remission, the disadvantages associated with prolonging treatment and the long-term adverse effects of the cumulative dose should not be disregarded.[20]

Considerations in Clinical Management

Narrowband UV-B is a safe and effective treatment for moderate to severe psoriasis in most patients and represents a good alternative for many patients for whom other treatments are contraindicated or associated with excessive risk.[21] The only absolute contraindications are comorbid dermatoses associated with photosensitivity to UV-B light, such as subacute lupus erythematosus, porphyrias, solar urticaria, and diseases associated with defective DNA repair, such as xeroderma pigmentosum. However, each case should be assessed individually prior to treatment, and the physician should discuss with the patient all the situations in which the risk-to-benefit ratio of treatment must be carefully evaluated (Tables 3 and 4). Blood tests are not necessary before treatment, except when the clinical picture is suggestive of subacute lupus erythematosus. The only ongoing monitoring required is assessment of efficacy and tolerance during treatment and an annual skin examination in patients who have received excessive doses (see below for more information on long-term adverse effects and carcinogenesis). For the patient, travelling to a hospital for phototherapy involves considerable inconvenience in terms of both time spent and the cost of travel. The patient's availability to attend appointments should be checked before treatment is started. Home phototherapy has been used successfully in several European countries, but this option is unavailable in most parts of Spain.

Treatment Regimen

An ideal treatment regimen has not been established for narrowband UV-B therapy, probably because of the wide

Table 4 Individualized Considerations Prior to Start of Treatment With Narrowband UV-B Therapy

Assessment of therapeutic indications and available alternatives
Complete medical history to identify anything that might represent a problem or contraindicate treatment
Patients should be provided with a full explanation and a written information sheet on the advantages and disadvantages of treatment. Check that the patient can attend the treatment sessions regularly
Informed consent
Determination of skin phototype (or MED)
Skin examination to identify premalignant and/or malignant skin lesions in patients at risk (actinic keratosis, atypical melanocytic nevi)
Clinical examination and assessment of symptoms to evaluate the extent of disease using the Psoriasis Area Severity Index, the Body Surface Area and/or the Dermatology Life Quality Index to ascertain whether treatment is justified
A complete record of the treatments prescribed to the patient with particular emphasis on those that might be associated with photosensitivity
Specific information about the patient's history of episodes of photosensitivity

Table 5 Narrowband UV-B Therapy: Proposals for Treatment Protocols Based on Skin Phototype or Minimal Erythema Dose (MED)

Initial dose:	
According to skin phototype	
II	200 mJ/cm^2
III	250 mJ/cm^2
IV	300 mJ/cm^2
V	400 mJ/cm^2
MED:	
Suberythemogenic regimen	35%-50%
Erythemogenic regimen	75%
Per-session increases:	
Skin phototypes	
II	10%
III	10%-20%
IV	20%
Suberythemogenic regimen	10%-20%
Erythemogenic regimen	40%
Approximate maximum dose	
Skin phototypes	
II	1200-1500 mJ/cm^2
III	1500-1700 mJ/cm^2
IV	1800-2300 mJ/cm^2
V	3000 mJ/cm^2
Average number of sessions	
Suberythemogenic regimen	25
Erythemogenic regimen	15-20

variety of equipment used and the heterogeneity of the target population. Regimens can be based on the minimal erythema dose (MED) or fixed doses may be chosen according to the patient's skin phototype. The latter method—a more individually tailored strategy—probably gives faster results. However, no significant differences between these 2 approaches in terms of either efficacy or safety has been demonstrated. In Table 5 we propose regimens for each approach. After the initial dose, the regimen should be adjusted on a case-by-case basis depending on erythemic response. Thus, in the presence of nonsymptomatic erythema, the dose increase is reduced by 50%; for example, if the regimen calls for an increase of 20%, an increase of 10% should be used. When minimally symptomatic erythema appears, the dose is maintained for the next session and the question of an increase is assessed in subsequent sessions; for example, if the regimen calls for an increase of 40% per session, the dose could be increased by only 20%. In the case of symptomatic erythema, treatment should be temporarily discontinued and later resumed at the last dose that was well tolerated by the patient.

The most usual frequency is 3 sessions a week, 48 hours apart. Depending on the patient's availability, treatment can be administered from 2 to 5 times a week.

Some authors have proposed erythemogenic regimens (an initial dose equal to 70% of the MED and dose increases of 40% per session); such regimens reduce the number of sessions needed for optimum response by 3 to 5 sessions per cycle on average.[22] However, no differences in outcomes have been detected, and suberythemogenic protocols are better tolerated and consequently better accepted by the patient. The probable relationship between the degree of erythema and the carcinogenic potential of therapy should also be taken into account. When an erythemogenic regimen is chosen, the patient should be assessed after 4 to 5 sessions to anticipate and attenuate possible adverse effects, which usually take the form of episodes of symptomatic erythema.[23] Differences in racial characteristics between populations could account for the marked differences in tolerance of erythemogenic regimens and the outcomes achieved.[23,24]

Safety

Short-Term Adverse Effects

The most commonly reported adverse effect is erythema, particularly with erythemogenic regimens. Erythema develops in around 50% of treatment cycles[17,22] but is significant and involves patient discomfort in only 16% of patients on conservative regimens and is the cause of definitive withdrawal in only 2% of such patients.[25] This side effect is more common in obese patients and in older patients.[26] Other common adverse effects are pruritus, especially following initial sessions, and xerosis. However, these effects are well tolerated and in most cases respond to treatment with emollients and antihistamines. In a recent study, itching of skin lesions prior to treatment was identified as an indicator for cases that would require more irradiation sessions and more prolonged treatment.[27] In any case, we recommend reducing the dose increase or even maintaining the highest well-tolerated dose when these side effects develop, providing symptomatic treatment of the pruritus (emollients and sedative antihistamines, such as dexchlorpheniramine) to improve the patient's wellbeing and favor adherence to treatment.

Other authors have reported the appearance of asymptomatic blisters on the treated areas, probably associated with a rapid decrease in epidermal acanthosis during treatment.[28] These lesions are not accompanied by any significant findings on direct immunofluorescence or alterations in porphyrin metabolism. Blistering is, in any case, a very rare adverse effect in clinical practice.

Long-Term Adverse Effects

Photoaging. Chronic exposure to UV-B and UV-A radiation is known to accelerate photoaging. Despite the lack of studies specifically evaluating the photoaging effects of narrowband UV-B therapy, this effect is observed in practice in patients who undergo prolonged treatment.[29]

Carcinogenesis. Based on evidence from theoretical studies and animal models, it is thought that the carcinogenic potential of narrowband UV-B therapy is comparable to that of conventional UV-B irradiation[30,31] and lower than the level than the risk associated with PUVA therapy.[32] If, hypothetically, the carcinogenic potential of narrowband UV-B therapy were similar to that of sunlight, it has been calculated that the administration of between 400 and 1200 treatments over a lifetime could increase the relative risk of developing nonmelanoma skin cancer between 1.2- and 2-fold.[30] To date, no prospective or retrospective studies have demonstrated a dose-dependent higher incidence of nonmelanoma skin cancer. A study that assessed 24 753 patient-years of treatment failed to identify any increase in the incidence of any type of skin cancer, even in the subgroup of patients who received the largest number of sessions.[33] In a meta-analysis of 11 studies on skin cancer incidence with a combined population of 3400 patients, no increase over the expected rate for the general population was identified.[34] We cannot, however, rule out the possibility that patients who have received high doses may have higher cancer rates on long-term follow-up. We therefore recommend a number of strategies for minimizing the carcinogenic effects of therapy (Table 6). Although some treatment guidelines propose a maximum limit on the number of sessions accumulated over a lifetime, this proposal is based on theoretical assumptions for which we currently have no solid scientific evidence.[35]

Special Considerations

Combination Therapy

Narrowband UV-B therapy plus topical treatments. Overall, the combination of various spectra of UV radiation with topical corticosteroids may accelerate response to treatment but does not influence the final outcome and may even favor earlier relapse.[36] The use of topical corticosteroids to complement phototherapy in inaccessible areas, such as skin folds and the scalp, appears to be appropriate.[37] In psoriasis, the addition of calcipotriol or tazarotene to the phototherapy regimen can reduce the number of treatment sessions and the cumulative dose, although the combination is not more effective than phototherapy alone (evidence level 2).[38,39] Patients often prefer calcipotriol because of better tolerance and

Table 6 Strategies for Minimizing Cancer Risk in Patients Receiving Narrowband UV-B Therapy

The clinician should record use of potentially phototoxic drugs and prescribe substitutes
The use of suberythemogenic regimens rather than erythemogenic regimens can yield satisfactory results even though more sessions may be necessary
Exposure to intense sunlight on the day of treatment should be avoided. Sun exposure can be permitted at weekends in moderation
A higher incidence of erythema has been reported in individuals over 70 years of age and care should be taken with dose increases in this group
Narrowband UV-B therapy should only be used as a maintenance therapy when there is no safer or more effective alternative
Sun block should be applied to the lips and patients should wear sunglasses with a UV radiation filter during treatment sessions
Before treatment, photoprotective creams should be applied to unaffected areas, in particular those normally exposed to sunlight (for example, the face, the back of the hands, and the neckline)
Patients should be advised to use photoprotection when exposed to sunlight to minimize cumulative actinic damage

Table 7 Administration of Acitretin in Combination With Narrowband UV-B Therapy

Dose Regimens: 0.3-0.5 mg/kg/d, or 25 mg/d if the patient weighs >70 kg and 10 mg/d if the patient weighs <70 kg, taken from 1 to 2 weeks before the start of phototherapy
If acitretin is added after narrowband UV-B therapy has been started, the dose of UV-B can be reduced by 30%
If the patient's skin phototype is used as a reference, caution should be exercised when increasing the dose (for example, it could be increased only every second session)
Once clearance has been achieved, phototherapy can be discontinued and acitretin treatment continued to achieve long-term control

its cosmetic effects.[40] When phototherapy is combined with vitamin D derivatives—or any topical treatment—the topical treatment should be applied after the phototherapy session, or the 2 treatments should be separated by at least a 2-hour interval to prevent interference.[41]

The results achieved with the combination of narrowband UV-B therapy and anthralins, whether using a short-contact regimen or modifications of the standard Ingram regimen, are comparable to those obtained with the same regimens plus broadband UV-B therapy.[42,43] However, none of the studies carried out to date have investigated whether the outcomes achieved are better than those that would be expected with narrowband UV-B therapy alone. Moreover, anthralins present cosmetic problems and their use is confined to phototherapy units located in day hospitals.

The application of mineral oils or 5% oleic acid prior to narrowband UV-B therapy increases its efficacy in psoriasis.[44,45] Conversely, a thick layer of petrolatum or of oily excipients containing salicylic acid is counterproductive because these products block the UV-B radiation.[46,47]

The combination of narrowband UV-B therapy with topical psoralen results in a slight improvement in response but is also associated with disadvantages, such as symptomatic erythema and local hyperpigmentation.[48] The use of this combination in clinical practice is exceptional.

Narrowband UV-B plus systemic therapy. The combination of narrowband UV-B therapy and acitretin is useful in patients with moderate or extensive plaque psoriasis whose disease does not respond adequately to phototherapy, photochemotherapy, or monotherapy with acitretin. Outcomes are comparable to those obtained with re-PUVA therapy, although no evidence demonstrates that it achieves longer periods of remission (evidence level 2).[49,50]

Given the lack of specific treatment protocols for combining acitretin with narrowband UV-B therapy, we recommend the regimens generally agreed upon for other types of phototherapy (Table 7) (evidence level 4).[51] Low doses of acitretin are usually sufficient and favor tolerance. It should be noted that the recommendation to reduce the dose of narrowband UV-B therapy when acitretin is added is based on assumptions about the mechanism of action of acitretin on epidermal acanthosis and not on specific evidence of any reduction in the MED in this setting.

Combinations or sequential use of methotrexate or ciclosporin with narrowband UV-B therapy are associated with a reduction in the number of sessions and cumulative dose but have no repercussions on the final efficacy of treatment or the duration of the remission period. Furthermore, since the factors that must be considered before using this combination should include those relating to both of these drugs, there are insufficient arguments in favor of recommending these combinations.[52-54]

Narrowband UV-B therapy plus biologic agents. Our experience with combinations of the various types of phototherapy and the new biologic agents is limited at present. However, because narrowband UV-B therapy acts rapidly and has a good safety profile and because it acts only on the skin, this modality is, a priori, an attractive option for use in association with the new biologics. We consider 3 scenarios in which combinations of narrowband UV-B therapy and biologic agents could be used:

1. Optimization of response in the short term. Narrowband UV-B therapy is added to treatment with a biologic agent to increase the prospects of a more effective response than can be achieved with the biologic agent alone. The combination most studied to date is narrowband UV-B therapy and etanercept. Based on the results of a few open-label randomized trials, this combination seems to improve the prospects of obtaining a response by 20% to 30% compared to monotherapy with the biologic agent and also shortens the interval needed to reach PASI 75 by a similar percentage (evidence level 3).[55]

2. Control of the transient relapses and fluctuations in response typical of the course of the disease in patients treated for long periods with biologic agents. The literature offers insufficient evidence to support a recommendation on this point. The available evidence is limited to a few isolated cases in which psoriasis exacerbations were controlled by adding short courses of narrowband UV-B therapy without discontinuing the biologic agent.[56,57]
3. Transition between treatments. There is insufficient evidence to support any recommendation concerning the use of narrowband UV-B therapy during the transition between withdrawal of treatment with a biologic agent or conventional systemic drug and the start of treatment with another in order to prevent the exacerbation of psoriasis and consequent loss of quality of life for the patient until the new treatment takes effect. However, given the response curve for narrowband UV-B therapy, its use for this purpose should begin when the prior treatment is withdrawn or even 2 or 3 weeks earlier and should continue for 6 to 10 weeks until the new biologic drug starts to take effect (evidence level 4).

The main problem with all of these proposals is the possibility that narrowband UV-B therapy could increase the incidence of nonmelanoma skin cancer in patients treated with anti-tumor necrosis factor agents.[58,59] This possibility has led the authors of some guidelines to advise against the combination. In any case, biologic agents should be combined with narrowband UV-B only for short periods and the combination should never be used as a medium- or long-term strategy. As always, each case should be assessed individually.

Nonplaque psoriasis. Localized forms of psoriasis are difficult to treat with narrowband UV-B therapy using equipment designed for full body application in the generalized forms of the disease. However, devices that administer targeted light therapy are now available.

Although the administration of narrowband UV-B to treat psoriasis of the scalp presents obvious logistic problems, specific comb devices—some using fiberoptic technology—have been designed for home use.[60] The evidence on results obtained with such devices is scant. In a study of 44 patients treated for 3 weeks, the results obtained with a UV-B comb were comparable to those obtained with betamethasone valerate solution, although relapse was less common in the group treated with phototherapy.[61]

Although anecdotal reports are favorable, narrowband UV-B therapy is not an appropriate treatment in most cases of intertriginous or nail psoriasis or in the pustular forms of the disease.[62-64] UV-B therapy in the treatment of palmoplantar psoriasis should only be used when PUVA is not available or when no other treatment is possible, given that the results are superior with PUVA in this setting.[65] We also lack evidence concerning the treatment of erythrodermic psoriasis with phototherapy in general or with narrowband UV-B therapy in particular. In fact, phototherapy is not recommended in this setting because of the instability and risk of photosensitivity associated with this variant of psoriasis in some patients. Narrowband UV-B therapy could, however, be used as a maintenance treatment in such patients once the disease process has been controlled with systemic therapy.[66]

Psoriasis in children. Narrowband UV-B therapy has been used successfully in children in small case series, where the rates of complete or almost complete response (between 60% and 90%) are even higher than in adults and tolerance is good in the short term (evidence level 3).[67,68] However, the open-label design and often retrospective nature of these studies and the limited use of the PASI to measure baseline severity means that these results must be viewed with caution. In order to minimize the impact of UV-B radiation over the long term, excessive cumulative doses should be avoided and particular attention should be paid to eye protection. Other considerations to take into account include the fact that treatment sessions will interfere with the child's schoolwork and the risks associated with other types of treatment.

Psoriasis in pregnant women and nursing mothers. Narrowband or broadband UV-B therapy is considered a safe treatment option for pregnant women and nursing mothers, and there are no reports of fetal damage in the literature (evidence level 4).[69]

Vaccination and narrowband UV-B therapy. No evidence has been put forth to show that narrowband UV-B therapy alters response to vaccination. Patients can be vaccinated according to the general recommendations for their age and clinical profile.

Psoriasis and chronic diseases. Narrowband UV-B therapy is a first-line option in patients with moderate to severe psoriasis and a history of chronic liver disease, irrespective of the nature and severity of the liver disease. This phototherapy is also effective and well tolerated in patients with chronic infection secondary to human immunodeficiency virus (HIV) and is not associated with any decrease in immune function or increase in opportunist infections or skin tumors (evidence level 3). Narrowband UV-B therapy should therefore be considered as a first-line therapy in HIV-infected patients with extensive psoriasis not controlled with topical treatments.[70]

Psoriasis and visceral or hematologic tumors. Together with oral retinoids, narrowband UV-B therapy is a first-line treatment in patients who have moderate to severe psoriasis uncontrolled by topical treatment and a history of visceral neoplasia, irrespective of the nature and risk of tumor recurrence.

Psoriasis and comorbidities. UV-B therapy has been shown to be associated with increased vitamin-D levels. In view of the beneficial effects of this hormone on both the metabolism and the immune system, such an increase could have a beneficial effect on the psoriasis-associated comorbidities such as diabetes mellitus or cardiovascular disease. However, this effect has not been demonstrated in clinical practice.[71,72]

Cost

The cost of narrowband UV-B therapy in Spain has not been calculated. In 2006, the cost of a complete cycle of narrowband UV-B therapy in a specialized European hospital was estimated to be €325, of which 70% was attributed to the cost of personnel.[73]

Excimer Laser and Monochromatic Excimer Systems (308 nm)

Excimer laser devices emit monochromatic light at a wavelength of 308 nm and can target affected areas without exposing healthy skin. Targeted treatment has the advantage that it minimizes the possible risk of photoaging and photocarcinogenesis associated with traditional phototherapy. The original laser devices had a spot size 14 to 30 mm in diameter. The more recently developed nonlaser monochromatic excimer light delivery systems have larger spots (16-512 cm^2) and are less expensive. The difference between an excimer laser and a monochromatic excimer light delivery system is basically that the former emits coherent, collimated 308 nm monochromatic light produced in an optical cavity while the new nonlaser systems emits a monochromatic but divergent light rather than a collimated one. Both systems use a xenon chloride medium to produce a 308 nm beam.

Excimer laser was first used to treat psoriasis in 1997, when it was compared with narrowband UV-B therapy in a study that found the new light to be effective in fewer sessions and at a lower cumulative dose.[74] The mechanism of action is thought to be induction of T cell apoptosis through breakage of DNA strands and the expression of mitochondrial proteins related to cell death. Excimer laser penetrates the skin more effectively than narrowband UV-B light and requires a lower energy density because of its higher irradiance.[75,76]

Efficacy

In an early study, Trehan et al[77] reported an improvement of more than 75% in 11 out of 16 patients within 1 month of excimer laser treatment with a single dose of either 8 or 16 times the MED. The problem with this high-dose regimen was that patients developed bullous lesions and burns. Most authors have used more moderate doses—between 1 and 3 MED—and adjusted the dose according to the response obtained. In a multicenter trial enrolling 124 patients treated with an initial dose of 3 MED, clearance of at least 75% of the lesions was recorded after a maximum of 10 twice-weekly sessions in 84% of the patients, while at least 75% clearance was achieved in 72% of patients after an average of 6.2 treatments.[78] Excimer light treatment is more effective in the management of psoriatic lesions of the macular type than in plaque or palmoplantar psoriasis.[79,80] The authors of an open-label prospective trial enrolling 120 patients reported an improvement of at least 90% in 85.3% of patients after 13 sessions of excimer laser therapy using an initial dose of 3 MED and increments of 1 MED.[81] In another study, complete remission was obtained in 57% of the 152 enrolled patients and significant improvement was seen in 27% after up to 16 sessions.[82]

Excimer light has been used successfully to treat psoriasis of the scalp using a comb or ventilator to part the hair so that the laser or light source can reach the site requiring treatment.[83,84] It has also been used successfully in palmoplantar psoriasis. In an open-label study of 54 patients, Nistico et al[85] reported clearance of the lesions in 57% of patients after an average of 10 sessions for palmar lesions and 13 session for plantar lesions, with initial doses of between 1 and 3 MED and increments of 250 to 500 mJ/cm^2 per session.

Excimer laser can be used to complement PUVA therapy, making it possible to reduce the cumulative dose of UV-A and achieve remission in half the time and half the number of sessions that would be needed with PUVA alone.[86]

Excimer laser can achieve prolonged remission of lesions in a considerable number of cases. The average duration of remission after completion of treatment is approximately 3 to 4 months, although remission has lasted 12 months in some cases.[87]

No data is available on the long-term use of excimer light therapy or on its use as a maintenance treatment. However, given the nature of phototherapy we do not consider the long-term or continuous use of this modality to be justified even though it is applied locally.

Toxicity

Toxicity is limited to the treatment site. The most commonly reported adverse effects are erythema, burning sensation, and hyperpigmentation. Blisters may develop when high energy densities are used. There is currently no information on long-term safety.

Treatment Regimen

No ideal regimen has been established for treatment with excimer laser or monochromatic excimer light delivery systems. In general, treatment involves 1 to 3 sessions a week with at least 48 hours between sessions depending on considerations of resource and staff availability and the patient's convenience. The initial dose is determined on the basis of the patient's MED: a dose between 1 and 3 times the MED is applied. Subsequent doses are increased depending on response to treatment and adverse effects. The ideal outcome after a session is slight erythema, that is, delivery of a suberythemogenic dose. If slight erythema is not achieved, the dose is increased by 15% to 25%. If erythema is intense, the dose is reduced by 15% to 25%. If blisters or crusting develop, the affected area is not treated again until these have resolved. Between 10 and 15 treatment sessions are generally required. In Table 8, we have included a proposed treatment regimen.

Special Circumstances

No information is available on the use of excimer light systems during pregnancy or breastfeeding. However, most authors consider these devices can be used safely in these settings. Experience in children is limited, but results to date have been similar to those achieved with adults. The reports of safety in children are similar to those for adults.[88]

Contraindications and Limitations

Particular care should be taken in individuals with a history of melanoma or previous phototherapy and in patients with photosensitive diseases, such as lupus erythematosus and xeroderma pigmentosum. There is insufficient experience or long-term monitoring to establish the carcinogenic risk

Table 8 Summary of Information on the Use of Excimer Systems in Psoriasis

1. Indication: plaque psoriasis not controlled by topical treatments and affecting less than 20% of the body surface
2. Approval: experience limited to the last 10 years
3. Regimen: initial dose is calculated on the basis of the MED (× 2-3). Dose is increased each session by between 10% and 40% using erythema as a reference. Keratolytic agents should be used prior to phototherapy on hyperkeratotic lesions
4. Response: appears after 2-3 weeks (6-10 sessions)
5. Short-term efficacy: only a few studies have used the PASI. PASI 75 in 80%-90% of patients at week 6 to 8 (13-16 sessions)
6. Long-term efficacy: not designed for long-term use
7. Contraindications: photosensitivity disorders triggered by UV-B light. Diseases associated with defective DNA repair, such as xeroderma pigmentosum. The desirability of treatment should be carefully evaluated in patients with a history of melanoma, multiple dysplastic nevi, or nonmelanoma skin cancer
8. Adverse reactions: erythema (in up to 50% of patients; generally well tolerated), vesiculobullous skin lesions, and postinflammatory hyperpigmentation. Potentially increases actinic damage and carcinogenesis in patients who receive a high cumulative dose on the treatment sites. This has not, however, been demonstrated
9. Baseline monitoring: skin examination to rule out the presence of malignant or premalignant lesions. A specific medical history targeting episodes of photosensitivity. Assessment of medications the patient is taking
10. Ongoing monitoring: regular assessment of tolerance and efficacy
11. Other considerations
    - There is no experience of use during pregnancy or breastfeeding, although nor is there any evidence that would contraindicate such use
    - The experience of use in children is insufficient to draw any conclusions
    - This treatment has no effect on joint disease. Other treatments should be used to address this problem, when necessary
    - This treatment is a good option for localized forms of psoriasis (scalp and palmoplantar)

Abbreviations: MED, minimal erythema dose; PASI, Psoriasis Area Severity Index.

of excimer light therapy, but the localized application of this phototherapy restricts the risk to the areas treated.

Cost

The cost of excimer light therapy in Spain has not been calculated. Excimer laser devices are much more expensive than monochromatic excimer light delivery systems; the latter are currently available at prices comparable to those of most phototherapy booths (UV-A and narrowband UV-B). Although an excimer light session may be more expensive than a traditional phototherapy session (PUVA or narrowband UV-B), the overall cost is much lower as fewer sessions are required, and the treatment is generally preferred by patients.[89,90]

Photodynamic Therapy

Photodynamic therapy involves the administration of a topical or systemic photosensitizing agent, which is taken up by the most metabolically active cells and subsequently activated by irradiation with a light source. Three elements are needed: photosensitizer, light source, and oxygen. This modality has been used experimentally to treat psoriasis in recent years. One of the advantages it may have over other forms of phototherapy is the absence of a carcinogenic effect.

Different types of light sources (red, blue, diode) have been used in conjunction with topical photosensitizing agents administered at different concentrations (aminolevulinic acid [ALA] at concentrations between 0.1% and 20%, methyl aminolevulinate, and methylene blue) or with systemic agents (oral ALA and intravenous verteporfin).[91,92] To date, studies in psoriasis have been small (fewer than 20 patients), and the results have generally been mediocre to moderate. The treatment regimens are not standardized and generally comprise between 1 and 3 sessions a week with treatment cycles of up to 12 weeks. Two trials comparing topical ALA to topical dithranol found little or no difference in efficacy.[93] In a comparison of narrowband UV-B therapy and photodynamic therapy with topical ALA, the former was shown to be more effective and better tolerated.[94] One of the problems reported in all these studies is poor tolerance of the smell and burning sensation associated with photodynamic therapy, which leads some patients to withdraw from treatment. These adverse effects have been shown to be dependent on the concentration of the photosensitizing agents used and the energy density of the dose applied. Another limitation of photodynamic therapy is its high cost. New and more effective photosensitizing agents with fewer adverse effects are therefore needed for treating psoriasis in the future. In this respect, a recent study demonstrated the efficacy of topical methylene blue in the treatment of resistant plaque psoriasis. Phthalocyanine Pc4 is another photosensitizer that is proving safe and effective in other skin diseases (mycosis fungoides) and might also be used to treat psoriasis.[95]

Conclusions

Narrowband UV-B therapy is currently a first-line treatment for psoriasis in cases in which the response to topical treatment is inadequate. The principal advantages of this phototherapy are efficacy, safety, and good tolerance. The main drawbacks are the logistics of treatment, the lack of specialized centers, and the fact that it has no effect on joint disease or unexposed areas of the body. The decision

on whether to choose narrowband UV-B therapy or a conventional or biologic treatment should be made on a case-by-case basis taking into account the characteristics of the patient. The safety profile of narrowband UV-B and the fact that it acts only on the skin make this modality appropriate for the management of moderate to severe psoriasis in pregnant women and patients with certain comorbidities and underlying diseases.

Targeted phototherapy—with excimer laser or excimer light delivery systems and, to a lesser extent, with photodynamic therapy—has the advantage of treating only the psoriatic lesions and requiring fewer sessions overall. However, these treatments are useful only when psoriasis is localized and the local adverse effects are notable. Furthermore, the availability of targeted phototherapy is currently limited.

Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. Puig L, Carrascosa JM, Dauden E, Sanchez-Carazo JL, Ferrandiz C, Sanchez-Regaña, et al. Guias españolas basadas en la evidencia sobre el tratamiento de la psoriasis moderada a grave con fármacos biológicos. Actas Dermosifiliogr. 2009;100: 386-413.
2. Nast A, Kopp IB, Augustin M, Banditt KB, Boehncke WH, Follmann M, et al. Deutsche Dermatologische Gesellschaft (DDG); Berufsverband Deutscher Dermatologen (BVDD). Evidence-based (S3) guidelines for the treatment of psoriasis vulgaris. J Dtsch Dermatol Ges. 2007;5 Suppl 3:1-119.
3. Parrish JA, Jaenicke KF. Action spectrum for phototherapy of psoriasis. J Invest Dermatol. 1981;76:359-62.
4. Ortel B, Honigsmann H. Phototherapy and photochemotherapy. In: Hawk JLM, editor. Photodermatology: Chapman & Hall; 1998. p. 223-40.
5. Duthie MS, Kimber I, Norval M. The effects of ultraviolet radiation on the human immune system. Br J Dermatol. 1999;140:995-1009.
6. Larko O, Swanbeck G. Home solarium treatment of psoriasis. Br J Dermatol. 1979;101:13-6.
7. Yano K, Kadoya K, Kajiya K, Hong YK, Detmar M. Ultraviolet B irradiation of human skin induces an angiogenic switch that is mediated by upregulation of vascular endothelial growth factor and by downregulation of thrombospondin-1. Br J Dermatol. 2005;152:115-21.
8. Van der Leun JC, Van Weelden H. UVB phototherapy; principles, radiation sources, regimens. Curr Probl Dermatol. 1986;15:39-51.
9. Larko O. Treatment of psoriasis with a new UVB-lamp. Acta Derm Venereol (Stockh). 1989;69:357-9.
10. Green C, Ferguson J, Lakshmipathi T, Johnson BE. 311nm UVB phototherapy: an effective treatment for psoriasis. Br J Dermatol. 1988;119:691-6.
11. Picot E, Meunier L, Picot-Debeze MC, Peyron JL, Meynadier J. Treatment of psoriasis with a 311-nm UVB lamp. Br J Dermatol. 1992;127:509-12.
12. Dawe RS. A quantitative review of studies comparing the efficacy of narrow-band and broad-band ultraviolet B for psoriasis. Br J Dermatol. 2003;149:655-80.
13. Gordon PM, Diffey L, Matthews JNS, Farr PM. A randomized comparison of narrow-band TL-01 and PUVA photochemotherapy for psoriasis. J Am Acad Dermatol. 1999;41:728-32.
14. Tanew A, Radakovic-Fijan S, Schemper M, Honigsmann H. Narrow-band UV-B phototherapy vs photochemotherapy in the treatment of chronic plaque-type psoriasis. A paired comparison study. Arch Dermatol. 1999;135:519-24.
15. Koek MB, Buskens E, van Weelden H, Steegmans PH, Bruijnzeel-Koomen CA, Sigurdsson V, et al. Home versus outpatient ultraviolet B phototherapy for mild to severe psoriasis: pragmatic multicentre randomised controlled non-inferiority trial (PLUTO study). BMJ. 2009;338:b1542.
16. Boztepe G, Karaduman A, Sahin S, Hayran M, Kolemen F. The effect of maintenance narrow-band ultraviolet B therapy on the duration of remission for psoriasis: a prospective randomized clinical trial. Int J Dermatol. 2006;45:245-50.
17. Carrascosa JM, Bigata X. UVB terapia de banda estrecha: experiencia en la práctica clínica y factores predictivos de respuesta. Actas Dermosifiliogr. 2000;91:555-62.
18. Leenutaphong V, Nimkulrat P, Sudtim S. Comparison of phototherapy two times and four times a week with low doses of narrow-band ultraviolet B in Asian patients with psoriasis. Photodermatol Photoimmunol Photomed. 2000;16:202-6.
19. Dawe RS. Using 'number needed to treat' to express the magnitudes of benefit of ultraviolet B phototherapy and of antitumour necrosis factor-alpha therapies for psoriasis. Br J Dermatol. 2010;162:456-7.
20. Feldman SR, Garton R, Averett W, Balkrishnan R, Vallee J. Strategy to manage the treatment of severe psoriasis: considerations of efficacy, safety and cost. Expert Opin Pharmacother. 2003;4:1525-33.
21. Dawe RS. Towards optimal regimens for the UVB phototherapy of psoriasis: A mathematical model. Acta Derm Venereol. 2004;84:259-64.
22. Kleinpenning MM, Smits T, Boezeman J, van de Kerkhof PCM, Evers AWM, Gerritsen MJP. Narrowband ultraviolet B therapy in psoriasis: randomized double-blind comparison of high-dose and low-dose irradiation regimens. Br J Dermatol. 2009;161: 1351-6.
23. Dawe RS. Comparing narrowband ultraviolet B treatment regimens for psoriasis. Br J Dermatol. 2009;161:1215-6.
24. Youssef RM, Mahgoub D, Mashaly HM, El-Nabarawy E, Samir N, El-Mofty M. Different narrowband UVB dosage regimens in dark skinned psoriatics: a preliminary study. Photodermatol Photoimmunol Photomed. 2009;24:256-9.
25. Carrascosa JM. Fototerapia y fotoquimioterapia. Actas Dermosifiliogr. 2004;95:259-84.
26. Gloor M, Scherotzke A. Age dependence of ultraviolet light induced erythema following narrow-band UVB exposure. Photodermatol Photoimmunol Photomed. 2002;18:121-6.
27. Evers AWM, Kleinpenning MM, Smits T, Boezeman J, Van de Kerkhof PCM, Kraaimaat FW, et al. Itch and scratching as predictors of time to clearance of psoriasis with narrow-band ultraviolet B therapy. Br J Dermatol. 2009;161:542-6.
28. Calzavara-Pinton PG, Zane C, Candiago E, Facchetti F. Blisters on psoriatic lesions treated with TL-01 lamps. Dermatology. 2000;200:115-9.
29. Fisher GJ, Kang S, Varani J, Bata-Csorgo Z, Wan Y, Datta S, et al. Mechanisms of photoaging and chronological skin aging. Arch Dermatol. 2002;138:1462-70.
30. Gibbs NK, Traynor NJ, MacKie RM, Campbell I, Johnson BE, Ferguson J. The phototumorigenic potential of broad-band (270-350 nm) and narrow-band (311-313 nm) phototherapy sources cannot be predicted by their edematogenic potential in hairless mouse skin. J Invest Dermatol. 1995;104:359-63.
31. Tzung TY, Runger TM. Assessment of DNA damage induced by broadband and narrowband UVB in cultured lymphoblasts and

keratinocytes using the comet assay. Photochem Photobiol. 1998;67:647-50.
32. De Gruijl FR. Long-term side effects and carcinogenesis risk in UVB therapy. In: Honigsmann H, Jori G, Young AR, editors. The Fundamental Bases of Phototherapy. Milan: OEMF SpA; 1996. p. 153-70.
33. Hearn RM, Kerr AC, Rahim KF, Ferguson J, Dawe RS. Incidence of skin cancers in 3867 patients treated with narrow-band ultraviolet B phototherapy. Br J Dermatol. 2008;159:931-5.
34. Lee E, Koo J, Berger T. UVB phototherapy and skin cancer risk: a review of the literature. Int J Dermatol. 2005;44:355-60.
35. Ibbotson SH, Bilsland D, Cox NH, Dawe RS, Diffey B, Edwards C, et al. An update and guidance on narrowband ultraviolet B phototherapy: a British Photodermatology Group Workshop Report. Br J Dermatol. 2004;151:283-97.
36. Meola Jr T, Soter NA, Lim HW. Are topical corticosteroids useful adjunctive therapy for the treatment of psoriasis with ultraviolet radiation? A review of the literature. Arch Dermatol. 1991;127:1708-13.
37. LeVine MJ, Parrish JA. The effect of topical fluocinolone ointment on phototherapy of psoriasis. J Invest Dermatol. 1989;78:157-62.
38. Koo JY. Tazarotene in combination with phototherapy. J Am Acad Dermatol. 1998;39:144-8.
39. Woo WK, McKenna KE. Combination TL01 ultraviolet B phototherapy and topical calcipotriol for psoriasis: a prospective randomized placebo-controlled clinical trial. Br J Dermatol. 2003;149:146-50.
40. Schiener R, Behrens-Williams SC, Pillekamp H, Kaskel P, Peter RU, Kerscher M. Calcipotriol vs tazarotene as combination therapy with narrowband ultraviolet B (311 nm): efficacy in patients with severe psoriasis. Br J Dermatol. 2000;143: 1275-8.
41. McKenna KE, Stern RS. Photosensitivity associated with combined UVB and calcipotriene therapy. Arch Dermatol. 1995;131:1305-7.
42. Karvonen J, Kokkonen EL, Ruotsalainen E. 311 nm UVB lamps in the treatment of psoriasis with the Ingram regimen. Acta Derm Venereol. 1989;69:82-5.
43. Storbeck K, Holzle E, Schurer M. Narrow-band UVB (311 nm) versus conventional broad-band UVB with and without dithranol in phototherapy for psoriasis. J Am Acad Dermatol. 1993;28: 227-31.
44. Lebwohl M, Martinez J, Weber P, DeLuca R. Effects of topical preparations on erythemogenicity of UVB: implications for psoriasis therapy. J Am Acad Dermatol. 1995;32:469-74.
45. Brualla DA, Sanchez-Reñaga M, Massana J, Molinero J, Ojeda R, Umbert P. Optimización de la fototerapia UVB 311 nm con ácido oleico. Actas Dermosifiliogr. 2003;94 Suppl 1:66-7.
46. Fetil E, Ozka S, Soyal MC, Ilknur T, Erdem Y, Gunes AT. Effects of topical petrolatum and salicylic acid on the erythemogenicity of UVB. Eur J Dermatol. 2002;12:154-6.
47. George SA, Bilsland DJ, Wainwright NJ, Ferguson J. Failure of coconut oil to accelerate psoriasis clearance in narrowband UVB phototherapy or photochemotherapy. Br J Dermatol. 1993; 128:301-5.
48. Seckin D, Usta I, Yazici Z, Senol A. Topical 8-methoxypsoralen increases the efficacy of narrowband ultraviolet B in psoriasis. Photodermatol, Photoimmunol Photomedicine. 2009;25: 237-41.
49. Green C, Lakshmipathi T, Johnson BE, Ferguson J. A comparison of the efficacy and relapse rates of narrowband UVB (TL-01) monotherapy vs etretinate (re-TL-01) vs etretinate-PUVA (re-PUVA) in the treatment of psoriasis patients. Br J Dermatol. 1992;127:5-9.
50. Ozdemir M, Engin B, Baysal I. Mevlitoğlu I. A randomized comparison of acitretin-narrow-band TL-01 phototherapy and acitretin-psoralen plus ultraviolet A for psoriasis. Acta Derm Venereol. 2008;88:589-93.
51. Lebwohl M, Drake L, Menter A, Koo J, Gottlieb AB, Zanolli M, et al. Consensus conference: acitretin in combination with UVB or PUVA in the treatment of psoriasis. J Am Acad Dermatol. 2001;45:544-53.
52. Mahajan R, Kaur I, Kanwar J. Methotrexate/narrowband UVB phototherapy combination vs. narrowband UVB phototherapy in the treatment of chronic plaque-type psoriasis — a randomized single-blinded placebo-controlled study. J Eur Acad Dermatol Venereol. 2010;24:595-600.
53. Asawanonda P, Nateetongrungsak Y. Methotrexate plus narrowband UVB phototherapy versus narrowband UVB phototherapy alone in the treatment of plaque-type psoriasis: a randomized, placebo-controlled study. J Am Acad Dermatol. 2006;54:1013-8.
54. Calzavara-Pinton P, Leone G, Venturini M, Sala R, Colombo D, La Parola IL, et al. A comparative non-randomized study of narrowband (NB) (312 +/- 2 nm) UVB phototherapy versus sequential therapy with oral administration of low-dose Cyclosporin A and NB-UVB phototherapy in patients with severe psoriasis vulgaris. Eur J Dermatol. 2005;15:470-3.
55. Kircik L, Bagel J, Korman N, Menter A, Elmets CA, Koo J, et al. Utilization of narrow-band ultraviolet light B therapy and etanercept for the treatment of psoriasis (UNITE): efficacy, safety, and patient-reported outcomes. J Drugs Dermatol. 2008;7:245-53.
56. Lucas A, Belinchon I, Perez-Crespo M, Mataix J, Betlloch I. Successful response to narrow-band UVB in a patient undergoing concomitant treatment with adalimumab for psoriasis. Australas J Dermatol. 2008;49:173-4.
57. Carrascosa JM, Soria X, Ferrandiz C. Effective management of a psoriatic flare with narrowband UVB phototherapy during efalizumab therapy without discontinuing treatment. J Eur Acad Dermatol Venereol. 2007;21:828-9.
58. Tyring S, Gordon KB, Poulin Y, Langley RG, Gottlieb AB, Dunn M, et al. Long-term safety and efficacy of 50 mg of etanercept twice weekly in patients with psoriasis. Arch Dermatol. 2007;143:719-26.
59. Menter A, Tyring SK, Gordon K, Kimball AB, Leonardi CL, Langley RG, et al. Adalimumab therapy for moderate to severe psoriasis: A randomized, controlled phase III trial. J Am Acad Dermatol. 2008;58:106-15.
60. Taneja A, Racette A, Gourgouliatos Z, Taylor CR. Broad-band UVB fiber-optic comb for the treatment of scalp psoriasis: a pilot study. Int J Dermatol. 2004;43:462-7.
61. Braun R, Dotterud LK, Falk ES. Comparison of betamethasone valerate solution with phototherapy (UVB comb) in scalp psoriasis treatment. Acta Derm Venereol. 1998;78:385.
62. de Berker D. Management of nail psoriasis. Clinic Experimental Dermatol. 2000;25:357-62.
63. Chalmers R, Hollis S, Leonardi-Bee J, Griffiths CEM, Marsland A. Interventions for chronic palmoplantar pustulosis (Review). The Cochrane Library. 2009; Issue 1. Available from: http://www.thecochranelibrary.com.
64. Wang G, Li C, Gao T, Liu Y. Clinical analysis of 48 cases of inverse psoriasis: a hospital-based study. Eur J Dermatol. 2005;15:176-8.
65. Seker E, Erbil AH, Kurumlu Z, Tastan HB, Etikan I. Comparison of the efficacy of local narrowband ultraviolet B (NB-UVB) phototherapy versus psoralen plus ultraviolet A (PUVA) paint for palmoplantar psoriasis. J Dermatol. 2007;34: 435-40.
66. Rosenbach M, Hsu S, Korman NJ, Lebwohl MG, Young M, Bebo BF, et al. Treatment of erythrodermic psoriasis: From the medical board of the National Psoriasis Foundation. J Am Acad Dermatol. 2010;62:655-62.

67. Jury CS, McHenry P, Burden AD, Lever R, Bilsland D. Narrowband ultraviolet B (UVB) phototherapy in children. Clin Exp Dermatol. 2006;31:196-9.
68. Zamberk P, Velazquez D, Campos M, Hernanz JM, Lazaro P. Paediatric psoriasis-narrowband UVB treatment. J Eur Acad Dermatol Venereol. 2010;24:415-9.
69. Tauscher AE, Fleischer Jr AB, Phelps KC, Feldman SR. Psoriasis and pregnancy. J Cutan Med Surg. 2002;6:561-70.
70. Menon K, Van Voorhees AS, Bebo BF Jr, Gladman DD, Hsu S, Kalb RE, et al for the National Psoriasis Foundation. Psoriasis in patients with HIV infection: from the medical board of the National Psoriasis Foundation. J Am Acad Dermatol. 2010;62: 291-9.
71. Cicarma E, Mørk C, Porojnicu AC, Juzeniene A, Tam TT, Dahlback A, et al. Influence of narrowband UVB phototherapy on vitamin D and folate status. Exp Dermatol. 2010;19:e67-72.
72. Osmancevic A, Wilhelmsen, Larko O, Wennberg AM, Krogstad AL. Vitamin D production in psoriasis patients increases less with narrowband than with broadband ultraviolet B phototherapy. Photodermatol Photoimmunol Photomed. 2009; 25:119-23.
73. Langan SM, Heerey A, Barry M, Barnes L. Cost analysis of narrowband UVB phototherapy in psoriasis. J Am Acad Dermatol. 2004;50:623-6.
74. Bonis B, Kemeny L, Dobozy A, Bor Z, Szabo G, Ignacz F. 308 nm UVB excimer laser for psoriasis. Lancet North Am. 1997;350: 1522.
75. Novak Z, Bonis B, Baltas E, Ocsovszki I, Ignacz F, Dobozy A, et al. Xenon Chloride ultraviolet B laser is more effective in treating psoriasis and in inducing T cell apoptosis than narrowband ultraviolet B. J Photochem Photobiol B. 2002;67: 32-8.
76. Novak Z, Berces A, Ronto G, Pallinges E, Dobozy A. Efficacy of different UV-emitting light sources in the induction of T-cell apoptosis. Photochem Photobiol. 2004;79:434-9.
77. Trehan M, Taylor CR. High-dose 308 nm excimer laser for the treatment of psoriasis. J Am Acad Dermatol. 2002;46:732-7.
78. Feldman SR, Mellen BG, Housman TS, Fitzpatrick RE, Geronemus RG, Friedman PM, 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.
79. He YL, Zhang XY, Dong J, Xu JZ, Wang J. Clinical efficacy of a 308 nm excimer laser for treatment of psoriasis vulgaris. Photodermatol Photimmunol Photomed. 2007;23:238-41.
80. Han L, Somani AK, Huang Q, Fang X, Jin Y, Xiang LH, et al. Evaluation of 308 nm monochromatic excimer light in the treatment of psoriasis vulgaris and palmoplantar psoriasis. Photodermatol Photoimmunol Photomed. 2008;24:231-6.
81. Gerber W, Arheilger B, Ha TA, Hermann J, Ockenfels HM. Ultraviolet B 308 nm excimer laser treatment of psoriasis: A new photherapeutic approach. Br J Dermatol. 2003;149: 1250-8.
82. Nistico SP, Sarceno R, Schipani C, Costanzo A, Climenti S. Different applications of monochromatic excimer light in skin diseases. Photomed Laser Surg. 2009;27:647-54.
83. Taylor CR, Racette AL. A 308-nm excimer laser for the treatment of scalp psoriasis. Lasers Surg Med. 2004;34:136-40.
84. Morison WL, Atkinson DF, Werthman L. Effective treatment of scalp psoriasis using the excimer (308 nm) laser. Photodermatol Photoimmunol Photomed. 2006;22:181-3.
85. Nistico SP, Sarraceno R, Stefanescu S, Climenti SA. 308 nm monochromatic excimer light in the treatment of palmoplantar psoriasis. J Eur Acad Dematol Venereol. 2006;20:523-6.
86. Trott J, Gerber W, Hammes S, Ockenfels HM. The effectiveness of PUVA treatment in severe psoriasis is significantly increased by additional UV 308-nm excimer laser sessions. Eur J Dermatol. 2008;18:55-60.
87. Fikrle T, Pizinger K. The use of the 308 nm excimer laser for the treatment of psoriasis. J Dtsch Dermatol Ges. 2003;1:559-63.
88. Pahlajani N, Katz BJ, Lozano AM, Muphy F, Gottlieb A. Comparison of the efficacy and safety of the 308 nm excimer laser for the treatment of localized psoriasis in adults and in children: A pilot study. Pediatr Dermatol. 2005;22:161-5.
89. Marchetti A, Feldman SR, Kimball AB, Anderson RR, Miller LH, Martin J, et al. Treatment for mild to moderate recalcitrant plaque psoriasis: expected clinical and economic outcomes for first-line and second-line care. Dermatol Online J. 2005;11:1.
90. Gattu S, Rashid RM, Wu JJ. 308 nm excimer laser in psoriasis vulgaris, scalp psoriasis and palmoplantar psoriasis. JEADV. 2009;23:36-41.
91. Smits T, Kleinpennign MM, van Erp PE, van de Kerkhof PC, Gerritsen MJ. A placebo-controlled randomized study on the clinical effectiveness, immunohistochemical changes and protoporphyrin IX accumulation in fractionated 5-aminolaevulinic acid photodynamic therapy in patients with psoriasis. Br J Dermatol. 2006;155:429-36.
92. Tandon YK, Yang MF, Baron ED. Role of photodynamic therapy in psoriasis: a brief review. Photodermatol Photoimmunol Photomed. 2008;24:222-30.
93. Boehncke WH, Sterry W, Kaufmann R. Treatment of psoriasis by topical photodynamic therapy with polychromatic light. Lancet. 1994;343:801.
94. Beattie PE, Dawe RS, Ferguson J, Ibbotson S. Lack of efficacy and tolerability of topical PDT for psoriasis in comparison with narrowband UVB phototherapy. Clin Exp Dermatol. 2004;29:560-2.
95. Miller JD, Baron ED, Scull H, Hsia A, Berlin JC, McCormick T, et al. Photodynamic therapy with the phthalocyanine photosensitizer Pc 4: the case experience with preclinical mechanistic and early clinical-translational studies. Toxicol Appl Pharmacol. 2007;224:290-9.