Psoriasis is a common inflammatory skin condition with high morbidity. Unfortunately, the etiology of the disease currently is unknown, although genetic and environmental factors appear to play important roles in its pathogenesis. Because lasers are used extensively in dermatology to treat various conditions with proven efficacy and safety, they have been investigated as alternatives for treating psoriasis due to side effects that can occur with long-term use of potent topical corticosteroids. Lasers also have the potential to target specific plaques. Modalities that have been investigated for treatment of various forms of psoriasis include the 308-nm excimer laser, psoralen plus UVA (PUVA), narrow-band UVB (NB-UVB), the pulsed dye laser, the 1064-nm Nd:YAG laser, the CO2 laser, and photodynamic therapy. In part 1 of this series, we review the etiology and clinical features of psoriasis and evaluate the efficacy and safety of the 308-nm excimer laser, PUVA, and NB-UVB in the treatment of this common disease.
dilated and prominent blood vessels in the dermis, and an inflammatory infiltrate of leukocytes that are primarily located in the dermis.³

Psoriasis has no validated diagnostic criteria; therefore, estimates of the prevalence of psoriasis in various parts of the world range from 0.6% to 4.8%.⁴ Two population-based studies of adults in the United States have found the prevalence among Americans to be approximately 2.2%⁵ to 2.6%.⁶ More recently, a cross-sectional study using data from the National Health and Nutrition Examination Survey 2003-2004 showed the prevalence of diagnosed psoriasis in adults aged 20 to 59 years to be approximately 3.15%.³

Prevalence rates also vary greatly among patients from different ethnic backgrounds.³ For instance, psoriasis is more common among white individuals and affects only approximately 0.3% of the general population of China.⁶ Interestingly, latitude also appears to affect prevalence, possibly because of the beneficial effects of sunlight on psoriatic lesions.⁷ The mean age of onset for psoriasis vulgaris has been estimated to be approximately 33 years, with 75% of cases occurring before the age of 46 years.⁸ The onset of psoriasis has been observed to be bimodal, with peaks at 16 to 22 years of age and 57 to 60 years of age.⁹ The age of onset seems to be slightly younger in women than men, but psoriasis tends to have approximately similar prevalence in both genders.¹⁰ There are different subtypes of psoriasis and patients may exhibit more than 1 type. The most common type, plaque psoriasis, affects 80% to 90% of patients with psoriasis. On the other hand, guttate psoriasis occurs in less than 2% of patients with psoriasis.¹¹

**ETIOLOGY**

Genetic, immunologic, and environmental factors are believed to play a role in triggering the onset of psoriasis. Nine chromosomal loci (PSOR1–PSOR9) have a linkage to psoriasis.¹² PSOR1 has been shown to account for at least 35% to 50% of psoriasis heritability, which is located on the major histocompatibility complex on chromosome arm 6p.¹³ Recently, a deletion of the 32.2-kb region coding for late cornified envelope 3B and 3C on 1q21 was found to be more common in patients with psoriasis (68% [1926/2852]) than in control patients (59% [1648/2812]) and has been shown to be a risk factor for the development of psoriasis.¹⁴ Other genes with variants that appear to be associated with psoriasis include IL-23R, IL-12B, cyclin-dependent kinase 5 regulatory subunit–associated protein 1–like 1, and zinc finger protein 313 (also called ring finger protein 114).¹⁵-¹⁷

There also is strong evidence that the innate and adaptive immune systems play a role in initiating as well as maintaining psoriatic plaques. The majority of the cellular infiltrate consists of CD4⁺ and CD8⁺ T cells, which are known to precede the epidermal keratinocyte proliferation associated with psoriasis. Natural killer cells, myeloid dendritic cells, and neutrophils also are involved in the inflammatory reaction.¹⁸-²⁰ Some adhesion molecules, such as intercellular adhesion molecule-1 on epidermal keratinocytes and E-selectin on dermal capillaries, are highly expressed in the affected areas and promote leukocyte adherence.²¹ Although psoriasis is believed to be an autoimmune disease, no known autoantigen has been identified.⁶

Other factors associated with psoriasis include obesity, smoking, alcohol consumption, a prior episode of an infectious disease or upper respiratory tract infection, and prior infection with *Streptococcus pyogenes*. Certain drugs (ie, antibiotics, beta-blockers, lithium, and antimalarial drugs) also are associated with psoriatic exacerbations. Diabetes mellitus, cardiovascular disease, and an increased history of traumatic experiences in childhood or adulthood (eg, emotional abuse, neglect) also may be risk factors.²²-²⁷

**SKIN AND NAIL FINDINGS**

Psoriatic lesions typically demonstrate well-demarcated, raised, red plaques with overlying, silvery white scales. Lesions may begin as small papules that coalesce into larger plaques covering a substantial amount of the body surface area. Common sites include the elbows, knees, scalp, nails, and intertriginous regions.²⁸ Attempts to slough the white scales can elicit bleeding, a phenomenon known as the Auspitz sign.²⁹ Lesions also may be accompanied by pruritus, pain, superimposed infection, and arthritis. They are more likely to present symmetrically and on extensor surfaces, with sparing of the palms, plantar surfaces, and face, though localized palmoplantar variants do exist.

Nail involvement tends to be underappreciated but is estimated to affect 80% of psoriatic patients at some point in their lives.³⁰ Nail lesions may manifest as scattered pits or indentations and often herald the presence of concomitant arthritis. Other nail findings include onycholysis and subungual brown macules.²⁸

Histologically, early psoriatic lesions typically demonstrate edema and mononuclear cell infiltration of the upper dermis, which arrive via dilated venules. The epidermis proliferates, demonstrating parakeratosis and elongation of local capillaries, while the dermis becomes flooded by other immune cells, including T cells and dendritic cells. Mature lesions are characterized by elongated rete pegs, loss of the epidermal granular layer, and transition from the normal basket weave appearance of the stratum corneum to a compact appearance.
The histopathology of nail findings depends on the site of involvement. Nail pitting reflects matrix disease and demonstrates parakeratotic islands of variable size, which may progress to thick but friable plates. Onycholysis demonstrates spongiform pustulation. Microvascular changes as well as extravasation from capillaries and the trapping of neutrophils under the nail bed also may be apparent in the clinical setting of oil spotting and splinter hemorrhages. Finally, more proximal nail involvement often appears histologically similar to findings of skin sites.

MODALITIES USED FOR MANAGING PSORIASIS

The therapeutic options that are available for the management of psoriasis include topical agents (eg, calcipotriene, steroids, anthralin, tazarotene, tar); systemic agents, such as methotrexate, acitretin, and cyclosporine; anti-T-cell agents (eg, efalizumab, alefacept; anti–tumor necrosis factor agents (eg, infliximab, adalimumab, etanercept); anti–interleukin agents (eg, ustekinumab).

Lasers have been investigated as an alternative for treating psoriasis due to the numerous side effects that can occur with long-term use of potent topical corticosteroids. Most notably, corticosteroids can induce cutaneous atrophy, striae, and telangiectasia. Rare side effects include hypothalamic-pituitary-adrenal axis suppression, hepatotoxicity, and nephrotoxicity. In addition, the data for the long-term safety of biologics used for the treatment of psoriasis, such as etanercept, adalimumab, infliximab, ustekinumab, efalizumab, and alefacept, are relatively limited. Lasers are currently extensively used for various dermatologic conditions with proven efficacy and safety. They have the potential to target specific plaques in the treatment of psoriasis. Specifically, UV radiation with wavelengths in the range of 311 to 313 nm has been shown to be highly effective in the treatment of psoriasis while minimizing the risk for burns and erythema. This review will focus on the various lasers and light sources that can be utilized for the treatment of psoriasis. Part 1 discusses the excimer laser as well as narrowband UVB (NB-UVB) and psoralen plus UVA (PUVA) therapy; part 2 will discuss other lasers and light devices such as the pulsed dye laser, Nd:YAG laser, CO₂ laser, and photodynamic therapy.

Excimer Laser (308 nm)

The 308-nm excimer laser, approved by the US Food and Drug Administration in 2000 for the treatment of psoriasis, generates a single wavelength of UVB radiation with a spot size of 2×2 cm and a pulse repetition rate of 200 Hz or less. The pulse width is 30 nanoseconds and the average power delivered is 2 to 3 W. Potential adverse effects include pain, erythema, burning, blistering, and discoloration at the treatment site (Figure). The excimer laser appears to exert its therapeutic effect by direct T-cell cytotoxicity. It induces T-cell apoptosis, inhibits cytokine secretion, and impairs antigen presentation by Langerhans cells.

Overall, it appears that substantial improvement has been observed in psoriatic plaques after treatment with the 308-nm excimer laser (Table). Most studies reported the following promising findings: no pain or minimal pain during the treatment, treatment sessions were completed in several minutes at maximum, and side effects were temporary. However, most of the studies in the literature evaluated a small number of participants, which limits the power of the conclusions. The studies by Hadi et al and Feldman et al included larger study groups (98 and 92 participants, respectively), and both demonstrated clearance of psoriatic plaques with use of the 308-nm excimer laser. More studies should be conducted prospectively with larger sample populations.

In addition to the excimer laser, another option is monochromatic excimer light (MEL), which utilizes a lamp that emits noncoherent monochromatic 308-nm light; unlike PUVA, MEL does not require a photosensitizing agent and requires less frequent treatment sessions than NB-UVB. Another advantage of MEL is that it targets affected sites only, avoiding irradiation of normal skin and thereby preventing unnecessary carcinogenic potential adverse effects of treatment with the 308-nm excimer laser. Reprinted with permission from Gerber et al.
### Studies of the 308-nm Excimer Laser for the Treatment of Psoriasis

<table>
<thead>
<tr>
<th>Reference (Year)</th>
<th>Study Objective</th>
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<tr>
<td>Goldberg et al²⁹ (2011)</td>
<td>Examine efficacy of 308-nm excimer laser in treatment of palmoplantar psoriasis</td>
<td>10 participants presenting with mild to severe psoriasis involving palms and soles</td>
<td>All participants showed 50%–100% improvement in PASI score with no relapse reported at 3 mo posttreatment</td>
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<tr>
<td>Hadi et al⁴⁰ (2010)</td>
<td>Investigate effectiveness of 308-nm excimer laser for treatment of various forms of localized stable psoriasis</td>
<td>Retrospective chart review of 98 patients (41 males, 57 females)</td>
<td>60.2% (59/98) of patients demonstrated significant improvement (&gt;70% clearance)</td>
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<tr>
<td>Gattu et al⁴¹ (2009)</td>
<td>Review of recent trials on efficacy of 308-nm excimer laser in treating psoriasis</td>
<td>18 trials from comprehensive review of medical literature in PubMed database using search terms psoriasis and 308-nm excimer laser</td>
<td>Useful and effective for psoriasis and may be used as a compliment to topical medications and NB-UVB</td>
</tr>
<tr>
<td>Trott et al⁴² (2008)</td>
<td>Compare therapeutic response of PUVA plus up to 4 UVB 308-nm radiations vs PUVA monotherapy in patients with moderate to severe plaque-type psoriasis</td>
<td>256 participants with moderate to severe plaque-type psoriasis completed the study; 272 participants were enrolled (149 received PUVA plus excimer combination therapy; 123 received PUVA monotherapy)</td>
<td>No statistically significant difference between PUVA and PUVA plus excimer in clearance rate; on average, participants treated with combination therapy went into remission in half the treatment time</td>
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<tr>
<td>He et al²⁸ (2007)</td>
<td>Evaluate efficacy and safety of 308-nm excimer laser for treatment of psoriasis vulgaris</td>
<td>40 participants presenting with macular-type (26/40) or chronic plaque-type (14/40) psoriasis vulgaris who completed 15 laser treatments</td>
<td>PASI scores improved by 90.19% for macular-type and 77.34% for chronic plaque-type psoriasis</td>
</tr>
<tr>
<td>Morison et al³³ (2006)</td>
<td>Retrospective analysis of 308-nm excimer laser for treatment of scalp psoriasis</td>
<td>35 participants (10 males, 25 females) ranging in age from 8–81 y</td>
<td>49% (17/35) of participants demonstrated clearance of &gt;95%; 45% (16/35) demonstrated clearance of 50%–95% (mean number of treatments, 21)</td>
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<tr>
<td>Nisticò et al&lt;sup&gt;44&lt;/sup&gt; (2006)</td>
<td>Efficacy analysis of 308-nm excimer laser in treatment of palmoplantar psoriasis</td>
<td>54 participants (29 males, 25 females)</td>
<td>57% (31/54) of participants demonstrated complete remission; 24% (13/54) partial remission; 19% (10/54) moderate improvement</td>
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<tr>
<td>Taibjee et al&lt;sup&gt;45&lt;/sup&gt; (2005)</td>
<td>Controlled prospective trial comparing efficacy of 308-nm excimer laser to PDL</td>
<td>15 of 22 participants presenting with localized plaque psoriasis completed study</td>
<td>PASI improvement was significantly greater in excimer group (4.7) vs PDL group (2.7) (P&lt;.003)</td>
</tr>
<tr>
<td>Pahlajani et al&lt;sup&gt;46&lt;/sup&gt; (2005)</td>
<td>Comparison of efficacy and safety of 308-nm excimer laser for treatment of localized mild to moderate plaque-type psoriasis in children vs adults</td>
<td>4/7 children and 12/18 adults completed the study</td>
<td>Children group had a greater reduction from mean baseline PASI (P=.008)</td>
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<td>Köllner et al&lt;sup&gt;47&lt;/sup&gt; (2005)</td>
<td>Compare 308-nm excimer laser and 308-nm excimer lamp with 311-nm NB-UVB in treatment of psoriasis</td>
<td>15 participants presenting with 3 plaques</td>
<td>PASI scores did not demonstrate a statistically significant difference</td>
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<tr>
<td>Taylor and Racette&lt;sup&gt;48&lt;/sup&gt; (2004)</td>
<td>Pilot study to investigate effectiveness of 308-nm excimer laser in combination with a hair blower for treatment of scalp psoriasis</td>
<td>13 participants (7 males, 6 females) completed the study (mean age, 44 y)</td>
<td>Mean MED, 311 mJ/cm²; mean treatment duration, &lt;5 min; mean number of treatments, 29; difference in mean modified PASI scores between the control and treated sites, 4.0 (P&lt;.001); 12/13 participants improved</td>
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<tr>
<td>Gerber et al&lt;sup&gt;37&lt;/sup&gt; (2003)</td>
<td>Develop new treatment parameters and determine whether effectiveness of excimer laser could be improved; also to determine whether cumulative dose and adverse effects could be minimized</td>
<td>120 standard protocol participants with chronic plaque psoriasis; 43 participants received an experimental supraverythemogenic treatment</td>
<td>Standard protocol group: 65.8% (67/102) demonstrated ≥90% clearance after maximum of 10 treatment sessions; experimental group: demonstrated a similar clearance rate (83.7%) in 34 of 40 participants</td>
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<tr>
<td>Taneja et al&lt;sup&gt;49&lt;/sup&gt; (2003)</td>
<td>Evaluate response of psoriatic plaques to 308-nm excimer laser</td>
<td>14 participants presenting with recalcitrant plaque psoriasis completed the study (44 total plaques)</td>
<td>Treatment group showed significant improvement compared to control (P&lt;.001)</td>
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<tr>
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<td>Rodewald et al(^5) (2002)</td>
<td>Assess patient impressions and satisfaction with 308-nm laser for treatment of mild to moderate psoriasis</td>
<td>124 participants with mild to moderate psoriasis</td>
<td>55% (68/124) of patients reported overall satisfaction with treatment; 63% (78/124) thought they needed additional treatments; 25% (31/124) reported laser treatments were better than any prior treatments they had tried</td>
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<tr>
<td>Trehan et al(^6) (2002)</td>
<td>Evaluate role of high-dose 308-nm excimer laser treatments for treatment of stable plaque-type psoriasis</td>
<td>16 participants completed the study; average age, 40.7 y</td>
<td>At baseline, mean modified PASI score was 6.31; 4 weeks after a single treatment, the mean PASI score was 3.56 ((P &lt; .001)); 11/16 (69%) demonstrated substantial improvement after 4 weeks; 5/16 (31%) demonstrated minimal improvement after 4 weeks</td>
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<tr>
<td>Trehan et al(^7) (2002)</td>
<td>Evaluate efficacy of multiple medium-dose 308-nm excimer laser treatments for psoriasis</td>
<td>15 participants completed study (8 males, 7 females); mean age, 44.9 y</td>
<td>Mean cumulative UV radiation dose was 6.1 J/cm(^2); mean remission time was 3.5 mo; mean number of treatments to achieve &gt;95% clearance was 10.6</td>
</tr>
<tr>
<td>Feldman et al(^8) (2002)</td>
<td>Demonstrate the efficacy of the 308-nm excimer laser for treatment of psoriasis</td>
<td>92 participants with stable mild to moderate plaque-type psoriasis</td>
<td>Initial dose based on multiples of predetermined MED; subsequent doses based on response to treatment; 72% (66/92) of participants achieved at least 75% clearance (mean number of treatments, 6.2)</td>
</tr>
<tr>
<td>Asawanonda et al(^9) (2000)</td>
<td>Determine the dose-response relationship of excimer laser–generated 308-nm UVB for treating plaque psoriasis</td>
<td>13 patients with at least 4 large stable plaques (mean age, 36.9 y; baseline PASI, 6)</td>
<td>Treatment with high fluences produced significantly better results than with medium and low fluences at weeks 4, 6, 8, and 10 ((P &lt; .05)); mean cumulative dose, 203.03 mJ/cm(^2)</td>
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</table>

Abbreviations: PASI, psoriasis area and severity index; NB-UVB, narrowband UVB; PUVA, psoralen plus UVA; PDL, pulsed dye laser; MED, minimal erythema dose.
Lasers and Light for Psoriasis

exposure. Monochromatic excimer light and the 308-nm excimer laser appear to have similar efficacy and evade some of the problems than can arise when utilizing other light therapies.

Phototherapy
Phototherapy using UVA or UVB irradiation is another important treatment option for psoriasis. Psoralen plus UVA employs the use of topical psoralen, which is absorbed preferentially by rapidly proliferating cells, followed by the application of 320- to 400-nm wavelength UVA light. The UVA light is strongly absorbed by the psoralen, having a mutagenic effect and inducing apoptosis. In a review of the literature, Dogra and De56 determined that PUVA is comparable to NB-UVB in efficacy but may induce longer remission times; in one retrospective study, Brazzelli et al157 estimated a remission time of approximately 386 days for PUVA. Unfortunately, PUVA simultaneously irradiates both affected and normal skin, thereby increasing carcinogenicity. Narrowband UVB therapy applies light at a wavelength of 311 nm and, similar to other phototherapies, affects DNA integrity, promotes cell-cycle arrest and apoptosis,56 and also exerts some anti-inflammatory effects. Narrowband UVB has demonstrated efficacy in clearing moderate to severe chronic psoriasis; however, similar to PUVA, NB-UVB poses a carcinogenic risk to exposed skin.58 Both PUVA and NB-UVB therapies serve as important modalities for chronic psoriasis, especially in patients with disease that is refractory to topical treatment, but these therapies also pose a risk for future cutaneous malignancy due to an accumulation of UV irradiation. The magnitude for this risk is still being elucidated.

CONCLUSION
Psoriasis has a complex pathophysiology in which both environmental and genetic factors play a role. Unfortunately, there is no known specific etiology for this relatively common chronic disease. Many therapeutic options are available for treating psoriasis, such as topical agents, systemic agents, NB-UVB and PUVA light modalities, and various lasers. Each of these modalities targets a contributing factor in the pathophysiology of psoriasis and contains specific side effects. Lasers have been investigated as alternatives for treating psoriasis due to the side effects of long-term use of potent topical corticosteroids, such as atrophy, striae, and telangiectasia. Overall, the 308-nm excimer laser is an effective treatment option for psoriasis. Most of the studies are small, though some larger ones also exist to support the positive results of the smaller studies. There are few side effects and the actual treatment time is only a few minutes. Phototherapy using UVA (320–400-nm light) or NB-UVB (311-nm light) is also effective in treating psoriasis, except, unlike the excimer laser, it may pose a higher risk for skin cancer due to the greater amount of healthy skin exposed to the carcinogenic light.

REFERENCES
17. Wolf N, Quaranta M, Prescott NJ, et al. Psoriasis is associated with pleiotropic susceptibility loci identified in type II diabetes
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