Vitiligo is an acquired cutaneous disorder of pigmentation with a 1% to 2% incidence worldwide, without sex or skin color predilection. The clinical presentation is characterized by solitary or multiple depigmented macules or patches that may arise in a localized, segmental, or generalized distribution.

Various treatment modalities have been described in the literature. The surgical modalities consist of autologous transplantation and include split-thickness epidermal grafting, epidermal blister grafting, and grafting of cultured melanocytes. The nonsurgical modalities, considered first-line therapy, include corticosteroids (oral, topical, and intralesional), oral or topical psoralens plus ultraviolet A (PUVA), and recently, narrow-band ultraviolet (UV) B therapy.

PUVA is a well-described therapy for vitiligo; its limitations include acute side effects such as nausea and phototoxic reactions, as well as long-term carcinogenic risk. In the past few years, two studies on narrow-band UVB for vitiligo have been published, both from a single center in Europe, and one of them specifically evaluated the efficacy and safety in children. We present our experience with narrow-band UVB phototherapy as further evidence of its utility in the treatment of vitiligo.

**PATIENTS**

All of the patients were seen in the dermatology clinic, Henry Ford Hospital, Detroit, Michigan. Patients with localized, segmental, or generalized vitiligo who initiated treatment over a 12-month period (November 1998-November 1999) were included in this data analysis. Eleven patients (6 men, 5 women) were included in the study. The ages of these 11 patients ranged from 19 to 59 years (median, 40 years). The patients were assessed for Fitzpatrick skin phototypes, overall disease duration, and history of previous therapy.

**METHODS**

This article reports a retrospective review of our experience with narrow-band UVB phototherapy for vitiligo. All 11 patients were treated with nar-
RESULTS
Profile of patients

Of the 11 patients, 4 were lost to follow-up because of scheduling difficulties. None of these patients experienced any adverse effects from phototherapy that warranted discontinuation of the phototherapy. Seven patients completed a course of therapy or were continuing to receive therapy as of April 2000. As shown in Table I, the age range was 19 to 59 years, with a mean of 37.6 years. Three of the 7 patients had skin phototypes IV and V, and the rest had skin phototypes II and III. Disease duration ranged from 5 months to 12 years. By history, previous therapies, including topical corticosteroids (n = 5) and oral PUVA (n = 1), had failed in 5 of the 7 patients.

Treatment outcome

The outcomes are presented in Table II. Five of 7 patients showed greater than 75% repigmentation after a mean number of 19 treatments (Fig 1). The mean duration of disease among these 5 patients was 13 months (Table III). Two of 7 patients failed to show repigmentation of greater than 75% after 46 and 48 treatments, respectively, although they did exhibit 50% and 40% repigmentation. The mean duration of disease in these two patients was 132 months.

Repigmentation in 6 cases was follicular in nature; it was most prominent in the center of each lesion. In one case (localized vitiligo of the right temporal area), row-band UVB as a monotherapy from November 1998 to November 1999. All patients were treated in a phototherapy unit (Ultralite 6809 Phototherapy Process Controller, Lawrenceville, Ga) containing a bank of 48 fluorescent tubes (TL-100W/01, Phillips, Eindhoven, The Netherlands) with peak emission at 311 to 312 nm. Therapy was administered 3 times a week, on nonconsecutive days. Affected segments of the body were exposed during each treatment. The genital area was shielded in all cases. Phototesting was not done as the lesional skin of all patients was considered to be Fitzpatrick skin phototype I. A minimal erythema dose (MED) of 400 mJ/cm² was predetermined for this skin phototype. The initial fluence for each patient was 70% of the MED, or 280 mJ/cm². The irradiation dose was increased by 15% for each subsequent treatment. If the patient reported mild erythema or pruritus, the irradiation dose was held constant for the subsequent treatment, or until resolution of symptoms. If symptomatic erythema (burning, pain) or blistering developed, the irradiation dose was decreased by 15%. A physician (L. S., J. J. K., or H. W. L.) examined patients every 2 weeks. Once 75% repigmentation was achieved, the frequency of treatments was tapered to twice a week for 4 weeks, then weekly for 4 weeks. Lesional photography was performed at the initial pretreatment visit and monthly thereafter.

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>Age (y)/Sex</th>
<th>Skin type</th>
<th>Duration of disease</th>
<th>Disease phase</th>
<th>Previous therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>53/M</td>
<td>II</td>
<td>6 mo</td>
<td>Latent</td>
<td>Topical corticosteroids</td>
</tr>
<tr>
<td>2</td>
<td>25/M</td>
<td>V</td>
<td>3 y</td>
<td>Progressive</td>
<td>Topical corticosteroids</td>
</tr>
<tr>
<td>3</td>
<td>24/F</td>
<td>III</td>
<td>1 y</td>
<td>Latent</td>
<td>Topical corticosteroids</td>
</tr>
<tr>
<td>4</td>
<td>59/F</td>
<td>IV</td>
<td>8 mo</td>
<td>Progressive</td>
<td>None</td>
</tr>
<tr>
<td>5</td>
<td>54/M</td>
<td>V</td>
<td>5 mo</td>
<td>Progressive</td>
<td>None</td>
</tr>
<tr>
<td>6</td>
<td>29/F</td>
<td>II</td>
<td>10 y</td>
<td>Regressive</td>
<td>Topical corticosteroids, PUVA</td>
</tr>
<tr>
<td>7</td>
<td>19/M</td>
<td>II</td>
<td>12 y</td>
<td>Latent</td>
<td>Topical corticosteroids</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Patient No.</th>
<th>% Repigmentation</th>
<th>No. of treatments for repigmentation</th>
<th>Cumulative dose (J/cm²)</th>
<th>Side effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt;75</td>
<td>11</td>
<td>7.4</td>
<td>Mild erythema</td>
</tr>
<tr>
<td>2</td>
<td>&gt;75</td>
<td>19</td>
<td>11.1</td>
<td>Mild erythema</td>
</tr>
<tr>
<td>3</td>
<td>&gt;75</td>
<td>20</td>
<td>14.7</td>
<td>Pruritus</td>
</tr>
<tr>
<td>4</td>
<td>&gt;75</td>
<td>25</td>
<td>26.6</td>
<td>Mild erythema</td>
</tr>
<tr>
<td>5</td>
<td>&gt;75</td>
<td>22</td>
<td>18.8</td>
<td>None</td>
</tr>
<tr>
<td>6</td>
<td>50</td>
<td>46</td>
<td>77.0</td>
<td>None</td>
</tr>
<tr>
<td>7</td>
<td>40</td>
<td>48</td>
<td>63.8</td>
<td>Mild erythema</td>
</tr>
</tbody>
</table>
observed repigmentation occurred from the periphery (Fig 2). Of note, most patients experienced initial repigmentation that was darker than surrounding nonlesional skin. This darker pigmentation was especially prominent in patients having skin phototypes IV and V. In all cases, the color intensity normalized over several weeks, providing a good cosmetic result without any ancillary intervention, even while patients continued to receive therapy (Fig 1).

Six of the 7 patients continue to be followed up in the dermatology clinic, whereas one was lost to follow-up. In the assessment of duration of response, 4 patients have retained their repigmentation. In fact, one subject has remained completely repigmented 11 months after phototherapy was discontinued. By contrast, two patients experienced a loss of pigmentation. Approximately 4 months after phototherapy was discontinued, several depigmented macules and patches in previously uninvolved skin developed in one of these two patients. The second patient experienced a loss of pigment in newly repigmented areas when phototherapy was tapered to twice a week. In both cases, repigmentation occurred after narrow-band phototherapy treatments were reinitiated at 3 times a week.

### Adverse effects
Adverse side effects were minimal. Four patients reported mild asymptomatic erythema and one patient reported pruritus, which resolved spontaneously. No patients experienced symptoms that warranted suspension or discontinuation of narrow-band UVB phototherapy.

### DISCUSSION
In 1981 Parrish and Jaenicke found that 311-nm wavelength UVB radiation was most effective for the
of our 7 patients had more than 75% repigmentation after a mean of 19 treatments (ie, 6-7 weeks), a response rate that was faster and higher than that reported previously. Whether the differences in the treatment protocols and in the distribution of skin types between the two analyses have contributed to the different response remains to be investigated.

Potential limitations of narrow-band UVB phototherapy are the scheduling difficulties and time commitment. At our center, phototherapy treatments are initiated on a 3-times-weekly schedule. Multiple visits are required for successful repigmentation. At present, in the United States, narrow-band UVB phototherapy is only available in a few centers; therefore patients often have to commute long distances for treatment. In fact, 4 of our initial 11 patients, or 36%, discontinued narrow-band UVB phototherapy because of time and schedule restraints. Issues with insurance coverage are also germane since the therapy is not covered by all insurance carriers.

In a recent meta-analysis of nonsurgical therapies for vitiligo by Njoo et al,17 corticosteroid therapy was reported to have a success rate of 56% in localized disease. However, the high incidence of cutaneous side effects makes corticosteroid therapy undesirable for long-term use; it is also impractical in cases involving large body surface area. In the same analysis, high success rates in the treatment of generalized vitiligo were seen with oral PUVA (51%), broadband UVB (57%), and narrow-band UVB (63%). Our results extended these previous observations by demonstrating that rapid repigmentation occurs in patients with skin types IV and V. A noteworthy observation in our patients is that longer duration of disease seems to correlate with less successful repigmentation (Table III). The mean duration of disease

The use of narrow-band UVB phototherapy for vitiligo was first reported by Westerhof and Nieuweboer-Krobotova2 in 1997. These investigators compared twice-weekly topical PUVA to twice-weekly narrow-band UVB phototherapy. They showed that after 4 months of therapy, 67% of patients undergoing narrow-band UVB phototherapy showed repigmentation compared with 46% of patients receiving topical PUVA. The extent and rates of repigmentation among patients receiving narrow-band UVB were further examined in a separate subset of patients. In this subset, 8% of patients repigmented greater than 75% after 3 months of treatment and 63% did so after 12 months. It was concluded that compared with topical PUVA phototherapy, narrow-band UVB was equally, if not more, effective and was associated with fewer side effects.

There are several key differences between the findings of Westerhof and Nieuweboer-Krobotova2 and ours. Their study design was a two-arm treatment trial, whereas ours is a report of prescribed therapy. The starting dose in this previous study was 75 mJ/cm², and treatment frequency was twice weekly. In contrast, we used a starting dose of 280 mJ/cm², and treatment was given 3 times per week. Eighty-six percent of the patients in the previous study had skin types II and III, whereas the corresponding percentage in our patients was 57% (4/7 patients). Eighty-six percent of the patients in the previous study had skin types II and III, whereas the corresponding percentage in our patients was 57% (4/7 patients).
among the best responders (>75% repigmentation) was 13 months, compared with 132 months among the poor responders (<75% repigmentation). Thus those patients who had more than 75% repigmentation had a 10-fold shorter disease duration than the patients who repigmented less than 75%. This correlation has not been previously reported; it is difficult to say whether these data represent a significant finding or reflect our small sample size (n = 7). However, this observation suggests that it may be best to initiate narrow-band therapy in the early stages of the disease process.

The mechanism of action of narrow-band phototherapy in vitiligo has not been completely understood. Vitiligo is characterized by the selective destruction of melanocytes; the cause is unknown, but is generally believed to be an autoimmune process. Repigmentation, when it occurs, begins at the hair follicle, where dopa-negative, amelanotic melanocytes in the outer root sheaths are somehow activated to proliferate, produce melamins, and migrate outward to surrounding depigmented skin. Melanocyte mitogenesis, melanogenesis, and melanocyte migration have been shown to be induced by various cytokines and inflammatory mediators, including interleukin (IL)-1, tumor necrosis factor–α, and leukotriene C4. IL-1α stimulates the synthesis of endothelin-1, a potent vasoconstrictive peptide that has mitogenic and melanogenic properties. Imokawa, Miyagishi, and Yada found that expression of endothelin-1, IL-1α, and tyrosinase in human keratinocytes in vitro and in vivo were increased after UVB irradiation, suggesting a possible mechanism of UVB-induced repigmentation.

Another new approach in the treatment of vitiligo comes from recent investigations on the effect of oxidative stress in vitiligo. Schallreuter et al reported low epidermal catalase in lesional and nonlesional skin, resulting in the accumulation of hydrogen peroxide. They demonstrated that application of topical pseudocatalase, a nonenzymatic complex capable of degrading hydrogen peroxide to water and oxygen after photoactivation with narrow-band UVB, resulted in repigmentation.

In summary, our findings extend previous observations that narrow-band UVB is a useful and well-tolerated treatment option for patients with vitiligo. It is clear that much still needs to be elucidated at both the clinical and molecular levels in the pathogenesis of and therapy for this disease.

REFERENCES