

## What Is New in Narrow-Band Ultraviolet-B Therapy for Vitiligo?

### Abstract

Vitiligo is an acquired disorder of skin pigmentation that produces significant psychological impact especially in those with skin of color. Narrow-band ultraviolet B (NB-UVB) therapy, which was first used in vitiligo in 1997 by Westerhof and Nieuweboer-Krobotova, has emerged as one of the safest and most effective therapy for this dermatosis. The light source used for NB-UVB phototherapy is the TL-01 lamp, and the most common model of the NB-UVB phototherapy device is the upright in-office booth or chamber which has 24–48 such lamps. In recent years, there have been several advances in the understanding of the mechanism of action of NB-UVB and the use of combination treatments, many of which increase the efficacy of NB-UVB. In 2017, the Vitiligo Working Group made vital recommendations on the dosage, frequency, and safety of NB-UVB in vitiligo. Furthermore, home phototherapy devices are gaining popularity as they lead to an improved patient compliance. There is still need for large multicenter randomized controlled trials to assess benefits of home phototherapy in vitiligo and studies investigating additional benefits of phototherapy following surgical therapy.

**Keywords:** *Advances, narrow-band UV-B, phototherapy, vitiligo*

### Introduction

Vitiligo is an acquired disorder of skin pigmentation that produces significant psychological impact especially in those with skin of color.<sup>[1]</sup> Various topical and systemic treatment modalities are available; however, phototherapy especially narrow-band ultraviolet B (NB-UVB) has emerged as one of the safest and most effective therapy for this condition.<sup>[2]</sup> Among the phototherapeutic modalities, psoralen plus ultraviolet A (PUVA) was very popular earlier. However, the side effects of psoralen such as nausea, vomiting, phototoxicity, and carcinogenic potential of PUVA therapy resulted in its decreased popularity.<sup>[3]</sup> NB-UVB was first used in vitiligo in 1997 by Westerhof and Nieuweboer-Krobotova.<sup>[4]</sup> The light source used for NB-UVB phototherapy is the TL-01 lamp, and the most common mode of delivery is through the upright in-office booth or chamber which has 24–48 such lamps. TL-01 lamp is a phosphor-coated fluorescent bulb emitting wavelengths between 310 and 315 nm. The peak emission is at 311 nm and this ensures reduction of superfluous radiation,

consequently minimizing the risk of severe burning or other cutaneous side effects of UV radiation. This specific wavelength is very effective in vitiligo because it can stimulate the dormant skin melanocytes and also modulate the cutaneous immune system.<sup>[5]</sup> However, the exact mechanism of NB-UVB-induced pigmentation still remains unknown.<sup>[6]</sup>

Westerhof *et al.* first provided encouraging results in favor of NB-UVB in vitiligo in which 63% of their patients achieved 75% or greater repigmentation after 12 months of twice-weekly therapy when compared with 46% of patients achieving similar degree of repigmentation with topical PUVA.<sup>[4]</sup> Scherschun *et al.* who treated their vitiligo cases with NB-UVB monotherapy three times/week, with end points of 75% repigmentation or no further improvement, reported this result in five of their seven patients after a mean of 19 treatments, with improved clinical outcomes in patients with shorter disease duration.<sup>[2]</sup> Yones *et al.* in a randomized study of 25 patients each of generalized vitiligo receiving either twice-weekly NB-UVB phototherapy or twice-weekly oral PUVA showed greater than 50% overall repigmentation in 64% of patients in the NB-UVB group compared with 36% patients in the oral PUVA group.

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

Urmi Khanna,  
Sujay Khandpur<sup>1</sup>

Department of Dermatology,  
Cleveland Clinic, Cleveland,  
Ohio, USA, <sup>1</sup>Department of  
Dermatology, All India Institute  
of Medical Sciences, New Delhi,  
India

### Address for correspondence:

Dr. Sujay Khandpur,  
Department of Dermatology,  
All India Institute of Medical  
Sciences, Ansari Nagar,  
New Delhi - 110 029, India.  
E-mail: sujay\_khandpur@yahoo.  
com

### Access this article online

Website: [www.idoj.in](http://www.idoj.in)

DOI: 10.4103/idoj.IDOJ\_310\_18

### Quick Response Code:



**How to cite this article:** Khanna U, Khandpur S. What is new in narrow-band ultraviolet-B therapy for vitiligo? *Indian Dermatol Online J* 2019;10:234-43.

**Received:** August, 2018. **Accepted:** February, 2019.

The median number of treatment sessions was 97 and 47, respectively. Excellent color match was seen in all patients treated with NB-UVB when compared with only 44% cases in the PUVA group.<sup>[7]</sup> Njoo *et al.*, in their meta-analysis of nonsurgical therapies in generalized vitiligo, observed repigmentation in higher percentage (63%) of NB-UVB treated cases than with oral PUVA (51%).<sup>[8]</sup> Due to absence of psoralen-related side effects and better color match, NB-UVB is also preferred in childhood vitiligo.<sup>[8,9]</sup> In an open trial consisting of 51 children with generalized vitiligo, NB-UVB was found to be effective and safe. It is also safe in pregnancy and lactation.<sup>[9]</sup> Therefore, NB-UVB has emerged as a leading treatment modality for vitiligo, and in this article, we aim to discuss the recent advances in NB-UVB-based phototherapy for this condition. Table 1 below summarizes the evolution of NB-UVB.

### New Concepts in NB-UVB's Mechanism of Action in Vitiligo

NB-UVB has been found to be the most powerful stimulus for vitiligo repigmentation; however, the exact pathomechanism is still not clearly understood. A part of NB-UVB-induced repigmentation may be explained by NB-UVB-activated vitamin D3 synthesis,<sup>[18]</sup> which is explained as follows in Figure 1.

In more recent studies, authors have proposed that cumulative doses of NB-UVB could improve low vitamin D and this in turn may influence the rate of repigmentation.<sup>[19,20]</sup> Patients with vitiligo have been noted to have lower expression of vitamin D receptor and also lower serum levels of vitamin D when compared with a

control population.<sup>[20]</sup> Atas *et al.* in their study found that while treatment with NB-UVB improved vitiligo, it led to decrease in serum vitamin B12 level.<sup>[21]</sup> However, serum levels of folate and homocysteine showed no significant change after treatment. The authors proposed that more studies are needed to clarify the influence of NB-UVB phototherapy on vitamin B12 and homocysteine and consequently their effect on repigmentation in vitiligo patches.<sup>[21]</sup> Table 2 further summarizes other recent studies exploring the mechanisms of NB-UVB in vitiligo.

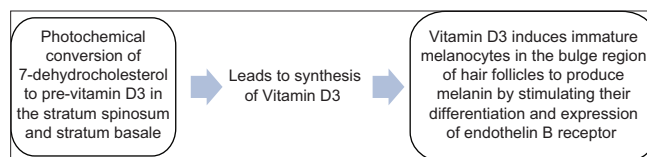
### Clinical Practice Updates for NB-UVB-Based Therapy in Vitiligo

The Vitiligo Working Group's (VWG) phototherapy group addressed 19 critical questions to formulate the phototherapy recommendations for vitiligo, for better clinical management and help identify areas warranting future research in the field of phototherapy for vitiligo. These consensus guidelines on NB-UVB treatment in vitiligo are summarized in Table 3. The VWG guidelines highlighted that repigmentation is dependent on the total number of sessions, with earlier onset of pigmentation seen in patients who receive thrice-weekly dosing, with no published literature directly comparing the differential efficacy of twice- versus thrice-weekly regimens.<sup>[27]</sup> To avoid phototoxic adverse effects and also for the sake of convenience, it recommended that a fixed dosing protocol be initiated at 200 mJ/cm<sup>2</sup> regardless of skin type.<sup>[27]</sup> For darker skin types, dosing strategy tailored to skin type could also be used. The group also proposed the maximum acceptable dose for the face in a given treatment to be 1500 mJ/cm<sup>2</sup>, while the maximum dose for the body to be 3000 mJ/cm<sup>2</sup>. Often 18–36 exposures are necessary before assessing treatment response. A lack of response is said to occur in those who fail to respond after a minimum of 48 NB-UVB sessions.<sup>[27]</sup>

A meta-analysis published in 2017 assessed the treatment response to phototherapy in vitiligo by identifying prospective studies on NB-UVB and PUVA. A total of 35 studies were finally included in the analysis, of which 29 were based on NB-UVB and 9 on PUVA. The meta-analysis showed that NB-UVB resulted in better treatment response. It also concluded that longer treatment duration should be encouraged to enhance treatment response, and a minimum period of 6 months is required to assess response to phototherapy. The best response was seen on face and neck, whereas the least responsive areas to phototherapy were hands and feet.<sup>[28]</sup> Chahar *et al.*

**Table 1: Evolution of NB-UVB**

Year	Event
1400 BC	First use of light therapy in vitiligo in 1400 BC with use of plant concentrates of <i>Psoralea corylifolia</i> in India and <i>Ammi majus</i> Linnaeus in Egypt in topical or oral forms followed by sun exposure <sup>[10]</sup>
19 <sup>th</sup> century	Real use of UV therapy in skin diseases started. Niels Finsen received Nobel Prize in 1903 for its use in lupus vulgaris <sup>[11]</sup>
1974	Use of PUVA by Parrish in psoriasis <sup>[12]</sup>
1977	Fischer found that 313 nm UV light cleared psoriatic plaques <sup>[13]</sup>
1978	Introduction by Wiskemann of cabin with broadband UVB tubes for psoriasis. Lack of efficacy in psoriasis. Broadband UVB went into disrepute <sup>[14]</sup>
1987	Diffey and Farr found UVB to be most effective and viable at 311 nm <sup>[15]</sup>
1990	It was established that 313 nm was the most reduced and effective wavelength and least erythemogenic-ideal "phototherapy index" for psoriasis <sup>[16]</sup>
1997	NB-UVB first used in vitiligo by Westerhof and Nieuweboer-Krobotova <sup>[4]</sup>
1997	Use of 308 nm excimer XeCl laser <sup>[17]</sup>



**Figure 1: Role of Vitamin D3 in NB-UVB induced repigmentation in vitiligo**

**Table 2: Recent studies evaluating the molecular basis/pathogenesis of vitiligo and NB-UVB therapy**

Study	Methodology	Results
Evaluation of skin expression profiles of patients with vitiligo treated with narrow-band UVB therapy by targeted RNA-sequence. <sup>[22]</sup>	Forty-five Mexican patients were enrolled and 2 biopsies each (from pigmented and nonpigmented tissue) were obtained pre- and post-NB-UVB treatment. RNAs extracted from biopsies were analyzed for gene expression.	Five genes involved in skin pigmentation were identified, 2 genes involved in apoptosis, 2 in cell survival, 2 in oxidative stress responses, and 1 gene involved in signal transduction ( $P<0.05$ ).
Activation of melanoblasts and melanocytes after treatment with MEL and NB-UVB in skin of patients with vitiligo. <sup>[23]</sup>	Macules of 28 patients with vitiligo were repeatedly exposed to MEL/NB-UVB, followed by punch biopsies of center and edge of lesional skin and normal skin and processed for dopa and combined dopa-premelanin reactions.	Two patterns of repigmentation observed - marginal and perifollicular - with no difference in the number of melanocytes or melanoblasts at the center and edge of lesions, and mean percentage repigmentation in both patterns being comparable.
Repigmentation of human vitiligo skin by NB-UVB is controlled by transcription of glioma-associated oncogene (GLI-1) and activation of the beta catenin pathway in the hair follicle bulge stem cells. <sup>[24]</sup>	The authors developed an application that combined laser capture microdissection and subsequent whole transcriptome RNA sequencing of hair bulge melanocyte precursors and compared their gene signatures with regenerated mature epidermal melanocytes from NB-UVB-treated vitiligoskin.	The study found upregulation of several genes in bulge melanocytes and of tyrosinase gene in the epidermal melanocytes of NB-UVB-treated vitiligo skin. GLI-1 was significantly upregulated in melanocytes captured from NB-UVB-treated vitiligo bulge.
Expression of JAK-1 in vitiligo and psoriasis before and after NB UVB: a case-control study. <sup>[25]</sup>	JAK1 levels before and after NB-UVB treatment (36 sessions) were measured using Western blot assay in 10 patients each of psoriasis and vitiligo and 10 controls.	JAK1 levels were significantly higher in vitiligo and psoriasis, with significant decline in their level after treatment. The study raises the possibility of using JAK1 inhibitors as targeted immunotherapy for vitiligo.
Selenium, zinc, copper, Cu/Zn ratio, and total antioxidant status in the serum of patients with vitiligo treated by narrow-band ultraviolet-B phototherapy. <sup>[26]</sup>	Trace elements and antioxidants were measured in serum of patients with vitiligo before and after phototherapy and in healthy controls.	Serum Se in patients with vitiligo was significantly lower before and after phototherapy compared with controls. Zn level decreased significantly after phototherapy. A higher Cu/Zn ratio was found in patients than in control group and after NB-UVB. Antioxidant levels were also decreased in serum of patients with vitiligo after NB-UVB.

NB-UVB=Narrow-band ultraviolet B; MEL=Monochromatic excimer light; JAK-1=Janus Kinase-1

conducted a study to assess the impact on quality of life in patients with vitiligo treated with NB-UVB. A total of 54 patients, both adults and children, were included, and they received NB-UVB doses of 300 and 150 mJ/cm<sup>2</sup> twice weekly with 20% increment in doses. The Dermatology Life Quality Index (DLQI) improved significantly, especially in younger patients.<sup>[29]</sup> Mou *et al.* also demonstrated similar significant improvement in DLQI after NB-UVB treatment in their patients with vitiligo.<sup>[30]</sup> A recent study on 28 patients with head and neck vitiligo, evaluating low-dose NB-UVB (doses being held constant for six sessions before actually increasing them) compared with conventional NB-UVB therapy, concluded that low dose may be sufficient to induce repigmentation in cases with stable vitiligo and slow increase in fluence may actually have a noninferior efficacy to conventional UVB, while having advantages of lesser tanning and aging effects due to a lower cumulative dose.<sup>[31]</sup> All vitiligo lesions in a patient may not have a similar therapeutic response and this was clearly demonstrated by Anbar *et al.* in their study assessing response to NB-UVB in 25 patients with nonsegmental generalized vitiligo. The authors concluded that vitiligo lesions may not act as one unit and close follow-up using both objective and subjective measures may be necessary.<sup>[32]</sup>

A recent retrospective study that assessed treatment outcome and persistence of repigmentation from twice-weekly NB-UVB concluded that persistence of repigmentation was seen in 80% of patients even after a year of stopping therapy.<sup>[33]</sup>

### The Concept of “Very Slow Responders”

In a retrospective cohort study of 579 patients, Cabrera *et al.* attempted to develop a predictive model for response rate of nonsegmental vitiligo to NB-UVB phototherapy.<sup>[34]</sup> Treatment was continued for many patients who were previously considered nonresponders. Response rates were classified as very rapid, rapid, average, slow, and nonresponders.<sup>[34]</sup> The authors reported a new subgroup among the nonresponders as those who failed to respond in the first 48 sessions, but showed significant repigmentation after 96 sessions of NB-UVB. They termed this subgroup as “very slow responders.” According to the observations of VWG committee members, a slower than usual response could be seen in some patients, thus a minimum of 72 NB-UVB sessions should be administered before labeling a patient as a nonresponder.<sup>[27]</sup>

**Table 3: Salient features of the Vitiligo Working Group's (2017) phototherapy recommendations<sup>[22]</sup>**

1. Frequency of administration
  - Three times per week (optimal): earlier onset repigmentation
  - Two times per week (acceptable): convenient, improved patient compliance, increase patient capacity at phototherapy centers
2. Dosing protocol
  - Starting dose: fixed dose of 200 mJ/cm<sup>2</sup> irrespective of skin type
  - Increment in dose: 10%-20% per session
3. Maximum acceptable dose
  - Face: 1500 mJ/cm<sup>2</sup>
  - Body: 3000 mJ/cm<sup>2</sup>
  - Higher doses may be tolerated by individuals; however, there are no long-term studies on carcinogenic risk of phototherapy, so caution is advised
4. Maximum number of exposures
  - Skin photo types IV-VI: no ceiling number
  - Skin photo type I-III: more data on long-term carcinogenic effect is needed before this can be ascertained
5. Course of narrowband ultraviolet B (NB-UVB)
  - About 18-36 sessions needed prior to assessing treatment response
  - ≥48 sessions needed before discontinuing phototherapy due to lack of response
  - Others believe ≥72 sessions needed before stopping phototherapy especially in slow responders
6. Dose adjustment
  - Absence of perceptible erythema: increase dose by 10%-20%
  - Pink asymptomatic erythema lasting <24 h (desired response): maintain at current dose till erythema disappears and then increase by 10%-20%
  - Bright red asymptomatic erythema: withhold phototherapy till it becomes light pink, and then restart at previous dose
  - Symptomatic (pain/blistering) erythema: withhold phototherapy and wait till area becomes healed and light pink and then resume at last tolerated dose
7. Dose adjustments for missed doses
  - 4-7 days between treatments: maintain constant dose
  - 8-14 days between treatments: reduce dose by 25%
  - 15-21 days between treatments: reduce dose by 50%
  - >21 days between treatments : restart at baseline dose
8. Dose adjustment after device calibration or replacement of bulb (s)
  - Decrease dose by 10%-20%
9. Evaluating treatment response at baseline and during follow-up
  - Serial photography: ideally every 3 months
  - Validated scoring systems: Vitiligo Area Scoring Index, Vitiligo European Task Force Assessment
10. Post NB-UVB exposure recommendations
  - Sunscreen - apply broad-spectrum sunscreen regardless of skin type; minimum skin protection factor of ≥30 and reapply every 2 h
  - Avoid additional sun exposure
11. Topical products before phototherapy
  - Mineral oil: can be used topically before phototherapy in case of dry thickened skin such as elbows and knees as it enhances penetration of light
  - All other topical applications: avoided for ≥4 h before phototherapy as they lead to deactivation or interfere with NB-UVB penetration
12. Special sites precautions during phototherapy
  - Face: cover face during phototherapy if uninvolved
  - Male genitalia: use shields
  - Female areola: use sunscreen before treatment especially in skin photo types I-III
  - Eyelid lesions can be treated with phototherapy, however tape the eyelids together to keep eyes firmly closed
13. Maintenance regimen for NB-UVB after plateau in response
  - 1<sup>st</sup> month: continue phototherapy 2 times/week
  - 2<sup>nd</sup> month: continue phototherapy 1 time/week
  - 3<sup>rd</sup> month: continue phototherapy once every alternate week
  - 4 months and beyond after plateau in treatment response discontinue the phototherapy
14. Follow-up after phototherapy
  - All patients to return for treatment in case of relapse

*Contd...*

**Table 3: Contd...**


---

Skin photo types I-III: annual full body skin examination to screen for malignancy
Skin photo types IV-VI: no need for follow-up screening as no reports of malignancy exist for this group
14. Management of skin changes secondary to NB-UVB
Xerosis: emollient or mineral oil
Skin thickening: topical corticosteroids or keratolytics
15. Combination treatments
Main aim is to stabilize the lesions
Therapies increasing photosensitivity in the UVB range should be avoided
Oral antioxidants: ginkgo biloba, alpha lipoic acid, and polypodium leucotomos extract
Topical treatments
Oral pulse corticosteroids: dexamethasone for 2 consecutive days/week
16. NB-UVB in children
No clear-cut minimum age - but typically when children are able to stand in phototherapy booth with eyes closed or wearing goggles; usually around 7-10 years of age

---

NB-UVB=Narrow-band ultraviolet B

### NB-UVB for Childhood Vitiligo

The VWG recommends that children 7–10 years of age who are able to stand in the cabinet with either of their eyes closed or while wearing goggles can receive phototherapy.<sup>[27]</sup> For younger children, an adult can remain with the child; however, incomplete photoprotection may often lead to unnecessary exposure of the adult, and also in some cases the body of the adult can shield the child from the therapeutic radiation.<sup>[9,27]</sup> In a study of 28 children treated with NB-UVB, 43% showed good to excellent response, with no major side effects.<sup>[35]</sup> Dayal *et al.* assessed the efficacy of NB-UVB monotherapy versus phototherapy following topical tacrolimus ointment (0.03%) application in 20 children between 4 and 14 years of age and found significant advantage of using NB-UVB in combination with tacrolimus.<sup>[36]</sup>

### NB-UVB – Safety Recommendations

Phototherapy is an effective treatment for eyelid vitiligo.<sup>[37]</sup> *In vitro* studies have shown that NB-UVB has negligible penetration through the eyelid, and thus patients are advised to keep their eyes closed firmly during the treatment session. In a study evaluating the ocular side effects of NB-UVB over a 13-month treatment period, it was noted that there was no decrease in visual acuity or ocular complications including cataract.<sup>[37]</sup>

During therapy, the face if uninvolved should be covered, male genitalia should be shielded to reduce risk of genital malignancy, and a sunscreen should be applied over the female areola to protect it from burns.<sup>[38]</sup> The cutaneous carcinogenic effect of NB-UVB has been hypothesized but not proven. In a retrospective study involving 375 patients, with vitiligo and psoriasis being the predominant diseases, in which the carcinogenic potential of NB-UVB was evaluated during a mean follow-up period of 6.9 years, 8 patients (2.1%) were diagnosed with nonmelanoma skin cancer after about 5 years of the

onset of phototherapy and these were particular seen in elderly patients with psoriasis. No malignant melanoma was observed.<sup>[39]</sup> In fact, NB-UVB has been safely used in vitiligo-induced by immune check point inhibitors used to treat melanoma.<sup>[40]</sup>

### Combination Treatments – What Is New?

Combination treatments have several advantages including reduced total number of phototherapy sessions, decreased side effects, and quicker repigmentation. Shin *et al.* studied the combined use of NB-UVB and excimer laser and found that it could enhance treatment responses and increase patient compliance.<sup>[41]</sup> They first treated their patients with NB-UVB; excimer laser was then used along with phototherapy in those with delay or plateau in response with continuous NB-UVB monotherapy. Among 80 patients, 54 (67.5%) responded after combined treatment with excimer laser, while the remaining 32.5% subjects showed no significant repigmentation. About 46% of the nonresponders had acral vitiligo, a treatment resistant site.<sup>[41]</sup> Lee *et al.* in their study concluded that oral methyl prednisolone mini-pulse therapy combined with NB-UVB rapidly induced repigmentation and arrested vitiligo progression with minimal side effects. All 32 patients with nonsegmental vitiligo showed arrest in disease progression within 12 weeks, and about 40% cases reported satisfactory repigmentation in more than 50% of their lesions.<sup>[42]</sup> Doghaim *et al.* evaluated the safety and efficacy of fractional carbon dioxide (CO<sub>2</sub>) laser therapy followed by NB-UVB phototherapy in 32 patients with stable resistant vitiligo. The authors concluded that combination therapy shortens treatment duration and improves efficacy and patient compliance.<sup>[43]</sup> In contrast to this study, another trial combining the two modalities in nonsegmental vitiligo failed to show significant advantage over NB-UVB alone.<sup>[44]</sup> More studies evaluating this combination over longer follow-up periods are needed. Namazi *et al.* in their study proposed that vanillic acid

ethyl ester, available as 20% cream formulation and used twice a day, could serve as a useful adjunct to NB-UVB.<sup>[45]</sup> Vanillic acid scavenges hydrogen peroxide which is present in high levels in vitiligo patches. This reduces the oxidative stress which is one of the theories implicated in the pathogenesis of vitiligo, thereby enhancing the effect of NB-UVB. An innovative topical cream (Photocil®) blocks the nontherapeutic solar radiation and selectively delivers NB-UVB therapy.<sup>[46]</sup> It is water-in-oil emulsion and is applied only on vitiliginous patches thrice a week for 12 weeks, with average treatment time of 30 min. Diethylamino hydroxybenzoyl hexyl benzoate and alpha-glucosyl hesperidin, the glucosylated derivatives of natural plant flavonoids, are the active ingredients of the cream.<sup>[46]</sup> Stanimirovic *et al.* investigated a unique treatment strategy for resistant vitiligo, especially acrofacial lesions.<sup>[47]</sup> They used NB-UVB and topical latanoprost solution (0.005% solution) with or without microneedling. Repigmentation rates were low (38%) with more than 50% of repigmentation seen only in 8.8% of repigmenting lesions. Addition of microneedling did not improve treatment outcome. However, this study did provide some evidence supporting the combined use of latanoprost with NB-UVB phototherapy to induce repigmentation in difficult-to-treat vitiligo lesions.<sup>[47]</sup> A meta-analysis by Li *et al.* assessing utility of combination treatment of topical agents with NB-UVB, in which seven randomized controlled trials were included, found no significant difference in clinical outcomes by addition of topical calcineurin inhibitors/vitamin D3 analogs to NB-UVB. The study, however, did report that the addition of calcineurin inhibitors to NB-UVB improved repigmentation rates in vitiligo affecting face and neck.<sup>[48]</sup> Decreasing oxidative stress in vitiligo by addition of oral and topical (pseudo-catalase) antioxidants has been found to improve repigmentation rates and decrease the mean number of combination therapies needed with NB-UVB.<sup>[49]</sup> Dell'Anna *et al.* found that the addition of a tablet containing vitamins E and C, alpha-lipoic corrosive, polyunsaturated fats, and cysteine monohydrate led to 47% of subjects achieving greater than 75% of repigmentation compared with just 18% attaining a similar response in the NB-UVB monotherapy group.<sup>[50]</sup> Afamelanotide is a synthetic analog of naturally occurring  $\alpha$ -MSH which has a potent and long-lasting effect. In a study combining afamelanotide with NB-UVB, it was noticed that there was quicker and deeper repigmentation due to its effect on melanoblast differentiation, proliferation, and eumelanogenesis.<sup>[51]</sup> In another recent study, patients with vitiligo with skin photo types III–VI were subjected to combination treatment (afamelanotide with NB UVB) versus NB-UVB monotherapy. The combination therapy group received four monthly subcutaneous afamelanotide implants. The authors concluded that patients with darker skin types responded more rapidly to combination treatment.<sup>[52]</sup> In another study, intradermal 5-fluorouracil

appeared to enhance NB-UVB efficacy, with 48% of patients accomplishing >75% repigmentation in contrast to 7% patients treated with NB-UVB monotherapy.<sup>[53]</sup> Other recent studies evaluating the role of NB-UVB in combination with other treatment modalities in vitiligo are listed in Table 4.

### Home Phototherapy – New NB-UVB Delivery Devices

Handheld NB-UVB units are portable and lightweight devices, useful for treating vitiligo affecting small areas. The advantages of using handheld devices at home include significant reduction in the number of hospital visits, which in turn leads to reduced traveling expense, sparing of uninvolved skin, and decreased threshold to start treatment in individuals with limited disease activity.<sup>[62]</sup> The Hi-Light trial registered in 2015 was a placebo-controlled randomized feasibility trial in which 29 patients with nonsegmental vitiligo received therapy with handheld NB-UVB home phototherapy devices or placebo, using placebo irradiation.<sup>[63]</sup> Various CE marked brands of hand-held NB-UVB units were used, with dummy units being identical to the active devices. Treatment lasted for 4 months, with three to four sessions per week in which 84% of subjects were compliant with their treatment regimen and most of them said they would recommend the handheld device due to its portability, convenience, and compactness. This trial was not of sufficient duration to formally assess repigmentation rates, but it paved the way for further studies, defining outcomes, minimal erythema dose testing prior to initiating phototherapy, and training patients on their use.<sup>[63]</sup> In the classic phototherapy in office chamber, it has been shown that the intensity of light is less at the upper and lower ends of the bulbs.<sup>[62]</sup> Consequently, patients with lesions on the lower legs have to stand on a small stool to ensure adequate exposure. This problem can be easily overcome by handheld devices which can target such areas in a uniform manner. Other models for home phototherapy include single-, double-, and triple-paneled units, handheld wands, and hand and foot devices.<sup>[64]</sup> Triple-paneled units are most commonly prescribed for home phototherapy when significant body surface area is involved. They usually consist of 8–12 lamps and can be used to treat the whole body with two sets of exposures. The handheld wands are useful in treating scalp and localized lesions. They consist of one to two lamps and are used over vitiliginous areas of 1 × 4.5 inches to 3.3 × 5.5 inches.<sup>[62]</sup> The hand-foot units usually have a single panel with 4–20 lamps per unit, with some available as table top units that can be used in a table top cart for simultaneous treatment of hand-foot vitiligo.<sup>[62]</sup> The prerequisites for home-based phototherapy include motivated patients who are able to comply with instructions and return regularly to the physician for reevaluation.<sup>[62]</sup> A survey study from the Netherlands compared twice-weekly office versus home phototherapy in 104 patients (57 home phototherapy

**Table 4: Studies on the use of combination treatment modalities with NB-UVB phototherapy in vitiligo**

Study	Methodology	Results
Patient-reported outcomes for intensified vs. conventional NB-UVB treatment in NSV. <sup>[54]</sup>	Retrospective, questionnaire-based cohort study in which both groups received home NB-UVB. Group 1 (conventional treatment) irradiation on 2 nonconsecutive days/week. Group 2 (intensified treatment) irradiation on 3 nonconsecutive days/week, with topical therapy on nonirradiation days.	Conventional and intensified treatments were comparable.
The effect of NB-UVB on NMKTP in treatment of generalized vitiligo using two different D/R ratios. <sup>[55]</sup>	A non-randomized prospective trial in 42 patients with bilateral and symmetrical lesions. Patients were divided into two groups. Group 1: treated with NMKTP using a D/R ratio of 1/3. Group 2: treated with NMKTP using a D/R ratio of 1/10. To study the role of adjuvant phototherapy, lesions in each patient were divided into two subgroups (a and b): lesions in subgroups Ia and IIa (did not receive NB-UVB) and lesions in subgroups Ib and IIb (received adjuvant phototherapy, two sessions per week for 6 months).	Higher density of epidermal cells used in suspension led to greater repigmentation. Adjuvant phototherapy following NMKTP enhanced repigmentation.
Efficacy of NB-UVB, microneedling with TAC and combination of both modalities in treatment of vitiligo: a comparative study. <sup>[56]</sup>	60 patients with acrofacial vitiligo were randomly divided into three groups. Group 1: NB-UVB alone. Group 2: microneedling once/week followed by topical application of TAC 10 mg/mL. Group 3: microneedling once/week followed by topical application of TAC 10 mg/mL and NB-UVB.	Microneedling yielded good to excellent response in 45% cases and its combination with NB-UVB improved response to 70%. Addition of microneedling to NB-UVB was found a reasonable combination therapy for resistant vitiligo.
Combined treatment with fractional CO <sub>2</sub> laser, autologous PRP and NB-UVB for vitiligo in different body sites. <sup>[57]</sup>	A prospective randomized trial on 80 adult patients with localized nonsegmental vitiligo. Four treatment groups: Fractional CO <sub>2</sub> laser alone PRP alone Fractional CO <sub>2</sub> +PRP Fractional CO <sub>2</sub> laser CO <sub>2</sub> +NB-UVB.	The first two treatment groups had poor outcomes. Treatment of group 3 had the best rates of repigmentation followed by group 4.
The role of phototherapy in surgical treatment of vitiligo: a systematic review. <sup>[58]</sup>	It included all studies that investigated combining melanocyte transplantation with phototherapy (UVA, PUVA, NB-UVB, etc.).	Phototherapy does not produce significant improvement in outcomes/repigmentation after melanocyte transfer.
The effect of topical piperine combined with NB-UVB on vitiligo treatment: A clinical trial. <sup>[59]</sup>	A double-blind randomized trial involving 63 facial vitiligo cases, treated with piperine (cases) or placebo (controls). Both groups received concomitant NB-UVB phototherapy on alternate days ×3 months. Piperine is an alkaloid derived from black pepper extract and studies have found that it stimulates melanocyte proliferation and has immunomodulatory, antioxidant, and anti-inflammatory properties.	Repigmentation at each follow-up was significantly higher among cases ( $P<0.001$ ). NB-UVB combined with topical piperine showed significant benefit than NB-UVB alone.
The early repigmentation pattern of vitiligo is related to the source of melanocytes and by the choice of therapy. <sup>[60]</sup>	Retrospective cohort study reviewing detailed medical records including photographs of 116 patients with vitiligo with 326 lesions.	Perifollicular repigmentation occurred more frequently in lesions with complete depigmentation, macules on covered areas, stable lesions, and those treated with NB-UVB. Marginal repigmentation was frequent in lesions with complete depigmentation, those treated without NB-UVB and facial lesions treated with topical vitamin D monotherapy.

Contd...

Table 4: Contd...

Study	Methodology	Results
Microfocussed phototherapy associated with Janus kinase inhibitor: a promised valid therapeutic option for localized vitiligo. <sup>[61]</sup>	Multicenter observational retrospective study evaluating efficacy and safety of NB-UVB microphototherapy used alone or in combination with tofacitinib, 10 mg/day. BIOSKIN EVOLUTION® device delivered microfocussed phototherapy. It could provide a spectrum of intensity up to 400 mW/cm <sup>2</sup> with peak emission at 311 nm.	Combined microfocussed phototherapy and tofacitinib citrate provided better repigmentation.

NB-UVB=Narrow-band ultraviolet B; NSV=Nonsegmental vitiligo; NMKTP=Noncultured melanocyte and keratinocyte transplantation; D/R=Donor-to-recipient; TAC=Triamcinolone acetonide; PUVA=Psoralen plus ultraviolet A; PRP=Platelet rich plasma therapy

and 32 in-office phototherapy).<sup>[65]</sup> The results showed that home phototherapy patients received greater number of treatments per week, with no significant difference in the cumulative dose, the degree of repigmentation, or adverse events. However, time investment was much lower in the home phototherapy group. Shan *et al.* treated 93 patients with localized vitiligo with NB-UVB handheld device thrice weekly and observed onset of repigmentation mainly in the perifollicular areas at 1 month of initiation. Most subjects repigmented in the first 3 months and those who did not repigment during this time failed to respond to further treatments.<sup>[66]</sup>

### Home-Based Phototherapy – Handle With Care!

It is important to recognize patients who are at highest risk of side effects with home phototherapy. They are the ones who independently purchase units and self-administer phototherapy without physician advice.<sup>[62]</sup> Many devices are equipped with safety features such as timers, which allow for administration of a fixed number of treatments after which a new physician-generated code is required and key-locked on/off switches, limiting the length of treatment.<sup>[62]</sup> In addition, physicians can track treatments using an electronic data logger.<sup>[67]</sup> Support-staff can help reduce adverse effects by conducting patient education sessions on shielding special sites, wearing cut out clothing at each session, recognizing side effects, and contacting their dermatologist at appropriate times.<sup>[62,64]</sup>

### Future Goals

Since no consistent protocols still exist for NB-UVB therapy in vitiligo, further controlled studies are warranted which can help unify the therapeutic guidelines of this promising treatment. We also need multicenter trials comparing in-office versus home phototherapy and studies investigating the additional benefit of phototherapy following surgical treatment. Steps in this direction would definitely help us use this therapeutic modality to its fullest potential.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

### References

1. Mattoo SK, Handa S, Kaur I, Gupta N, Malhotra R. Psychiatric morbidity in vitiligo: Prevalence and correlates in India. *J Eur Acad Dermatol Venereol* 2002;16:573-8.
2. Scherschun L, Kim JJ, Henry W. Narrow-band ultraviolet B is a useful and well-tolerated treatment for vitiligo. *J Am Acad Dermatol* 2001;44:999-1003.
3. Kishan Kumar YH, Rao GR, Gopal KV, Shanti G, Rao KV. Evaluation of narrow-band UVB phototherapy in 150 patients with vitiligo. *Indian J Dermatol Venereol Leprol* 2009;75:162-6.
4. Westerhof W, Nieuweboer-Krobotova L. Treatment of vitiligo with UV-B radiation vs topical psoralen plus UV-A. *Arch Dermatol* 1997;13:1525-8.
5. Kanwar AJ, Dogra S, Parsad D, Kumar B. Narrow-band UVB for the treatment of vitiligo: An emerging effective and well-tolerated therapy. *Int J Dermatol* 2005;44:57-60.
6. Alikhan A, Felsten LM, Daly M, Petronic-rosic V. Vitiligo: A comprehensive overview. *J Am Acad Dermatol* 2011;65:473-91.
7. Yones SS, Palmer RA, Garibalinos TM, Hawk JL. Randomized double-blind trial of treatment of vitiligo: Efficacy of psoralen -UV-A therapy vs narrowband UV-B therapy. *Arch Dermatol* 2007;143:578-84.
8. Njoo MD, Spuls PI, Bos JD, Westerhof W, Bossuyt PM. Nonsurgical repigmentation therapies in vitiligo: Meta-analysis of the literature. *Arch Dermatol* 1998;134:1532-40.
9. Njoo MD, Bos JD, Westerhof W. Treatment of generalized vitiligo in children with narrow-band (TL-01) UVB radiation therapy. *J Am Acad Dermatol* 2000;42:245-53.
10. Fitzpatrick TB PM. Historical aspects of methoxsalen and other furocoumarins. *J Invest Dermatol* 1959;31:229-31.
11. Roelandts R. The history of phototherapy: Something new under the sun? *J Am Acad Dermatol* 2002;46:926-30.
12. Parrish JA, Fitzpatrick TB, Tanenbaum L, Pathak MA. Photochemotherapy of psoriasis with oral methoxsalen and long-wave ultraviolet light. *N Engl J Med* 1974;291:1207-11.
13. Fischer T. Comparative treatment of psoriasis with UV-light, trioxsalen plus UV-light and coal tar plus UV-light. *Acta Derm Venereol* 1977;57:345-50.
14. Wiskemann A. UVB-Phototherapie der psoriasis mit einer für die PUVA-therapie entwickelten stehbox. *Z Hautkr* 1978;53:633-6.
15. Diffey BL, Farr PM. An appraisal of ultraviolet lamps used for the phototherapy of psoriasis. *Br J Dermatol* 1987;117:49-56.
16. Van Weelden H, Baart de la Faille H, Young E, Van der leun JC. Comparison of narrow-band UV-B phototherapy and PUVA photochemotherapy in the treatment of psoriasis. *Acta Derm Venereol* 1990;70:212-5.



17. Bónis B, Kemény L, Dobozy A, Bor Z, Szabó G, Ignác F. 308 nm UVB excimer laser for psoriasis. *Lancet* 1997;350:1522.
18. Sehrawat M, Arora TC, Chauhan A, Kar HK, Poonia A, Jairath V. Correlation of vitamin D levels with pigmentation in vitiligo patients treated with NB-UVB therapy. *ISRN Dermatol* 2014;23:493213.
19. Ibrahim H, El Taieb M, El Gamel Z, El Saied AR. Effect of narrow-band ultraviolet B on the serum of 25-hydroxyvitamin D in vitiligo patients. *J Cosmet Dermatol* 2018;17:911-6.
20. El-Hanbuli HM, Dawoud NM, Mahmoud RH. Narrow-band UVB effects on cutaneous Vitamin D receptor expression and serum 25-hydroxyvitamin D in generalized vitiligo. *Photodermatol Photoimmunol Photomed* 2018;34:175-83.
21. Ataş H, Cemil BÇ, Gönül M, Baştürk E, Çiçek E. Serum levels of homocysteine, folate and vitamin B12 in patients with vitiligo before and after treatment with narrow band ultraviolet B phototherapy and in a group of controls. *J Photochem Photobiol B* 2015;148:174-80.
22. Ocampo-Candiani J, Salinas-Santander M, Trevino V, Ortiz-López R, Ocampo-Garza J, Sanchez-Dominguez CN. Evaluation of skin expression profiles of patients with vitiligo treated with narrow-band UVB therapy by targeted RNA-seq. *An Bras Dermatol* 2018;93:843-51.
23. Hirobe T, Enami H. Activation of melanoblasts and melanocytes after treatment with monochromatic excimer light and narrowband-ultraviolet B of skin of vitiligo patients. *Int J Dermatol* 2019;58:210-7.
24. Goldstein NB, Koster MI, Jones KL, Gao B, Hoaglin LG, Robinson SE, *et al.* Repigmentation of human vitiligo skin by NB-UVB is controlled by transcription of GLI1 and activation of the  $\beta$ -catenin pathway in the hair follicle bulge stem cells. *J Invest Dermatol* 2018;138:657-68.
25. Nada HR, El Sharkawy DA, Elmasry MF, Rashed LA, Mamdouh S. Expression of Janus Kinase 1 in vitiligo & psoriasis before and after narrow band UVB: A case-control study. *Arch Dermatol Res* 2018;310:39-46.
26. Waciewicz M, Socha K, Soroczyńska J, Niczyporuk M, Aleksiejczuk P, Ostrowska J, *et al.* Selenium, zinc, copper, Cu/Zn ratio and total antioxidant status in the serum of vitiligo patients treated by narrow-band ultraviolet-B phototherapy. *J Dermatolog Treat* 2018;29:190-5.
27. Mohammad TF, Al-jamal M, Hamzavi IH, Harris J, Leone G, Cabrera R, *et al.* The Vitiligo Working Group recommendations for narrowband ultraviolet B light phototherapy treatment of vitiligo. *J Am Acad Dermatol* 2017;76:879-88.
28. Bae JM, Jung HM, Hong BY, Lee JH, Choi WJ, Lee JH, *et al.* Phototherapy for vitiligo. A systematic review and meta-analysis. *JAMA Dermatol* 2017;153:666-74.
29. Chahar YS, Singh PK, Sonkar VK, Rajani I, Adil M. Impact on quality of life in vitiligo patients treated with narrow band ultraviolet B phototherapy. *Indian J Dermatol* 2018;6:399-402.
30. Mou KH, Han D, Liu WL, Li P. Combination therapy of orally administered glycyrrhizin and UVB improved active-stage generalized vitiligo. *Braz J Med Biol Res* 2016;49:e5354.
31. Chiu SH, Liu IL, Chen YW, Lan CC. Low-dose UVB therapy is comparable with conventional UVB phototherapy for treatment of vitiligo: A pilot study. *J Dermatol Sci* 2018;92:218-20.
32. Majid I. Efficacy of targeted narrowband ultraviolet B therapy in vitiligo. *Indian J Dermatol* 2014;59:485-9.
33. Silpa-Archa N, Weerasubpong P, Junsuwan N, Yothachai P, Supapuang O, Wongpraparut C. Treatment outcome and persistence of repigmentation from narrow-band ultraviolet B phototherapy in vitiligo. *J Dermatolog Treat* 2018;25:1-6.
34. Cabrera R, Hojman L, Recule F, Sepulveda R, Delgado I. Predictive model for response rate to narrowband ultraviolet B phototherapy in vitiligo: A retrospective cohort study of 579 patients. *Acta Derm Venereol* 2018;98:416-20.
35. Percivalle S, Piccinno R, Caccialanza M, Forti S. Narrowband ultraviolet B phototherapy in childhood vitiligo: Evaluation of results in 28 patients. *Pediatr Dermatol* 2012;29:160-5.
36. Dayal S, Sahu P, Gupta N. Treatment of childhood vitiligo using tacrolimus ointment with narrowband ultraviolet B phototherapy. *Pediatr Dermatol* 2016;33:646-51.
37. Prystowsky JH, Rabinowitz AD, Stevens A, DeLeo VA. Present status of eyelid phototherapy. Clinical efficacy and transmittance of ultraviolet and visible radiation through human eyelids. *J Am Acad Dermatol* 1992;26:607-13.
38. Stern RS. Genital tumors among men with psoriasis exposed to psoralens and ultraviolet A radiation (PUVA) and ultraviolet B radiation. The Photochemotherapy follow up study. *N Engl J Med* 1990;322:1093-7.
39. Raone B, Patrizi A, Gurioli C, Gazzola A, Ravaoli GM. Cutaneous carcinogenic risk evaluation in 375 patients treated with narrowband-UVB phototherapy: A 15-year experience from our Institute. *Photodermatol Photoimmunol Photomed* 2018;34:302-6.
40. Miyagawa T, Kadono T, Masui Y, Yamada D, Saigusa R, Numajiri H, *et al.* Nivolumab-induced vitiligo successfully treated with narrowband UVB phototherapy. *Eur J Dermatol* 2017;27:655-8.
41. Shin S, Hann SK, Oh SH. Combination treatment with excimer laser and narrowband UVB light in vitiligo patients. *Photodermatol Photoimmunol Photomed* 2016;32:28-33.
42. Lee J, Chu H, Lee H, Kim M, Kim DS, Oh SH. A retrospective study of methylprednisolone mini-pulse therapy combined with narrow-band UVB in non-segmental vitiligo. *Dermatology* 2016;232:224-9.
43. Doghaim NN, Gheida SF, El-Tatawy RA, Mohammed Ali DA. Combination of fractional carbon dioxide laser with narrow band ultraviolet B to induce repigmentation in stable vitiligo: A comparative study. *J Cosmet Dermatol* 2018;30:1-8.
44. El-Zawahry MB, Zaki NS, Wissa MY, Saleh MA. Effect of combination of fractional CO<sub>2</sub> laser and narrow-band ultraviolet B versus narrow-band ultraviolet B in the treatment of non-segmental vitiligo. *Lasers Med Sci* 2017;32:1953-8.
45. Namazi MR, Shotorbani K. Evaluation of the efficacy of topical ethyl vanillate in enhancing the effect of narrow band ultraviolet B against vitiligo: A double blind randomized, placebo-controlled clinical trial. *Iran J Med Sci* 2015;40:478-84.
46. Wang X, McCoy J, Lotti T, Goren A. Topical cream delivers NB-UVB from sunlight for the treatment of vitiligo. *Expert Opin Pharmacother* 2014;15:2623-7.
47. Stanimirovic A, Kovacevic M, Korobko I, Šitum M, Lotti T. Combined therapy for resistant vitiligo lesions: NB-UVB, microneedling, and topical latanoprost, showed no enhanced efficacy compared to topical latanoprost and NB-UVB. *Dermatol Ther* 2016;29:312-6.
48. Li R, Qiao M, Wang X, Zhao X, Sun Q. Effect of narrow band ultraviolet B phototherapy as monotherapy or combination therapy for vitiligo: A meta-analysis. *Photodermatol Photoimmunol Photomed* 2017;33:22-31.
49. Bakis-Petsoglou S, Le Guay JL, Wittal R. A randomized, double blinded, placebo-controlled trial of pseudocatalase cream and narrowband ultraviolet B in the treatment of vitiligo. *Br J Dermatol* 2009;161:910-7.
50. Dell'Anna ML, Mastrofrancesco A, Sala R, Venturini M,

- Ottaviani M, Vidolin AP, *et al.* Antioxidants and narrow band-UVB in the treatment of vitiligo: A double-blind placebo-controlled trial. *Clin Exp Dermatol* 2007;32:631-6.
51. Grimes PE, Hamzavi I, Lebwohl M, Ortonne JP, Lim HW. The efficacy of afamelanotide and narrowband UV-B phototherapy for repigmentation of vitiligo. *JAMA Dermatol* 2013;149:68-73.
  52. Lim HW, Grimes PE, Agbai O, Hamzavi I, Henderson M, Haddican M, *et al.* Afamelanotide and narrowband UV-B phototherapy for the treatment of vitiligo: A randomized multicenter trial. *JAMA Dermatol* 2015;151:42-50.
  53. Abd El-Samad Z, Shaaban D. Treatment of localized non-segmental vitiligo with intradermal 5-fluorouracil injection combined with narrow-band ultraviolet B: A preliminary study. *J Dermatolog Treat* 2012;23:443-8.
  54. Uitentuis SE, Narayan VS, Wind BS, Bekkenk MW, de rie MA, Wolkerstorfer A. Patient reported outcomes for intensified versus conventional NB-UVB treatment in non-segmental vitiligo. *J Dermatolog Treat* 2018;29:1-4.
  55. Tawfik YM, Abd Elazim NE, Abdel-Motaleb AA, Mohammed RAA, Tohamy AMA. The effect of NB-UVB on noncultured melanocyte and keratinocyte transplantation in treatment of generalized vitiligo using two different donorrecipient ratios. *J Cosmet Dermatol* 2018;10:1-9.
  56. Elshafy Khashaba SA, Elkot RA, Ibrahim AM. Efficacy of NB-UVB, microneedling with triamcinolone acetonide, and a combination of both modalities in the treatment of vitiligo: A comparative study. *J Am Acad Dermatol* 2018;79:365-7.
  57. Abdelghani R, Ahmed NA, Darwish HM. Combined treatment with fractional carbon dioxide laser, autologous platelet-rich plasma, and narrow band ultraviolet B for vitiligo in different body sites: A prospective, randomized comparative trial. *J Cosmet Dermatol* 2018;17:365-72.
  58. Lommerts JE, Uitentuis SE, Bekkenk MW, de Rie MA, Wolkerstorfer A. The role of phototherapy in the surgical treatment of vitiligo: A systematic review. *J Eur Acad Dermatol Venereol* 2018;32:1427-35.
  59. Shafiee A, Hoormand M, Shahidi-Dadras M, Abadi A. The effect of topical piperine combined with narrowband UVB on vitiligo treatment: A clinical trial study. *Phytother Res* 2018;32:1812-7.
  60. Yang K, Xiong X, Pallavi G, Ling Y, Ding F, Duan W, *et al.* The early repigmentation pattern of vitiligo is related to the source of melanocytes and by the choice of therapy: A retrospective cohort study. *Int J Dermatol* 2018;57:324-31.
  61. Gianfaldoni S, Tchernev G, Wollina U, RocciaMG, Fioranelli M, LottiJ, *et al.* Micro-focused phototherapy associated to Janus Kinase inhibitor: A promising valid therapeutic option for patients with localized vitiligo. *Open Access Maced J Med Sci* 2018;6:46-8.
  62. Mohammad TF, Silpa-Archa N, Griffith JL, Lim HW, Hamzavi IH. Home phototherapy in vitiligo. *Photodermatol Photoimmunol Photomed* 2017;33:241-52.
  63. Haines RH, Thomas KS, Montgomery AA, Ravenscroft JC, Akram P, Chalmers JR, *et al.* Home interventions and light therapy for the treatment of vitiligo (HI-Light Vitiligo Trial): Study protocol for a randomised controlled trial. *BMJ Open* 2018;8:e018649.
  64. Nolan BV, Yentzer BA, Feldman SR. A review of home phototherapy for psoriasis. *Dermatol Online J* 2010;16:1.
  65. Wind BS, Kroon MW, Beek JF, van der Veen JP, Nieuweboer-Krobotova L, Meesters AA, *et al.* Home vs. outpatient narrowband ultraviolet B therapy for the treatment of nonsegmental vitiligo: A retrospective questionnaire study. *Br J Dermatol* 2010;162:1142-4.
  66. Shan X, Wang C, Tian H, Yang B, Zhang F. Conventional S. Narrow-band ultraviolet B home phototherapy in vitiligo. *Indian J Dermatol Venereol Leprol* 2014;80:336-8.
  67. Yelverton CB, Balkrishnan R, Feldman SR. The utility of a data-logging device for measuring adherence to home phototherapy. *Photodermatol Photoimmunol Photomed* 2006;22:270-2.