

# Vitiligo: A Review of its Aspects and Treatment Modalities

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## Abstract

Vitiligo is a depigmentation disorder which occurs irrespective of parts of the body. Loss of melanin a pigment present in the body which occurs due to various factors including stress factors, hormonal, chemical factors, and genetics have been associated with the cause of the disorder. Many treatment methods are available for vitiligo, but no treatment produces complete repigmentation. Appearance of widespread patches on the body of the patients causes psychological distress. Most of the treatment methods utilize ultraviolet (UV) rays combinational strategy. Increased exposure of UV rays causes many side effects which include itching, burning sensation and xerosis.. It is not the affected area alone is exposed also the adjoining parts. The use of herbal medicines and other combination treatment can help to subside the progression of disease. In this review, we made an attempt to study the different methods of treatment, its mechanism and alternative methods for vitiligo.

**Key words:** Alternative treatment, depigmentation, grafting, models, phototherapy, vitiligo

## INTRODUCTION

Vitiligo refers to an idiopathic, usually progressive condition of skin due to depigmentation.<sup>[1,2]</sup> It is widely spread throughout the world irrespective of male/female, young and old, and all anatomical parts of the body. Although it is not a clinical/pathological condition, still a condition which the individuals segregated based on the appearance. A genetic predisposition is considered to be involved in the disease.<sup>[1,3]</sup> Research says that the condition is mainly due to loss of melanin pigment in the skin.<sup>[4]</sup> It is also considered as a hypopigmentary disorder that affects at least 1% of the general population, causing important cosmetic and psychosocial problems. India has the largest population suffering from vitiligo (1.7%). The incidence rate of vitiligo was between 0.1% and 2%. The causes of vitiligo may be due to genetic, immunological, and neurological factors. Most of the cases of vitiligo are mainly due to genetics which is triggered by environmental factors. In this review, we attempt to consolidate all the factors which affect the condition and treatment methods and modern approaches for the same.<sup>[5-8]</sup>

## CLASSIFICATION

Vitiligo is mainly classified as generalized and segmental. Generalized vitiligo is a disorder mainly due to loss of functioning melanocytes. It may result in macule which is nothing but a discolored area of skin that may differ in size and distributed uniformly.<sup>[4]</sup> Segmental vitiligo is mainly related to genetics. It affects the repairing of epidermal melanocytes due to a loss of antiapoptotic proteins or due to the high level of toxic neuromediators release.<sup>[9,10]</sup> Vitiligo is currently classified as Type A (non-segmental vitiligo) and Type B (segmental vitiligo). Type B occurs rarely and includes lesions that are restricted to a particular segment. They affect only particular area of the body and do not expand with time. Type A is frequently occurring which affects all

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the areas of the body and expands with time.<sup>[11,12]</sup> Another classification is based on the occurrence and spread of the lesions [Table 1].<sup>[13]</sup>

## TREATMENT METHODS

Nowadays, vitiligo can be managed using various methods each of which has various therapeutic efficiency and also with little side effects. The common treatment used for the treatment of vitiligo is psoralen plus ultraviolet A (PUVA) therapy. Side effects caused by this therapy involve erythema, redness and burns, tanning, nausea, itching, phototoxic reactions, cataracts, and carcinogenesis.<sup>[14]</sup> Hence, an alternate method with reduced side effects is the need of the time. Photochemotherapy with narrowband ultraviolet B therapy (NBUVB) results in mild erythema to mild itching and burning sensation.<sup>[15]</sup> Localized and generalized vitiligo is usually treated with topical steroids and NBUVB monotherapy. Apart from corticosteroids, calcineurin inhibitors and Vitamin-D derivatives the most commonly used treatment modalities are photochemotherapy (PUVA, psoralen with sunlight [PUVAso]), surgical techniques and combinational topical therapies. Results also show that the duration of treatment seems to be long for PUVA and NBUVB therapy which extends from months to year. The success rate in this therapy was found to be 60% and <50%, respectively, in 2–4 months and 12 weeks.<sup>[16]</sup> Results from Yones *et al.* studied a randomized double-blind trial of treatment for vitiligo using NBUVB and PUVA in 25 patients shows that out of 25 patients 65% of patients show >50% improvement in repigmentation compared to 36% of patients treated with PUVA. Repigmented skin color matches the normal skin color for all patients treated by NBUVB therapy but only 44% in case of PUVA.<sup>[17]</sup> Another study from Gaikwad *et al.* reports for the treatment of vitiligo using PUVA and NBUVB in 60 patients for 1 year. Total of 60 patients divided as 30 in PUVA group and another 30 in NBUVB group. The result arrived at that 29 of 30 patients in NBUVB group (96.66%) and 26 of 30 patients in PUVA group (86.66%) shows repigmentation.<sup>[18]</sup> A retrospective study was carried using PUVA in 33 patients for 12 years by Sahin. The results indicated that 12 patients show 51–75% repigmentation and 6 patients show >75% repigmentation.<sup>[19]</sup> These results indicate that the use of NBUVB is efficacious

than PUVA. Alhowaish *et al.* studied the effectiveness of 308 nm excimer laser for the treatment of vitiligo which resulted in >75% of repigmentation in 15 weeks, whereas results from Hofer *et al.* resulted in 67% of repigmentation in 6–10 weeks. This reveals a better treatment approach toward vitiligo.<sup>[20]</sup> Camouflage products and self-tanning dyes were also tried to achieve betterment in skin conditions.<sup>[21,22]</sup> As such the disease condition cannot be predicted easily since it varies from one person to another based on the root cause of depigmentation, which results in specific anatomic part of the body. In case of children's spontaneous repigmentation may occur but will be partial repigmentation. A summary of the treatments is given in Table 2.

### Photochemotherapy

Photochemotherapy can be provided in the form of psoralen plus UV radiation, broadband UVB, NBUVB, and targeted phototherapy using light sources or excimer lasers and lamps. Phototherapy results in repigmentation by enhancing migration and proliferation of melanocytes.<sup>[23,24]</sup> Irradiation by NB UV radiation affects both normal and diseased skin, whereas depigmented areas alone can be treated efficiently by targeted high-intensity light sources. Targeted phototherapy results in rapid therapeutic response and also reduce the amount of UV dose usage. In the management of vitiligo, excimer lasers were used extensively in recent times. The wavelength of 308 nm was used by excimer lasers (308 nm) and excimer lamps which allow targeted phototherapy and was proven to be most effective.<sup>[25-27]</sup>

### Oral psoralen photochemotherapy (PUVA)

Psoralen is used as a medication in PUVA therapy. Inactive melanocytes are stimulated using UV radiations in this therapy. Patients with severe vitiligo and patients showing resistance to topical phototherapy can be treated with oral photochemotherapy. Children <2 years are not usually treated with oral psoralens. Normally 8-methoxypsoralen is given in a range of 0.2–0.4 mg/kg which causes maximal repigmentation. The patients are subjected to UV exposure after 1–1½ h of drug ingestion. 1–2 J/cm<sup>2</sup> is the usual initial UVA exposure. Till the appearance of asymptomatic erythema,

**Table 1: Clinical classification of vitiligo**

Localized	Generalized	Universalis
Focal One or more discolored patches of skin with normal distribution	Vulgaris Patches are scattered extensively	Depigmented patches occurring almost completely of the skin surface
Unilateral One or more discolored patches of skin localized in a unilateral body region	Acrofacialis Localization of patches on distal extremities and face	
Mucosal Due to the huge involvement of mucous membrane	Mixed Mixed form of acrofacialis and vulgaris forms	

**Table 2:** Various treatments used for vitiligo

Photochemotherapy
PUVA therapy
Oral psoralen
PUVAsol
Topical PUVA therapy
NBUVB therapy
NBUVB microphototherapy
Excimer laser therapy
Other combinational therapy
Depigmentation Therapy
Involves depigmentation of normal skin surrounding the affected lesions to provoke repigmentation
Surgical Therapy
Split-thickness grafting
Micrografting
Suction blister grafting
Micropigmentation
Melanocyte culture and grafting

PUVA: Psoralen ultraviolet A, NBUVB: Narrowband ultraviolet B

treatment is increased by 1 J/cm<sup>2</sup>. Treatments should not be given on 2 consecutive days. Since the darker patients have greater tolerance to UVA dosage, they respond better to PUVA therapy compared with adults, children's show better repigmentation. Reports show that vitiligo responds better to PUVA therapy with respect to face, proximal extremities, and trunk. Better improvement in repigmentation is reported. UVA blocking glasses should be used by the patients at the time of exposure. Sunscreens and other sun protection clothes are also recommended for the patients at the time of treatment. Burn, erythema, pruritus, xerosis, carcinogenicity, pigmented lesions, cataracts, and aging were found to be potential side effects. In pregnancy or breastfeeding women, oral PUVA therapy shows contraindications.<sup>[28,29]</sup>

### PUVAsol

Geographical conditions with high radiation of sunlight and where artificial sources of light are often lacking, PUVAsol therapy can be used. In this therapy, natural sunlight is used rather than UVA which has been used in PUVA. The duration of exposure is short initially and duration is increased gradually until satisfactory erythema is achieved. After ingestion of the drug, the patients exposed to sunlight at 11 am to 3 pm. The body of the patients exposed to sunlight for 5 min initially. Subsequently, the therapy is given 2–3 times per week and the exposure time to a maximum of 45 min on each side by increasing 5 min each week. When erythema develops the dose is held constant. A record is kept of all treatments, which can be regularly reviewed by the physician. The patient is cautioned that a burning or an itching sensation, or scaling in treated areas, implies overexposure. In such a case, one dose can be skipped and treatments resumed with the previous lower exposure time.<sup>[30,31]</sup>

### Topical therapy

Patients with limited involvement or for children more than 5 years of age having localized skin lesions, topical psoralen photochemotherapy is generally recommended. Among the psoralens, Oxsoralen lotion is commonly used. The lotion is usually diluted with hydrophilic petrolatum or ethanol (0.01–0.1% concentration) and applied. After 15–20 min, the applied area has to be exposed to UVA radiations. Usually, dose of 0.12–0.25 J/cm<sup>2</sup> is used initially. The dose can be increased slowly until the appearance of mild erythema according to the skin type of patient. Treatments should not be given for 2 consecutive days. A broad-spectrum sunscreen is also recommended for the patients during the course of treatment.<sup>[30-33]</sup> PUVA (psoralen + UVA) therapy: The most successful treatment for vitiligo worldwide is PUVA therapy. Treatments using extracts from *Psoralea corylifolia* Linnaeus in India and *Ammi majus* Linnaeus in Egypt are very common in alternative medicine. Isolates (8-methoxypsoralen [MOP], 5-MOP, and psoralen) from these plants and a synthetic compound trisoralen were used in phototherapy incorporated in formulations such as creams, gels, and solutions or orally as tablets or capsules. After administration or application of medications, there is a necessity for exposure to natural sunlight (PUVAsol) or to artificial UVA radiation (PUVA). In PUVA, the patients treated with 8-MOP at a dose of 0.4–0.6 mg/kg. After 1 h, the lesions are exposed to UVA radiation because Oxsoralen-ultra is better and more consistently absorbed, it is the preferred formulation of the 8-MOP. Comparing to 8-MOP, trisoralen is categorized to be less effective.<sup>[30,34]</sup> Fatty foods will cause variations in the achievement of peak blood level in case of psoralen formulations. Hence, patients should be instructed regarding intake of food and administration of drug. The appearance of new lesions in healthy skin and phototoxicity may be caused during topical phototherapy. The preparations such as solution or cream are to be applied directly to the lesion. After 20 min, the lesions have to be exposed to UVA. The results with oral and topical PUVA therapy vary completely from each other. Only certain patients exhibit repigmentation completely, whereas in most of the patients improvement can be achieved using cosmetic aids. Repigmentation with phototherapy is observed around the hair follicles or from the outer limit (edges) of the lesions. By every 2–3 months, photographs have been taken and compared with the older ones.

### NBUVB

In this type of therapy, the principle involves focusing of narrowband UVB radiation on the areas of skin lesions. The main mechanism of action of NBUVB radiation is by suppression of immune system and by increasing the amount of melanocytes.<sup>[11,35]</sup> From the data of many animal models and research, it reveals that UVB radiation cause induction of T cell activity. These T cells causes suppression of autoreactive cells and prevents the occurrence of autoimmune disease.<sup>[36]</sup> UV radiation is mainly involved in

the stimulation of melanocyte, especially in the areas of skin lesion. The increase in the quantity of melanocyte is mainly due to stimulation of various melanocyte growth factors such as endothelin growth factor and basic fibroblast growth factor.<sup>[37,38]</sup> The initial dose of the therapy used is 100 mJ/cm<sup>2</sup>. The dose is increased until erythema was achieved. NB-UVB does not cause any side effects compared to PUVA such as phototoxicity and photoaging. Another main advantage of NB-UVB therapy was that pregnant women and children can be treated without causing any phototoxicity.

### NB-UVB microphototherapy

Treatment of vitiligo using microphototherapy<sup>[11,39]</sup> is in use since 1990 by group of researchers in Italy. UVB radiation with a wavelength of 280–315 nm was generally used. Penetration of UV radiation was enhanced by applying water and glycerine on the skin before exposure. The application of UVB radiation may cause slight burns. According to reports, 25% of patients show excellent repigmentation and 50% of patients show moderate repigmentation. The main purpose of the therapy is that only areas with depigmentation are exposed to UV radiation other than healthy skin. One of the drawbacks is that therapy needs exercised personnel and expensive equipment.

### NB-UVB narrowband excimer laser and monochromatic excimer light

UVB excimer laser with a wavelength of 308 nm was used in the treatment of vitiligo which is quite similar to NB-UV radiation. These lasers are useful in providing targeted phototherapy and also reduced side effects. Many researches have been done using excimer laser and reports show 55% success rate.<sup>[40]</sup> This therapy can be used mainly for segmented and generalized vitiligo.<sup>[11,39]</sup>

### New topical treatments and antioxidants

Immunosuppressing agents such as tacrolimus can also be used in the management of vitiligo. Tacrolimus can be combined with 308 excimer laser for improving the efficacy of treatment, but this may result in occurrence of unexpected burns.<sup>[41]</sup> Prostaglandin E (PGE) was also used in the management of vitiligo. This induces melanin synthesis and results in cause of repigmentation. At present, many researches have been performed on vitiligo patients using PGE<sub>2</sub> and reports show that 60% of patients show complete repigmentation, 20% show moderate repigmentation, and 20% show no improvement.<sup>[42]</sup> PUVA and topical calcipotriol combination therapy can also be used in the management of vitiligo.<sup>[43-45]</sup> Recent researches using antioxidant extracts from *Cucumis melo* in combination with NB-UVB resulted in effective treatment. NB-UV radiation B phototherapy is combined with Vitamin C and E, and polyunsaturated fatty acids, alpha lipoic acid, and immunomodulatory plant extract which causes subjective improvement.<sup>[46,47]</sup>

### Phenylalanine

Repigmentation can also be achieved by the combinational therapy of UV light and phenylalanine. Basically, melanin is derived from L-tyrosine and L-phenylalanine. In case of vitiligo, the amount of L-phenylalanine will be less. By providing supplementation of phenylalanine, the production of melanin can be increased. Camacho and Mazuecos performed a retrospective study on 193 patients and the results found to be good.<sup>[48,49]</sup> Siddiqui *et al.* made a study using L-phenylalanine by two different trials. One trial was conducted on 149 patients for 18 months and small trial was conducted on 39 patients for 6 months. They reported that success rate on the first trial was about 77% and 60% for the second trial.<sup>[50]</sup>

### Khellin (Kuva)

Khellin is a furochromone derivative and has structural, photochemical, and phototherapeutic properties as that of 8-MOP. It has been used along with UVA for repigmentation in the treatment of vitiligo. Ortel *et al.* used KUVA in 28 patients, and reported 70% improvement in 41% of patients.<sup>[51]</sup> Abdel-Fattah *et al.* performed a study on 30 vitiligo patients using oral Khellin and reported that only 16% of patients show excellent improvement, whereas others show moderate results.<sup>[52]</sup> Valkova *et al.* made an effective approach by comparing KUVA and PUVA therapy on 33 patients and reported that KUVA therapy causes repigmentation effectively compared to systemic PUVA therapy.<sup>[53]</sup> Orecchia and Perfetti performed research on topical Khellin using 41 patients and compared with placebo therapy. They reported that only 10 patients treated with Khellin show improvement.<sup>[54]</sup>

### Depigmentation therapy

Depigmentation therapy is usually done to provide evenly appearance in patients with more body lesions. Depigmentation therapy has also been used in patients having extensive hypopigmentation and widespread lesions. Premature aging, sunburns, and skin cancer may be caused due to depigmentation. Vitiligo patients having more than 50% of body lesions were applied with 20% of monobenzyl ether of hydroquinone cream (MBEH). This therapy results in initial slow and increased destruction of epidermal melanocytes by delivery of oxygen free radicals. This therapy causes depigmentation after 4–12 months. Dermatitis, pigmented lesions in conjunctiva, and leukomelanoderma are some of the side effects. 4-methoxyphenol is also used other than MBEH. Methoxyphenol was also tried in combination with Q ruby laser.<sup>[55,56]</sup> Q-switched ruby laser with 694 nm wavelength destroys melanin. This technique causes loss in pigmentation within 7–14 days, whereas bleaching agents need 1–12 months, with a very less risk of scarring. This therapy will cause little pain, and hence, therapy was



performed using local anesthetics. Depigmentation was also done by cryotherapy<sup>[57]</sup> and it does not cause side effects.

### Surgical therapies

Surgical therapy is found to be the best treatment in case of patients who are not responding to other medical treatments. In surgical therapy, treatment has been done using skin grafts. This therapy is used to attain repigmentation in case of thermal burns, trauma, and inflammation.

### Split-thickness grafting

Using the dermatome, the superficial layer of normally pigmented skin was obtained.<sup>[58]</sup> The obtained tissue was then placed on the area of vitiligo patches. This technique had a success rate of more than 80% and had side effects such as milia formation, partial loss of grafts, and scar formation at the donor site.

### Minigrafting

In this technique, 1–2 mm punches with needle or syringe is made to obtain grafts from normal donor areas such as the buttocks and the donor areas were covered with sterile dressings. Similarly, 4–5 mm of skin was taken from recipient areas and discarded. The grafts obtained from the donor area were then placed in patient's body and dressed with adhesive tape. After 15 days, the dressing was removed and melanocyte proliferation was induced by PUVA. The procedure can be repeated until complete repigmentation is achieved. The success rate of this procedure was 67%.<sup>[59]</sup> “Polka dot” appearance and “cobblestoning” were potential adverse effects. Scarring at both donor sites and the recipient sites was another problem.

### Suction blister grafting

In this technique, negative pressure is applied to obtain blister from normally pigmented donor skin. Special apparatus is used to produce a negative pressure of 200 mm for 2–3 h. Regular syringes and tubing can also be used to produce blisters. With the help of suction blisters, the donor site is prepared. Using scissors the layer of blister containing the melanocytes is removed. The harvested skin is placed on the recipient site and dressed with non-adherent dressings for 7 days. This technique does not produce any scars as the only epidermis is used. A success rate of 90% is reported.

### Micropigmentation

Micropigmentation therapy can be used for treating small lesions on the lips, areolae, and hands.<sup>[60]</sup> Mainly iron oxide pigment was used for the purpose. This pigment is injected into the layer of the dermis. This does not produce an exact

match to the normal skin. Patients with darker skin show the excellent result to the therapy compared to patients with fair skin.<sup>[61]</sup>

### Melanocyte culture and grafting

The main principle involved in this therapy is obtaining the melanocytes from the patient's skin by small biopsy. The obtained melanocytes were cultured<sup>[62-65]</sup> separately in culture media to obtain the huge amount of melanocytes. The cultured melanocytes were transferred from culture media to the area of lesions in vitiligo patients. Falabella *et al.* had performed this technique in nine patients and observed 40% success rate. Remaining patients show moderate improvement.<sup>[66]</sup> The main problem associated with this technique is the expense in culturing of cells and also difficulties in the transformation of cells.

## ALTERNATIVE METHODS TO CONVENTIONAL TREATMENT

Karin U. Schallreuter, Hartmut Rokos surveyed and found that Asian patients who consume curcumin daily do not show improvement in the treatment.<sup>[67-69]</sup> It states that curcumin results in stress due to the formation of free radical on oxidation and affects repigmentation process.<sup>[70-72]</sup> Pravit Asawanonda, and Siri-On Klahan, conducted a preliminary randomized control study using tetracurcuminoid cream<sup>[73-75]</sup> and reported that curcumin having an anti-inflammatory effect which inhibits COX-2, lipoxygenase, and i-NOS. It also protects skin by suppressing free radicals and also inhibits nuclear factor Kb (kappa b) which makes this compound useful for the treatment of depigmentation.<sup>[76,77]</sup> Vitamin D analogs reduce the depigmentation by acting on the immune system stress due to oxidation and apoptosis which results in protection of melanocyte unit. Other than these mechanisms Vitamin D analogs interfere with pathways that mainly responsible for activation, proliferation, and migration of melanocytes.<sup>[78]</sup> Ginkgo biloba has many properties such as antioxidant and anti-inflammatory properties which are mainly responsible for ceasing oxidative stress which can be considered as alternative treatment for vitiligo.<sup>[79-82]</sup> Vitamin E, Vitamin B12, Vitamin C, phenylalanine, and folic acid can also be used for treating vitiligo by reducing oxidative stress.<sup>[83,84]</sup> Dead Sea climatotherapy was used in ancient times which involve bathing in the Dead Sea during February and mid-November. Since Dead Seawater contains huge concentration of magnesium chloride along with solar radiation which can be considered as an effective treatment for vitiligo.<sup>[85]</sup> Polypodium leucotomos is also used in treating vitiligo but cause itching.<sup>[86]</sup> Jequirity, kodalimurungai, turmeric, avaram senna, black catechu, ashwagandha, karpokarishi (babchi), and true indigo can also be used in treating vitiligo.<sup>[87]</sup> Various types of plants and their parts<sup>[88]</sup> used in treating vitiligo are given in Table 3.

**Table 3: Plants used in the treatment of vitiligo**

Common name	Parts used
Amla	Fruit
Almond	Seeds
Aloe vera	Leaves
Black cummin	Seeds
Cinnamon tree	Bark
Colocynth	Fruit
Celery	Roots
Common grapevine	Fruit
Ceylon leadwort	Bark
European wild ginger	Rhizomes
Fig	Fruit
Fennel	Roots, seeds
False daisy	Whole plant
Golden rain tree	Fruit pulp
Ginger	Rhizome
Indian barberry	Stem
Liquorice	Roots
Marshmallow plant	Seeds
Myrobalan	Fruit
Malacca bean	Seed, oil
Peppermint	Whole plant
Pomegranate	Flower, fruit
Quince fruit	Seed mucilage
Radish	Rhizome
Senna tora	Seeds

### IN VITRO MODELS FOR VITILIGO

Studies from Lin *et al.* on determining the effect of the proliferation of melanocytes using *in vitro* models reported the efficacy of amides derived from Piper nigrum in replication of melanocytes.<sup>[89,90]</sup> The use of *in vitro* models helps in assessing the effect of formulation before performing *in vivo* studies. The researchers used melan-A, pigmented, and non-tumorigenic mouse melanocyte cell line<sup>[91]</sup> and reported that piperine induce the replication of melanocytes. Similar work by Lei *et al.* performed a research in assessment of pigmentation using melanocyte-keratinocyte coculture model.<sup>[92]</sup> Since culturing and maintaining of human cell cultures is difficult, they made an alternative coculturing of murine SP-1 keratinocytes<sup>[93]</sup> with melan-A cell line. With the help of this model cell lines, they assessed the percentage tyrosinase activity using different concentrations of various melanocyte stimulators<sup>[94]</sup> and they compared the effect of these stimulators with only melanocyte cell line. On comparison found that keratinocytes play a major role in regulating the melanogenic process using various stimulators.

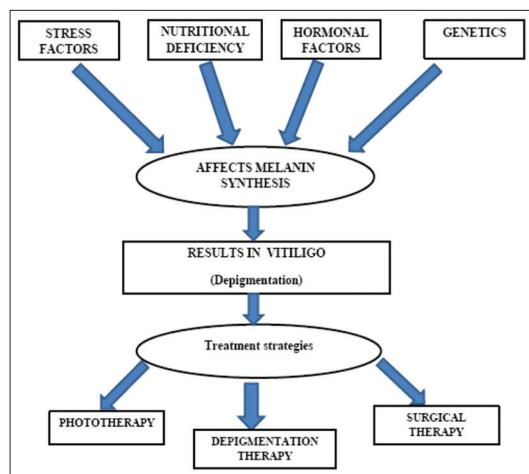
<sup>[95,96]</sup> Yoon *et al.* made a study of pigmentation using reconstituted three-dimensional human skin from various origins as *in vitro* model. In this study, *in vitro* model used is melanoderm which contains both melanocyte and keratinocytes from various origins. The study involved tyrosinase activity and melanin content responsible for pigmentation using melanogenic stimulators and inhibitors and reported their effects in pigmentation.<sup>[97]</sup>

### ANIMAL MODELS USED IN VITILIGO

Essien *et al.* made a review on animal models used for vitiligo. The study focus on the use of various animals models in determining disease progression and efficiency in treatment.<sup>[98]</sup> It also reported that various horse breeds can be used as model since they tends to develop vitiligo on face and other perigenital areas. Certain dog breeds such as German shepherds, Rottweiler can also be used as models. Mainly genetics is involved in the occurrence of vitiligo in these dog models.<sup>[99]</sup> The study revealed that Smith line chicken exhibits vitiligo which is having similar characteristics as that of human vitiligo.<sup>[100,101]</sup> Mice can also be used as a model for vitiligo. In mice, vitiligo can be induced by stress, immunization, and genetics. Jean-Paul Ortonne and Sumit Kumar Bose made a survey on vitiligo. They revealed their idea regarding the use of animal models for vitiligo. Earlier studies include Belgian dog varieties.<sup>[102]</sup> These dogs tend to develop depigmentation which is similar to human, but no detailed studies have been made in this model. Many studies have been done on various horse varieties.<sup>[103]</sup> These horse models show depigmentation in the areas of face and anus. Genetics mainly involved in the occurrence of depigmentation. They mentioned pigs may also be used as models for vitiligo. Immune response is mainly responsible for depigmentation. They reported that many studies have been done on chicken species and revealed that various chicken species such as white leghorn, Plymouth can be used as animal models for the study of vitiligo in humans.<sup>[104]</sup> Genetics plays a major role on the occurrence of vitiligo in these models.

### CONCLUSION

Although vitiligo is not a chronic disorder, its occurrence on some parts of the body (especially on the face) leads to psychological distress for the affected people. Most of the treatment methods utilize UV rays on post application of drugs. Use of UV radiation may also leads to various effects on healthy skin also. Use of UV radiation alone cannot cause any remarkable changes in the treatment strategies. Hence, the combination therapy is recommended. Studies on exclusion of UV rays need to be strengthened so that combination therapy with UV rays and its exposure can be reduced. Moreover, use of herbal drugs to stimulate the pigmentation is an area where research can also be concentrated.



Graphical Abstract

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