Abstract

Background: Physical therapies refer to non-medical treatment strategies, including surgery, cryotherapy, ultraviolet (UV) phototherapy, and acupuncture. Most physical approaches are inappropriate in the context of itch. UV phototherapy and acupuncture may be effective in the management of itch. Methods: A literature search was performed using MEDLINE and EMBASE. Bibliographies were reviewed for relevant articles. Results: Narrowband UVB (311–313 nm) and UVA1 (340–400 nm) are equally effective in managing atopic dermatitis and associated itch. The efficacy of broadband UVB in reducing uraemic itch has been demonstrated in a series of randomised controlled trials, but more recent studies have failed to reproduce these results. Non-randomised, uncontrolled studies and case series suggest that UV is effective in managing itch associated with cholestasis, chronic urticaria, prurigo, cutaneous T-cell lymphoma, aquagenic itch, and scleroderma. UV phototherapy is well tolerated, and no significant relationship between UVB therapy and skin cancer has been found. Experimentally, acupuncture has been shown to reduce allergen-related itch, although this finding has been limited by the small number of studies, inconsistency in agreement on acupuncture sites and study design, small sample sizes, and limited follow-up. Conclusions: UV phototherapy is an effective treatment for itch associated with atopic dermatitis. UVB may be effective in managing itch associated with end-stage kidney disease, cholestasis, chronic urticaria, prurigo, cutaneous T-cell lymphoma, aquagenic itch, and scleroderma. Phototherapy should be combined with standard first-line therapies. Insufficient evidence exists to justify acupuncture as a physical therapy for itch. Further well-designed studies are required to establish the effectiveness of physical therapies in managing itch.

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proach to managing itch which exposes patients to controlled quantities of UV light in order to induce changes in the skin that reduce itch sensation, while acupuncture is a complementary therapy that involves the insertion of needles into acupuncture points, which may reduce allergen-induced itch sensation. The exact mechanism by which UV reduces itch in patients with atopic dermatitis, psoriasis, end-stage kidney disease, biliary obstruction, and chronic urticaria is not yet fully understood, but is thought to be related to its immunosuppressive effects. This chapter seeks to assess the evidence behind the use of physical therapies in itch involving normal-looking and diseased skin, and clarify their clinical application. It should be noted that studies investigating the antipruritic effects of UV phototherapy in diseased skin rarely use itch as a primary study outcome. Rather, they focus on itch as a component of the overall disease state.

History of the Development of UV Delivery Devices

While the therapeutic potential of sunlight was already noted in Ancient Egypt and during the Islamic Golden Age, modern phototherapy involving sophisticated UV delivery devices able to control wavelength and dosage did not exist until the 20th century [1, 2]. Experiments with PUVA (psoralen + UVA) in 1974 and broadband (BB) UVB throughout the 20th century found UV phototherapy to be effective treatments for psoriasis and associated itch [3]. However, the popularity of BB-UVB has declined in recent years, as NB-UVB has been found to be more effective and less carcinogenic at clinically effective doses [8–10]. While medical UVB units only emit UV along a specific wavelength spectrum, at a specific level of irradiance, tanning booths emit an inconsistent proportion of UVA and UVB wavelengths, at an irradiance level up to 10–15 times stronger than the midday Mediterranean sun [11]. No significant link between medical UVB and skin cancer has been established, but sunbed use is associated with a significant increase in melanoma risk, especially when initial usage begins at a young age (<35 years) [11–13]. However, long-term follow-up of medical UVB use is required because of the potential for carcinogenicity [14, 15].

Currently Available UV Devices

UV phototherapy can include BB-UVB (280–315 nm), BB-UVA (315–400 nm), NB-UVB (311–313 nm), UVA1 (340–400 nm), and PUVA. Longer wavelengths (UVA) are capable of penetrating deeper into the skin, and may work via a different mechanism to UVB. Full body machines cost approximately USD 40,000, while ‘hand and foot’ machines cost approximately USD 10,000.

UVB (Narrowband and Broadband)

BB-UVB refers to UV light with a wavelength of between 280 and 315 nm. BB-UVB combined with coal tar was first shown in 1925 by Goeckerman as an effective treatment for psoriasis [7]. However, the popularity of BB-UVB has declined in recent years, as NB-UVB has been found to be more effective and less carcinogenic at clinically effective doses [8–10]. While medical UVB units only emit UV along a specific wavelength spectrum, at a specific level of irradiance, tanning booths emit an inconsistent proportion of UVA and UVB wavelengths, at an irradiance level up to 10–15 times stronger than the midday Mediterranean sun [11]. No significant link between medical UVB and skin cancer has been established, but sunbed use is associated with a significant increase in melanoma risk, especially when initial usage begins at a young age (<35 years) [11–13]. However, long-term follow-up of medical UVB use is required because of the potential for carcinogenicity [14, 15].
Broadband UVA and UVA1

BB-UVA refers to wavelengths between 315 and 400 nm. Clinically, BB-UVA is often combined with psoralen (a photosensitising agent) as PUVA, or photochemotherapy, for the treatment of psoriasis [16]. However, NB-UVB is preferred as a first-line treatment for psoriasis, as it does not lead to the systemic photosensitivity of the eyes and liver, or the increased skin cancer risk associated with PUVA [17]. A limited number of studies suggest that BB-UVA is effective in reducing the severity of atopic dermatitis, but is less effective than BB-UVB and NB-UVB in reducing itch [18, 19]. A more comprehensive body of work has established the efficacy of UVA1 (340–400 nm, lower UVA wavelengths filtered out) as a treatment for atopic dermatitis and itch [20–22]. However, UVA1 machines are a rarity in many countries. In this case, NB-UVB can often be used.

Guidelines for Use

Figure 1 shows an example of a BB-UVA/NB-UVB unit. Patients wearing underwear and eye protection stand in the centre of the machine. The machine then closes to expose the patient to BB-UVA or NB-UVB from all directions.

Dosage guidelines vary by UV wavelength, cause of itch, and country. For atopic dermatitis, NB-UVB dosage protocols in studies frequently begin at 70% of the minimum erythema dose (MED) [22, 23], increasing by 10–20% on subsequent visits to a maximum of 1.3–1.5 J/cm² [10, 19]. This is less intensive than the UV dosage schedule recommended in psoriasis, but dosage and frequency are not standardised and vary between studies. To determine the MED, a section of the patient’s skin is exposed to UV light at intervals and the exposed area is examined after 24–48 h. The section of skin that is erythematous after the shortest period of UV exposure indicates the MED [24]. Modern machines will automatically increase dosage by 10% per session, plateauing after 15 treatments for safety. Dosages should not be increased if patients experience burning, and should be reduced if patients miss sessions. Typically, patients undergo 3 sessions per week, but frequency can range from 2 per week to daily as inpatients. Some clinicians may also opt to follow the psoriasis dosage guidelines [25]. Dosage may vary depending on the Fitzpatrick skin type of the patient, and should always be adjusted to the needs of the individual patient. Treatment courses usually last at least 6 weeks or until a satisfactory outcome is achieved.
Adverse Effects of Phototherapy

Phototherapy is generally well tolerated, and short-term adverse effects are minimal. These include burning, exacerbation of eczema [26, 27], erythema and burns [15, 28, 29], itch [30] sweating [31], and herpes simplex and varicella zoster reactivation [14]. Evidence suggests that there is no significant relationship between UVB therapy and skin cancer, but long-term follow-up is required [12–15]. PUVA in psoriasis patients is, however, linked with a significant increase in the risk of squamous cell carcinoma [32]. UV is safe and effective in paediatric populations when they are mature enough to protect their eyes during treatment, but patients should be monitored for long-term adverse effects not documented in the literature [23, 29].

UV Phototherapy in Itchy Skin Diseases

Atopic Dermatitis
Phototherapy is a second-line treatment modality for atopic dermatitis which can involve NB-UVB, BB-UVB, BB-UVA, UVA1, PUVA, and UVA and UVB simultaneously [25]. Numerous studies have shown UV phototherapy to be effective in treating atopic dermatitis and associated itch [6]. Initial research in this area focused on the efficacy of BB-UVB (280–315 nm) [33]. In recent years, it has been established that NB-UVB is more effective than BB-UVB, without an increased risk of adverse effects [4].

NB-UVB produces clinically significant reductions in atopic dermatitis symptoms, including itch, and improvement is sustained 3 months after treatment (p < 0.0001 at 3 months) [23, 26]. Medium-dose UVA1 and NB-UVB are equally effective in treating atopic dermatitis and associated itch, although lower levels of irradiation are required to produce a similar therapeutic effect with NB-UVB [6, 10, 22]. A 2001 randomised controlled trial by Reynolds et al. [26] noted that NB-UVB was more effective than BB-UVA in reducing itch. High-dose UVA1 and medium-dose UVA1 are similarly effective [34].

Given that NB-UVB is cheaper, more readily available, and requires lower dosages than UVA1 [10], its use may be preferred in clinical practice. The long-term efficacy of phototherapy is difficult to judge, owing to lack of follow-up in trials. A study of medium-dose UVA1 found that symptoms recurred within 3 months [27], and a trial of NB-UVB in children found that beneficial effects are sustained for at least 6 months after treatment (p = 0.0012) [23].

The antipruritic mechanisms of UV phototherapy in atopic dermatitis have not yet been fully elucidated, but it is thought to be related to its immunosuppressive effects, which reduces overall disease activity [35]. UVA1, which penetrates deeper into the skin [36], decreases T_{H2}-cell-derived IL-5, IL-13, and IL-31 mRNA expression [37]. Similar effects on T_{H2} pathways have been observed in NB-UVB [38]. UVA1 and UVB also induce apoptosis of T lymphocytes and antigen-presenting Langerhans cells [39–41], reducing inflammatory infiltrate. UVA and UVB are also able to modulate the activity of ICAM1, the overexpression of which acts as a binding site for inflammatory leukocytes [41–43]. UVB further prevents the degranulation of mast cells [44].

While the literature focuses on UV monotherapy because of the need to study its effects in isolation, phototherapy should be combined with topical corticosteroids and other first-line treatments in clinical practice.

Itch in Psoriasis
Psoriasis is an inflammatory disorder that manifests as scaly erythematous patches, papules, and plaques [45]. While itch may accompany these skin lesions, it is typically not a major complaint. Itch is not included in the Psoriasis Area and Severity Index (PASI), which is used to assess the extent of the disease. Phototherapy, including

Physical Therapies for Itch
NB-UVB or BB-UVB, is a first-line treatment for psoriasis that reduces both overall disease severity and itch [46, 47]. PUVA is an effective treatment, but is not first-line because of risks associated with photosensitivity and skin cancer [17]. Topical PUVA (e.g. with 0.01% oxsoralen cream) may be used for palmoplantar psoriasis, and does not involve the systemic adverse effects of oral psoralen [17, 48, 49]. Further information may be found in the chapter by Szepietowski and Reich [this vol., pp. 102–110].

*Itch in Chronic Urticaria*

UV light may also be used as an adjunct treatment for symptomatic relief of itch in chronic idiopathic urticaria. A 2012 study found that NB-UVB was effective in clearing or reducing itch compared to baseline in chronic urticaria, although this study was not blinded or randomised [50]. NB-UVB with antihistamine has also been found to be more effective in reducing itch than antihistamine monotherapy [51]. PUVA and NB-UVB are equally effective at reducing itch in chronic urticaria [52]. A retrospective review of NB-UVB in 84 patients with chronic urticaria reported that 85% of subjects experienced clearance or moderate improvement [53]. Overall, studies and evidence in this area are poor, no rigorous randomised controlled trials have been carried out, and phototherapy is not included in the treatment algorithm of major chronic urticaria guidelines [54, 55]. Nevertheless, it may be considered as an adjunct second-line treatment if systemic agents are deemed inappropriate.

*Other Indications for UV Phototherapy in Itchy Skin Diseases*

Case series have documented the successful use of BB-UVB [56] (monotherapy or supplemented with topical steroids + coal tar [57] or PUVA [58]), NB-UVA + PUVA [59], and UVA1 + topical steroids [60] in reducing itch associated with prurigo nodularis.

Cutaneous T-cell lymphoma (CTCL) may present with itch, and PUVA is an established therapy for early-stage CTCL [61]. BB-UVB, NB-UVB, and UVA1 have also been shown in case series to be effective in patients with CTCL [62–64]. UV phototherapy may reduce itch in these patients by treating the underlying CTCL, but studies of UV in CTCL have not examined the effect of UV on itch directly [65]. Low-dose UVA1, medium-dose UVA1, and NB-UVB have been trialled with success in localised scleroderma, but only medium-dose UVA1 significantly reduced itch [66, 67]. UVA1 and PUVA may be effective in systemic scleroderma, but evidence in this area is poor [68, 69].

**UV Phototherapy for Itch in Normal-Looking Skin**

*Uraemic Itch*

Itch is commonly associated with renal failure. Gilchrest et al. [70–72] found BB-UVB phototherapy to be more effective than a UVA placebo in treating uraemic itch, with long-lasting relief following treatment for 50% of patients. It appears to have a systemic effect, as half-body exposures to BB-UVB light resulted in whole-body reductions in itch [70]. However, a 1981 double-blind crossover study with 12 subjects failed to confirm these findings [73]. An uncontrolled trial suggested that NB-UVB could be effective in the treatment of uraemic itch [74], but a 2011 randomised controlled trial did not reach significance compared to placebo [75]. A 2003 case report involving a single patient found that BB-UVB, but not NB-UVB, was effective in clearing uraemic itch. Dosage in the Gilchrest studies on which this treatment is based started at 75% of the MED, increasing by 25% of the MED to a maximum of 480 mJ/cm² [70].

The mechanisms of phototherapy in treatment uraemic itch are unknown, but its systemic effects are thought to be related to the photoinac-
tivation of an itch-inducing substance produced in renal failure [70, 76]. Other theories include mast cell apoptosis by UVB [77], an UVB-induced reduction in mast cell histamine release [78], and a reduction in skin divalent ion content, particularly phosphorus [79].

**Cholestatic Itch**

Itch is a common symptom associated with chronic liver disease and cholestasis. The efficacy of phototherapy has only been examined in a small number of unblinded, non-randomised pilot studies and case reports. These studies suggest that BB-UVB is effective in reducing cholestatic itch [80–83]. BB-UVB treatment was further found to reduce itch in 12/13 patients with cholestasis in a 2012 study [84]. Due to the lack of randomised controlled trials investigating the use of UV phototherapy in cholestatic itch, it is not recommended as a treatment modality in major treatment guidelines [85, 86]. Further information can be found in the chapter by Mittal [this vol., pp. 142–148].

**Other Indications for UV Phototherapy in Normal-Looking Skin**

BB-UVB, NB-UVB, and PUVA have all been reported as being effective in reducing aquagenic itch in case series, but remission appears to be short-lived [87–89].

**Acupuncture and Itch**

Acupuncture belongs to the traditional Chinese medicine family of complementary therapies, dating as far back as 6000 BC, and formally codified in ‘The Yellow Emperor’s Classic of Internal Medicine’ around 100 BC [90]. Acupuncture involves the insertion of needles (0.25 × 40 mm) 2–3 cm deep into acupuncture points (as defined by traditional literature) for a variable amount of time, ostensibly to influence the flow of ‘Qi’, or energy, around the body in order to reduce itch sensation [91, 92]. Electroacupuncture is a form of acupuncture that involves passing an electrical current through an inserted needle. As a complementary and alternative therapy, research investigating the role of acupuncture in managing itch is largely insufficient.

Acupoints linked to itch are located on the upper and lower limbs, and preventive electroacupuncture applied before the induction of itch by an allergen at these locations were more effective than placebo and equally effective as oral cetirizine (antihistamine) at reducing the intensity of itch, although these were unable to reduce itch to below the scratch threshold [91, 93]. Abortive acupuncture, where acupuncture and itch induction occur simultaneously, is more effective than both preventive acupuncture and oral cetirizine, reducing itch to below the itch threshold [91, 93]. Electroacupuncture, where an electrical current is passed through the needle, is more effective than acupuncture without electrical stimulation [94].

The antipruritic mechanisms of acupuncture are poorly understood, but are thought to be related to a reduction in sensory nerve fibre density [95], reduced basophil activation [96], and its ability to distract the patient [91]. Acupuncture reduces itch-induced response in the putamen and insular, premotor, and prefrontal cortical areas of the human brain, as measured by changes in cerebral blood flow [97]. Furthermore, referred itch sites appear to have a high degree of correlation with acupuncture meridians [98].

The small sample size and number of trials, as well as lack of follow-up to evaluate long-term effectiveness diminishes the usefulness of acupuncture in a clinical setting [91, 99]. Furthermore, acupuncture regimens are not standardised and clinical trials utilise inconsistent acupoints and protocols, making it difficult to determine the best course of treatment [91, 94]. In addition to inadequate experimental evidence, there are also differences of opinion amongst acupuncture practitioners regarding the locations and therapeutic effects of acupoints [98]. While acupunc-
ture enjoys a good safety profile [100], it remains costly and invasive compared to medical and other physical approaches. Therefore, while acupuncture has demonstrated antipruritic effects in atopic itch under controlled conditions, its use in clinical practice remains questionable. There is also insufficient evidence to justify the use of acupuncture for uraemic itch [101].

**Other Physical Approaches**

Massage as an adjunct to standard care has been shown to significantly reduce itch in children with atopic dermatitis compared to conventional treatments [102]. The addition of essential oils to the massage regimen does not further reduce itch, suggesting that the physical act of massage plays a role in mediating itch sensation in children [103].

**Conclusion**

Physical approaches to itch are largely limited to UV phototherapy and acupuncture. Convincing evidence exists for the use of UV phototherapy in itch associated with atopic dermatitis and psoriasis. Evidence supporting the use of UV in itch related to chronic urticaria, end-stage kidney disease, and biliary obstruction is less convincing, but UV phototherapy may be indicated in these conditions when first-line therapies are inappropriate. On the basis of current evidence, acupuncture cannot be recommended as a therapy to treat itch in a clinical setting.

**References**

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