ARC Journal of Dermatology
Volume 8, Issue 2, 2025, PP 17-30
ISSN No. (Online) 2456-0022
DOI: https://doi.org/10.20431/2456-0022.0802002
www.arcjournals.org

Sweat Smarter, Not Harder: Fresh Approaches to Occlusive Hyperhidrosis

Darianne Zimmer[1], Justin Flores[2], Rachel Santana Felipes[3], Sriya Kakarla[4], Bailey Patrick[5], Nicholas Doss-Hom[6], Navya Peddireddy[7], Kelly Frasier[8*]

[1]*University of California, Riverside School of Medicine, Riverside, CA*

[2]*California Health Sciences University College of Osteopathic Medicine, Clovis, CA*

[3]*Albert Einstein College of Medicine, Bronx, NY*

[4]*UTHealth Houston McGovern Medical School, Houston, TX*

[5]*University of Missouri - Columbia School of Medicine, Columbia, MO*

[6]*Lewis Katz School of Medicine - Philadelphia, PA*

[7]*Texas College of Osteopathic Medicine, Fort Worth, TX*

[8]*Department of Dermatology, Northwell Health, New Hyde Park, NY*

Received: 03 January 2025 Accepted: 28 January 2025 Published: 10 February 2025

Corresponding Author:** ***Kelly Frasier, *Department of Dermatology, Northwell Health, New Hyde Park, NY*

Abstract

Occlusive hyperhidrosis, characterized by excessive sweating in localized areas, poses significant physical and psychological challenges for affected individuals, often leading to social withdrawal and decreased quality of life. Recent advancements in therapeutic strategies have introduced a range of novel and innovative solutions aimed at managing this condition effectively. Emerging treatments include the development of specialized topical formulations incorporating advanced absorbent materials and dermatologically active agents designed to reduce moisture accumulation while maintaining skin integrity. Innovative devices, such as iontophoresis machines and wearable micro-electromechanical systems (MEMS), are gaining traction, utilizing electrical stimulation to temporarily reduce sweat gland activity. Additionally, the integration of botulinum toxin injections remains a cornerstone of hyperhidrosis management, with recent studies exploring optimized dosing protocols and new delivery techniques to enhance efficacy and minimize discomfort. Furthermore, advancements in laser therapy, particularly in selective sweat gland destruction, have shown promising results in providing long-term relief with minimal side effects. As the understanding of the pathophysiology of occlusive hyperhidrosis evolves, researchers are also investigating the role of genetic and environmental factors, which may contribute to individual variability in treatment responses. This comprehensive examination of current and emerging solutions underscores the importance of personalized treatment approaches, combining pharmacological and non-pharmacological strategies tailored to individual needs. The pursuit of innovative solutions highlights a critical step toward enhancing the overall quality of life for those impacted by occlusive hyperhidrosis

1. Introduction

Hyperhidrosis is a dermatologic disorder characterized by excessive sweating beyond what is needed for thermoregulation. It is clinically diagnosed when sweating impairs daily activities and creates physical, social, and emotional discomfort. Excessive sweating creates a moist environment which increases one's risk of cutaneous bacterial, viral, and fungal infections [1, 2]. In addition, it contributes to body odor and poor posture in an effort to hide sweating [1, 3]. This disorder is further classified as either primary, often idiopathic in nature or secondary. With most cases being idiopathic, the etiology behind hyperhidrosis is not well understood, but it is theorized to be caused by neurologic hyperactivity of the sympathetic innervation of the eccrine glands [3, 4]. Notably, eccrine glands are mainly found in the palms, soles, forehead, and axilla, which are primary regions of excessive sweating for those with primary hyperhidrosis. In comparison, secondary hyperhidrosis is more generalized and asymmetric in distribution. Studies have shown the prevalence of hyperhidrosis in the United States is 4.8%, which is conservative when compared to the higher rates in other countries [5]. This highlights possible difficulties with diagnosing hyperhidrosis due to underreporting because of psychosocial factors such as embarrassment and lack of awareness that this is a medical condition. Beyond its physical manifestations, hyperhidrosis has notable psychological and social impacts. Individuals experience a reduced quality of life with negative emotions such as internalized stigma, depression, anxiety, and embarrassment that impact social and intimate relationships. [6, 7, 8]. Patients cope by carrying a change of clothes and extra towels, restricting choices of clothing, taking multiple showers, and having a portable fan [7,8]. Traditional treatments for hyperhidrosis such as antiperspirants, oral medications, and iontophoresis, often provide limited and inconsistent relief [9]. This led to the development of alternative methods such as botulinum toxin injections and surgery. While botulinum toxin injections and surgical interventions such as sympathectomy offer more targeted solutions, they are invasive, expensive, and not without risks, including compensatory sweating or nerve damage [9, 10]. Furthermore, not all patients respond adequately to these treatments, and many find that side effects or treatment fatigue diminish long-term compliance. Given these limitations, there is a pressing need for more personalized and effective approaches to managing occlusive hyperhidrosis. Current research emphasizes the importance of tailoring treatments to individual patient needs, considering factors such as the severity of sweating, the location of affected areas, and the psychological impact. Moreover, the development of non-invasive or minimally invasive options that offer long-term control of symptoms could greatly enhance patient outcomes. Innovative solutions that integrate new technologies, such as wearable devices for monitoring sweat patterns or advanced topical treatments, hold promise for improving the quality of life for individuals with this debilitating condition.

2. Physiological Basis of Sweating

Hyperhidrosis arises from the body's inability to regulate sweat production through the autonomic nervous system. This system, which controls involuntary bodily functions, including sweating, involves overactive eccrine glands as primary contributors. These glands, concentrated in the axillae, palms, and soles, release sweat through acetylcholine stimulation, binding to muscarinic receptors and initiating secretion [11, 12]. In hyperhidrosis, sweat production occurs independently of temperature or physical activity. This dysregulation results in excessive sweating, often linked to heightened sympathetic activity, leading to physical discomfort and emotional distress [13]. As patients usually feel embarrassed by visible sweating, the condition can impair professional and social interactions, causing further anxiety. Effective management must address both physiological and psychological components to improve outcomes.

Environmental factors, such as tight clothing or synthetic fabrics, worsen symptoms by trapping sweat against the skin. This retained moisture promotes bacterial or fungal infections, further complicating management and necessitating timely interventions to improve skin health [14]. In addition, physical activity, especially in occluded areas like the underarms or feet, impedes sweat evaporation, intensifying discomfort and exacerbating symptoms. Emotional stress further amplifies sweat production in areas with dense eccrine glands like the palms [15]. This can disrupt tasks such as gripping objects or shaking hands, causing social and functional challenges. Implementing a combined strategy of lifestyle changes, medical interventions, and behavioral therapies is crucial to improving outcomes. Encouraging patient adherence to non-invasive interventions, such as wearing breathable clothing and engaging in stress reduction practices, further optimizes the effectiveness of comprehensive management plans.

3. Genetic and Environmental Influences

3.1. Hereditary Factors

Early diagnosis is essential for managing hyperhidrosis, particularly in individuals with a family history of the condition, as it enables preventive strategies that may reduce symptom severity. Familial cases often follow an autosomal dominant and, to a lesser extent, autosomal resistive pattern, with symptoms emerging during childhood or adolescence. Genetic studies have identified regions on chromosomes 2, 14, and 16, but the findings still need to be consistent and limited. Primary hyperhidrosis appears to have a polygenic inheritance pattern, necessitating further research to clarify its genetic basis [16]. Recognizing the condition early is especially important, as those with genetic predispositions can benefit from personalized interventions. Severe cases in adolescents may lead to bullying, low self-esteem, and social isolation, but timely treatment can help prevent these complications. Clinicians considering both the hereditary and immunogenetic aspects of hyperhidrosis can develop treatment plans that balance genetic risks with lifestyle adjustments, improving long-term outcomes. Addressing the interplay between genetics, immune factors, and environmental influences allows for personalized care, enhancing quality of life across all age groups.

3.2. Lifestyle and Dietary Contribution

Environmental factors also significantly influence the severity of hyperhidrosis. Lifestyle choices such as exercise, heat, tobacco, alcohol, or spicy foods can trigger excessive sweating, complicating symptom management. Intense physical activity adds to this burden, particularly in individuals with focal hyperhidrosis [11]. Stress amplifies these effects by stimulating the sympathetic nervous system, increasing sweat production in areas like the hands and feet [11, 17]. Incorporating stress-reduction techniques, such as mindfulness or yoga, mitigates symptoms and promotes emotional well-being. Maintaining a healthy weight and choosing appropriate clothing also help reduce thermal stress and moisture retention. In addition to these strategies, avoiding dietary triggers allows for better symptom control, particularly in socially significant scenarios. The combination of lifestyle modifications and medical interventions ensures a holistic approach to managing hyperhidrosis effectively.

4. Topical Formulations

Innovative absorbent materials significantly advance hyperhidrosis management by controlling moisture without compromising skin integrity. Hybrid cotton-hydrogel yarns, which integrate natural fibers with hydrogel technology, enhance moisture absorption while allowing for thermoregulation [18]. These advanced fabrics prevent sweat ducts from occluding. Their flexibility and durability make them ideal for high-sweat areas like the axillae and feet, offering protection from friction and irritation. Using these materials regularly can reduce skin damage and infections, especially in patients engaging in physical activities [18]. The psychological benefits of reducing visible sweat include improved self-esteem and social confidence. Ultimately, these materials serve as a complementary tool that empowers patients to manage hyperhidrosis more effectively in their daily lives.

Beyond comfort, absorbent materials complement medical treatments such as iontophoresis or anticholinergic agents, enhancing localized sweat control [18]. By reducing moisture buildup, these materials help prevent skin breakdown and irritation, improving patients' quality of life. These materials also provide patients with non-invasive options that minimize reliance on clinical procedures [18]. Moreover, their accessibility and affordability make them valuable to hyperhidrosis management, especially in resource-limited settings. Integrating these products into personalized care plans supports long-term maintenance of sweat control.

4.1. Antiperspirants

In addition to absorbent materials, dermatological agents have evolved to target sweat glands more effectively. Traditional antiperspirants containing aluminum-based compounds reduce sweat production by blocking sweat ducts through forming metallic plugs, inhibiting secretion [13, 14]. These treatments offer a straightforward approach to managing mild hyperhidrosis. However, aluminum-based antiperspirants may cause irritation or allergic reactions, limiting widespread use. Patients must adhere to consistent application routines to maximize efficacy. Adjusting frequency and timing based on individual sweat patterns ensures optimal results, with education on proper use enhancing outcomes.

4.2. New Ingredients and Formulations

New topical agents, such as oxybutynin 10% gel, inhibit acetylcholine at the gland level, reducing excessive sweating while offering a non-invasive alternative to systemic therapies [19]. This gel, designed for focal hyperhidrosis, minimizes the burden associated with more invasive procedures. Clinical research has confirmed the effectiveness of other topical formulations, including glycopyrronium bromide 1% cream, which achieved significant sweat reduction in axillary hyperhidrosis within four weeks [20]. These topical therapies are beneficial for individuals seeking to avoid surgical or systemic options, especially in cases of mild to moderate hyperhidrosis. Sofpironium bromide gel has also shown sustained relief over a 52-week study, demonstrating the potential for long-term symptom control with minimal side effects [21]. These agents offer localized control of sweat production, but patient adherence to consistent application schedules remains essential for maintaining outcomes. As these new treatments become more accessible, clinicians should emphasize their benefits during patient education to foster adherence and improve outcomes.

Further evidence from the ATMOS-1 and ATMOS-2 phase III trials has highlighted the effectiveness of glycopyrronium tosylate (Qbrexza) in treating axillary hyperhidrosis, with participants reporting improved quality of life [22]. This formulation provides precise control over localized sweat glands with fewer systemic side effects than oral medications, making it suitable for long-term management. One study found that the systemic absorption of topical glycopyrronium tosylate was significantly lower when compared with oral anticholinergics, and no anticholinergic-related adverse events were reported [23]. Reviews of these treatments highlight that their ease of application and ability to target specific areas increases patient satisfaction [19]. However, these formulations may only partially address symptoms in more severe cases, where combination therapies might be necessary. Dermatologists should evaluate individual sweating patterns to recommend personalized regimens that align with patient lifestyles. Encouraging lifestyle changes, such as wearing breathable fabrics and minimizing exposure to known triggers like caffeine, can further enhance the effectiveness of these treatments. Integrating new topical agents with behavioral strategies offers a comprehensive, non-invasive approach to symptom control.

Topical agents are particularly effective for palmar hyperhidrosis, which can interfere with daily activities such as gripping objects, driving, or shaking hands. Excessive sweating in these areas presents unique challenges, often requiring multiple interventions for sustained relief. Combining anticholinergic agents with stress management strategies can mitigate the sympathetic overactivity that worsens palmar sweating [13, 14]. In such cases, tailored treatment plans ensure that patients receive comprehensive physical and psychological care. Furthermore, incorporating wearable absorbent materials helps prevent discomfort and improve activity performance [18]. These multimodal strategies ensure patients can manage symptoms effectively while maintaining productivity in personal and professional settings.

4.3. Innovative Device-Based Treatments

Beyond topical options, various device-based therapies have been developed to address hyperhidrosis by targeting eccrine gland function or modifying glandular structure. The most established of these is iontophoresis, which applies a direct electrical current to intact skin, often using tap water as a conductive medium. A modified form known as "dry-type" iontophoresis uses the patient's sweat as a conduit, providing an alternative approach. Although the precise mechanism remains unclear, it is hypothesized that iontophoresis disrupts sympathetic nerve transmission and obstructs sweat flow by altering pH or ion concentration within the sweat ducts [24]. It is recommended that this modality be used 3-4 times weekly with a current set to 15-20 mA [25]. However, studies have shown that 6 to 15 treatments may be required to achieve anhidrosis. In a trial of eight sessions, there was an 81% reduction in plantar or palmar hyperhidrosis [26]. Nevertheless, iontophoresis can cause discomfort during treatment, paresthesia, erythema, and skin dryness and is contraindicated in those with metal implants, implantable electronic devices, or those who may be pregnant. Other emerging device-based treatments include micro-focused ultrasound waves, which generate localized heat through vibration to destroy axillary sweat glands. A randomized control trial demonstrated that more than 50% of participants achieved at least a 50% reduction in sweating from baseline, with effects lasting up to 12 months following treatment [27]. This long-term efficacy makes ultrasound an appealing option for patients seeking sustained results. Another intervention, liposuction curettage, uses a liposuction device combined with a sharp cannula to disrupt sweat glands at the dermal-subcutaneous fat interface. Clinical studies reported a 79% reduction in resting sweat rate three months post-procedure, with remission maintained for up to six months [28]. A comparative study indicated that subcutaneous curettage and botulinum toxin A injections offer similar efficacy, although liposuction curettage may provide a cost-effective alternative, given the recurrent expense associated with botulinum toxin injections [28]. Moreover, there were no major adverse effects apart from the physiological scar created by the liposuction cannula.

Microwave therapy, exemplified by the FDA-approved 'MiraDry' device, represents another promising approach. This therapy applies controlled heat to the skin-subcutaneous tissue junction, causing thermolysis of eccrine sweat glands. Reported efficacy reaches approximately 90% and lasts for more than one year [29]. Among 24 participants, MiraDry reduced sweat by 80% following two sessions and notably improved symptoms of anxiety, depression, and social isolation after just one session [30]. However, safety concerns persist, as reports of median and ulnar nerve neuropathy have emerged when used for palmar hyperhidrosis, with some cases unresolved even at six-month follow-ups [31,32]. When used on the axilla, reported adverse effects include ecchymosis, axillary pain, numbness, and patchy alopecia. While each of these device-based treatments has unique advantages, they also present distinct limitations, underscoring the need for personalized treatment plans that consider individual patient needs, risk tolerance, and adherence factors.

4.4. Wearable Micro-Electromechanical Systems (Mems)

Wearable micro-electromechanical systems (MEMS) represent an exciting advancement in managing hyperhidrosis through real-time sweat monitoring and inventions. This technology utilizes mini sensors, actuators, and electronics embedded into wearable devices that can detect, quantify, and respond to physiological signals like sweat production. These sensors can track moisture levels and sweat composition, detecting pH and ionic concentrations. This can provide real-time insights into sweat dynamics that are not easily captured in the clinical setting. Ongoing research is exploring the use of these technologies in the treatment of hyperhidrosis. For example, a prototype glove has been developed by Stanford researchers that applies the principles of iontophoresis without a tap water bath [33]. The electrical current is delivered through an electrode powered by a wearable generator. This electrode set is placed inside a glove to treat palmar hyperhidrosis. This design is intended to improve comfort and convenience by reducing the time dedicated to treatment.

Other options for the treatment of hyperhidrosis include the Brella SweatControl Patch by Candesant Biomedical. This device consists of a sodium sheet with an adhesive overlay and utilizes targeted alkali thermolysis, which generates heat when sodium meets water, thus causing microthermal injury to the sweat glands. This patch is applied to each underarm for three minutes and has been shown to reduce sweating by more than 50% for 3-4 months [34]. Moreover, this device is noninvasive and well-tolerated, with more than 80% of participants experiencing no side effects [34].

5. Pharmacological Interventions

5.1. Botulinum Toxin Injections

Injectable therapy with botulinum toxin has been used for the treatment of hyperhidrosis since 1996 with consistently high efficacy and patient satisfaction levels [35]. Botulinum toxin is produced by the gram-negative bacteria *Clostridium botulinum*, and this blocks the release of acetylcholine from presynaptic vesicles by deactivating SNARE proteins. By blocking the nerve signals responsible for stimulating perspiration, sweat production is diminished. There are several types of botulinum toxin, including onabotulinum toxin A (BOTOX), incobotulinum toxin A (Xeomin), abobutulinum toxin A (Dysport), and rimabotilinum toxin B (Myobloc). Onabotulinum toxin A has been FDA-approved for the use of primary axillary hyperhidrosis; however, this treatment is also employed for palmar and plantar hyperhidrosis. This toxin is diluted with 0.9% saline and injected into the dermal-subcutaneous junction. These typically are spread 1-2 cm apart for a total of 10-20 injections, although palms and soles may require higher total doses [25]. The use of botulinum toxin has been studied for the use of axillary hyperhidrosis more than any other treatment options with reports of efficacy ranging from 82 and 87% [25]. Some studies have shown that botulinum toxin A injections reduce sweat production by more than 50% for 6 months or longer [24]. In a study of 145 patients treated with axillary botulinum toxin A, there was a 90% decrease in the mean rate of sweat production at two weeks and a 64% reduction at 24 weeks [36]. Moreover, in a comparison study between onabotulinumtoxin A and currettage, sweat production at the 3-month mark had decreased by greater than 72% and 60%, respectively, suggesting slightly greater efficacy, especially in heavy sweaters [37]. While this is contrary to Budamakuntla's study above suggesting similar efficacy between these treatment modalities, each study reported a similar decrease in sweat production by curettage and Ibrahim's study showed greater efficacy from botulinum toxin specifically for heavy sweaters. In a systematic review assessing the strength of evidence for various hyperhidrosis treatment options, botulinum toxin A injections received the highest strength of evidence, increasing confidence in the reliability of this treatment option [24]. The use of topical botulinum toxin A has also been studied for the use of axillary hyperhidrosis. While this treatment option is not yet commercially available, results from two clinical trials have been promising. In one trial, sweat production was reduced by 20-50% after two weeks and lasted approximately six weeks [38]. However, given that injectable therapy with botulinum toxin only requires 1-2 treatments annually, topical therapy may become a desired option. The use of botulinum toxin A for the treatment of palmar hyperhidrosis is limited, but current studies suggest a reduction in palmar sweat by two-thirds for 3 weeks and up to 6 months [39]. More recent studies also note that sweat quantity still remained less than half of the baseline 6 months following treatment [40]. However, the use of botulinum toxin A for palmar hyperhidrosis still remains limited secondary to handgrip weakness and intense pain from injections [41]. Moreover, approximately 50% of patients are dissatisfied with the results, suggesting that this modality may not be suited for palmer hyperhidrosis [42]. While the efficacy and longevity of injectable botulinum for axillary hyperhidrosis remains high, the cost of therapy presents a significant limiting factor for patient access.

5.2. Anticholinergics

The most commonly used oral medications to reduce excessive perspiration are anticholinergics like glycopyrrolate and oxybutynin. These oral medications reduce sweat production by blocking the action of acetylcholine, the chemical messenger that stimulates postsynaptic muscarinic receptors to induce eccrine sweat gland secretion. While these medications have long been used for the treatment of overactive bladder, among many other conditions, they are frequently used off-label for the treatment of hyperhidrosis. However, because there are acetylcholine receptors throughout the body, anticholinergics elicit their effects systemically and the use of these medications can be limited by their side effects, including dry mouth, urinary retention, constipation, and visual disturbances such as mydriasis. Moreover, given that oral anticholinergics reduce perspiration over the entire body rather than being localized to a specific target, there is an increased risk of heat intolerance and overheating. These side effects are often mitigated by adjusting dosages, using adjunctive therapy rather than monotherapy and adding medications to counteract experienced side effects. Oral options for the treatment of hyperhidrosis are beneficial when compared to alternative treatments given that these medications are widely available and cost-effective. However, it should be noted that this option is not recommended for those 65 years and older given the potential link between dementia and long-term anticholinergic use. However, when considering an anticholinergic option for elderly individuals, glycopyrrolate is often preferred because it is less likely to cross the blood-brain barrier given its limited ability to cross lipid membranes and is not included on the Beers list of inappropriate medications for the elderly. Additionally, precautions should be taken when considering this therapeutic option for those with closed-angle glaucoma, urinary retention, impaired gastric emptying, myasthenia gravis, pyloric stenosis, or those at risk of becoming overheated. However, this therapeutic option offers additional benefits given its various vehicles of delivery. A liquid form of glycopyrrolate and an orally disintegrating tablet of glycopyrrolate are both available for use in pediatric patients and those with impaired swallowing function, respectively, both of which have been used for the off-label treatment of hyperhidrosis. However, the adverse effects associated with this class of medications force up to one-third of patients to discontinue treatment.

5.3. Recent Advancements and Future Prospects

Despite an array of treatment options for hyperhidrosis including clinical procedures and off-label strategies, there continues to be a push for novel therapeutic modalities offering more effective options with the fewest side effects. The most recent advancements in the treatment of hyperhidrosis include the recently FDA-approved topical sofpironium bromide 12.45% gel (Sofdra), the first FDA-approved topical anticholinergic for hyperhidrosis approved since 2018. The results from these clinical trials showed that more than 60% of participants had a 50% or greater reduction in sweat production. Moreover, these trials also included participants aged 9 to 16 and found that despite use for more than 5 months, no severe side effects were reported, and 65% found improvement in their sweating severity. While not yet available, this topical medication offers new avenues for the treatment of hyperhidrosis while limiting unwanted side effects.

Moreover, a clinical trial investigating the use of topical oxybutynin 10% as a spray is being investigated for its efficacy compared to oral oxybutynin (NCT05102396). Another clinical trial investigating a combination oral therapy of oxybutynin and pilocarpine had finished phase 1 trials [43]. While oral oxybutynin is often used off-label for the treatment of hyperhidrosis, pilocarpine was added to mitigate possible side effects of oxybutynin. The product candidate was found to decrease sweating without the commonly experienced dry mouth side effects that occurred with oxybutynin alone. However, the biopharmaceutical company discontinued development for unknown reasons. Similar to the Brella SweatControl wearable device for axillary hyperhidrosis, Candescant Biomedical is also developing similar technology for the treatment of palmar, plantar, and facial hyperhidrosis, which is now approaching feasibility testing [44].

Beyond topical, oral, and wearable devices, even advancements in surgical options are being explored for the treatment of hyperhidrosis. Some studies suggest that sympathetic nerve clipping rather than videothorascopic sympathectomy allows for the removal of the clips in the event of intolerable compensatory sweating following surgery [45]. Others have explored how to predict compensatory sweating or reverse it with an additional surgical procedure [46,47]**.** However, many still remain skeptical of these approaches. Nevertheless, researchers continue to explore the range of therapeutic strategies to aid in the treatment of hyperhidrosis.

6. Minimally Invasive Procedures

In addition to pharmacological management, minimally invasive procedures can also be used to treat hyperhidrosis. One approach is using laser therapy to selectively destroy sweat glands. Lasers work by selectively heating and eradicating the glands, and frequencies of 924, 975, and 1064 nm have demonstrated efficacy in randomized control trials [48]. During this procedure, the treatment area is determined with the iodine starch test. Topical lidocaine can be used for pain control if desired. A small incision is made to accommodate the laser, the laser is fired, and the destroyed tissue is suctioned out. The procedure, typically completed within one hour, is generally well-tolerated, though it may occasionally result in swelling, bruising, or localized infection at the incision site.

Laser therapy has demonstrated efficacy in the treatment of hyperhidrosis, particularly in the axillary region. In a randomized clinical trial, therapy with 924 nm alone, 975 nm alone, and the two frequencies simultaneously all demonstrated significantly reduced sweating at one month and twelve months after a single treatment as measured by the iodine starch test [49]. In addition, patients reported significantly decreased symptom severity in the Hyperhidrosis Disease Severity Scale (HDSS) at one month and twelve months following treatment. At the follow-up visits, patients also assessed their degree of sweating with the Global Aesthetic Improvement Scale (GAIS). The results of this study indicate that not only does laser therapy improve the objective amount of perspiration, but also that patients are subjectively seeing improvement.

Aside from laser therapy, radiofrequency microneedling (RFMN) is another minimally invasive procedure that can treat hyperhidrosis. This technique delivers radiofrequency-generated thermal energy to the reticular dermis to destroy sweat glands. It has been studied primarily in axillary hyperhidrosis. Two studies with 50 participants demonstrated that individuals experienced a 42% to 46% improvement in hyperhidrosis after three sessions of RFMN [50]**.** A year after the last treatment, the RFMN-treated areas maintained an average improvement of 28% in hyperhidrosis compared to baseline. Although the effects of this treatment do not last as long as those of laser therapy, it is still efficacious and may be beneficial for patients who fail oral or topical agents. Like laser therapy, microwave-based treatment options offer long-term solutions for hyperhidrosis.

While microwave devices are not typically employed in dermatology, they can be fine-tuned to concentrate heat at the boundary between the skin and subcutaneous tissue, leading to irreversible destruction of the sweat glands located at that interface. For this treatment, the area is marked with a template, lidocaine is injected in the treatment area, and the microwave treatment is applied. In one randomized control trial, the treatment group showed a response rate of 89% thirty days post-treatment as measured by a two-point or greater decline in HDSS from baseline [51]. The treatment's effectiveness remained stable, with rates of 74% at 3 months and 69% at 12 months, when the follow-up concluded. Microwave therapy can cause local edema and mild discomfort in the treated area, on average lasting nine days post-treatment and typically well-controlled with ice packs and nonsteroidal anti-inflammatory medications. Microwave-based treatment offers an effective alternative for patients who do not achieve significant improvement with topical or oral agents.

One advantage of laser therapy and microwave-based therapies over other treatment modalities is that they are a long-term solution for patients. With laser and microwave therapy, the sweat glands are permanently destroyed and cannot regenerate. While botulinum toxin injections can reduce control hyperhidrosis for about three months, laser and microwave therapies offer a more permanent solution. However, these minimally invasive procedures are often not covered by insurance and may be cost-prohibitive for many patients.

7. Psychological and Behavioral Approaches

While pharmacologic and minimally invasive methods of management for hyperhidrosis are used most frequently, it is important to consider methods that also address the psychosocial aspects of the condition. It is widely accepted that this condition is associated with higher rates of anxiety, depression, and overall stress [52,53]. In a meta-analysis of over 200,000 patients, those with hyperhidrosis had 3.5 times increased odds of having anxiety and 2.4 times increased odds of having depression [52]. Other studies have found similar odds ratios for anxiety and depression as well as an estimate that nearly half of all patients with primary hyperhidrosis have anxiety or depression [53]. There is strong evidence supporting anxiety and depression as significant contributing factors in hyperhidrosis, necessitating providers directly address mental health when treating hyperhidrosis. Many factors impact the magnitude of mental health impact in this condition, especially stressors to the patient, which can itself contribute to increased sweating. This can take the form of social, emotional, or even internally derived unintentional stress driven by symptoms of existing anxiety and depression [52,53]. Some suggest that mindfulness meditation and concentrative meditation can help reduce stress with significant impacts on emotionally triggered skin disorders, including hyperhidrosis [54]. Overall, stress reduction can play a valuable role in reducing many aspects of this condition, such as stress and anxiety, which can lead to increased sweating, while also playing a role in directly treating hyperhidrosis.

Another approach to treatment of this condition can be cognitive behavioral therapy (CBT). Many patients with hyperhidrosis report severe encroachment into their daily life, with few developing the ability to cope over time [55]. This is where CBT can be used most effectively to help patients develop adequate coping techniques. This can be a good adjunctive approach to decrease embarrassment, frustration, and low self-esteem that can result from hyperhidrosis [55]. CBT presents an especially good option when caring for patients who wish to take more conservative approaches to care. Hypnosis is another behavioral approach that can prove beneficial in some patients by working to help with relaxation, especially before procedures like botulinum toxin injections [55]. While there is limited data on this method of treatment, it represents an opportunity to improve patient adherence to botulinum toxin injections when they may have otherwise chosen to stop. CBT and other non-invasive options, such as hypnosis, should always be considered when formulating an individualized treatment protocol for patients and should be offered to patients if they wish to try.

There are many ways that a patient's behavior can affect their hyperhidrosis, one of which is their diet. Diet modification is another way that physicians can practice patient-centered care and provide individualized treatment plans to patients. To minimize unnecessary exacerbation of the condition, patients should be counseled to avoid spicy foods, alcohol, and hot liquids [56]. This is an important way that patients can practice trigger avoidance. Food can also have more indirect effects on their condition. The consumption of anti-inflammatory foods can decrease overall stress, which has the potential to reduce the overall sweat burden [54]. By working with patients and providing numerous methods of treatment, patients will feel more involved and in control of their care, which increases satisfaction and thus has the possibility of further decreasing worry related to hyperhidrosis.

Providing patients with methods directly addressing stress reduction is another way that physicians can work to provide individualized care for patients. Some options that can be considered are Mindfulness-Based Stress Reduction (MBSR), CBT, and physical exercise. In particular, MBSR, in a recent study, was shown to be as effective as first-line medications for anxiety disorders and is easier to adhere to than CBT [57]. Teaching patients mindfulness meditation techniques can offer them more freedom to utilize learned tools to decrease stress and anxiety and manage events as they happen. Exercise, both aerobic and resistance training, is also a valuable behavioral change that can be incorporated into a treatment plan as it shows strong evidence of the ability to manage mental health conditions like depression and anxiety [58]. This offers benefits beyond the management of hyperhidrosis and puts patients on the path to healthier lifestyles physically and mentally. However, what is most important is introducing patients to different methods of symptom management and allowing self-exploration and optimization of different approaches. With the implementation of ideal management methods, exacerbations of hyperhidrosis due to uncontrolled stress, anxiety, and even depression can more effectively be managed.

8. Future Directions and Research Needs

Personalized treatment plans for occlusive hyperhidrosis represent a critical advancement in achieving greater therapeutic success and enhancing patient satisfaction. To manage this condition effectively, it is essential to incorporate various treatment modalities rather than relying on a single method. The diverse nature of hyperhidrosis, characterized by both physical symptoms and significant psychological distress, necessitates a multifaceted approach. For instance, while topical antiperspirants containing aluminum chloride offer some initial efficacy, their long-term use can lead to skin irritation [59]. To counteract this, combining these with advanced absorbent materials can mitigate discomfort and maintain skin health, creating a more holistic management plan. Additionally, iontophoresis, which employs mild electrical currents to reduce sweat gland activity, can be highly effective [59, 60]. This technique's effectiveness increases when sessions are tailored to the patient's needs and used in conjunction with botulinum toxin injections, which provide longer-lasting relief in areas like the palms and underarms. The evolution of botulinum toxin administration techniques further underscores the potential of tailored care, as they have become less painful and more efficient over time [60]**.** Moreover, laser therapy, which targets sweat glands through selective heat destruction, offers a long-term solution that can be even more effective when incorporated into a comprehensive regimen. This integration ensures that both the physiological and emotional burdens of hyperhidrosis are adequately addressed, enhancing sufferers' overall quality of life.

Personalized treatment, however, must be nuanced and patient-specific. For some individuals, alternating between topical and procedural treatments may help prevent skin irritation or treatment fatigue. Lifestyle adjustments, such as wearing moisture-wicking fabrics and employing stress management strategies, further support the effectiveness of medical interventions [59]**.** Healthcare providers must continually evaluate and adapt treatment plans to accommodate the variability in symptom severity and patient response. This dynamic strategy promotes patient empowerment, giving individuals a sense of control over their condition. The importance of this adaptability cannot be overstated, as hyperhidrosis often comes with considerable psychological impacts, including anxiety and social embarrassment. Thus, implementing regular follow-ups and offering psychological support, like cognitive-behavioral therapy, can be instrumental in improving patients' physical and mental well-being [61]. This approach ensures that each component of care is designed with the patient's unique circumstances in mind, reflecting a truly holistic method of treatment.

The need for patient-centered care models is paramount when treating hyperhidrosis, as these models go beyond physical management to address the emotional and social ramifications of the disorder. Effective patient-centered care involves engaging patients as active participants in their treatment decisions through shared decision-making, a process that fosters higher adherence and overall satisfaction [61]. For example, a patient wary of invasive options might choose to start with less aggressive treatments, like topical agents or iontophoresis, and gradually progress if needed. Comprehensive education is also a vital aspect of this care model, as informed patients are more likely to understand their condition and stick to their treatment plan. Understanding potential side effects, such as those associated with botulinum toxin or anticholinergic medications, allows patients to be better prepared and proactive about managing their treatment [59, 60]. Additionally, regular check-ins enable healthcare providers to make necessary adjustments and detect any emerging concerns early, fostering an environment where the patient feels supported and understood. Addressing psychological components, such as the stigma and anxiety associated with excessive sweating, through interventions like cognitive-behavioral therapy adds another layer to patient-centered care that is crucial for comprehensive well-being.

Further research is imperative for the continued evolution of hyperhidrosis treatment. New modalities, such as glycopyrronium bromide and oxybutynin gels, offer promising targeted relief with minimized systemic effects, yet require more extensive studies to confirm their long-term efficacy and safety [62]. These advancements are particularly relevant in a field where current treatments can have limitations or drawbacks. Another cutting-edge development is the use of wearable micro-electromechanical systems (MEMS) that provide real-time monitoring and management of sweat production [63]**.** These devices have the potential to revolutionize how hyperhidrosis is treated, making care more convenient and personalized. However, rigorous testing is needed to ensure these devices are not only effective but also practical and accessible for widespread use. This pursuit of innovation should also focus on refining existing treatments. For example, improving iontophoresis protocols to make patients' experience more comfortable and effective could increase its appeal and adherence rates [63]. Behavioral interventions like mindfulness-based stress reduction should also be considered as adjuncts to traditional treatments, especially given the role of stress in exacerbating symptoms. Multidisciplinary collaboration will be crucial in bringing these emerging therapies from research into clinical practice, allowing for a broader spectrum of patient-friendly options that align with individual needs.

Long-term studies on the efficacy and safety of hyperhidrosis treatments are equally crucial. Current options, such as botulinum toxin injections and laser therapies, show significant promise in the short term but lack comprehensive data on their prolonged use [64]. Understanding whether these treatments remain effective and safe over many years is essential, particularly when considering possible complications like nerve damage or compensatory sweating that might emerge. For instance, long-term use of aluminum-based topical treatments raises questions about potential skin damage or systemic absorption, which must be examined in future research. Similarly, anticholinergic medications, while effective, come with side effects like dry mouth and heat intolerance, which could present more serious health concerns with extended use. The advent of wearable MEMS devices also raises questions about durability, long-term patient adherence, and unforeseen risks, which need to be investigated thoroughly to establish a solid evidence base [65]. Longitudinal research will help clinicians make informed decisions, refine treatment protocols, and ultimately provide hyperhidrosis patients with safer, more effective, and more sustainable solutions.

9. Conclusion

Hyperhidrosis is a multifaceted condition with a complex etiology, significantly impacting patients physically, psychologically, and socially. Current management strategies, including antiperspirants, systemic medications like anticholinergics, botulinum toxin injections, and surgical options such as sympathectomy, offer varying degrees of relief. However, these approaches often fall short in efficacy, come with notable side effects, or fail to meet the unique needs of each patient. The substantial psychosocial toll, marked by social anxiety, isolation, and reduced quality of life emphasizes the need for a more personalized and holistic approach to care.

Recent advancements in therapeutic strategies have introduced innovative solutions to bridge these gaps. Topical agents like glycopyrronium tosylate and sofpironium bromide offer targeted management for localized hyperhidrosis with fewer systemic effects, while microwave thermolysis and laser therapies provide minimally invasive, long-term relief by permanently destroying sweat glands. Devices such as iontophoresis machines and wearable MEMS represent cutting-edge technologies for real-time sweat monitoring and intervention, though challenges like frequent usage requirements or high costs remain barriers for some patients. Advances in wearable fabrics and hydrogels further enhance daily management by integrating comfort and function.

In addition to these medical innovations, lifestyle modifications including wearing breathable fabrics, managing stress through techniques like Mindfulness-Based Stress Reduction (MBSR) or cognitive behavioral therapy (CBT), and avoiding dietary triggers can significantly enhance treatment outcomes. Combining these behavioral strategies with emerging treatments creates a comprehensive, patient-centered approach. Personalized care plans, developed through shared decision-making, empower patients to explore and optimize management strategies, addressing both their physical symptoms and emotional well-being.

To advance hyperhidrosis care, greater awareness and interdisciplinary research across dermatology, bioengineering, and psychology are essential. By developing new diagnostic tools, refining treatment modalities, and fostering open conversations, healthcare providers can improve accessibility, reduce stigma, and ultimately enhance the quality of life for individuals living with hyperhidrosis.

References

[1] Nawrocki, S., & Cha, J. (2019). The etiology, diagnosis, and management of hyperhidrosis: A comprehensive review: Etiology and clinical work-up. *Journal of the American Academy of Dermatology*, *81*(3), 657–666. https://doi.org/10.1016/j.jaad.2018.12.071

[2] Parashar, K., Adlam, T., & Potts, G. (2023). The Impact of Hyperhidrosis on Quality of Life: A Review of the Literature. *American Journal of Clinical Dermatology*, *24*(2), 187–198. https://doi.org/10.1007/s40257-022-00743-7

[3] Farrugia, M.-K., & Nicholls, E. A. (2005). Intradermal botulinum A toxin injection for axillary hyperhydrosis. *Journal of Pediatric Surgery*, *40*(10), 1668–1669. https://doi.org/10.1016/j.jpedsurg.2005.06.023

[4] Oshima, Y., Fujimoto, T., Nomoto, M., Fukui, J., & Ikoma, A. (2023). Hyperhidrosis: A targeted literature review of the disease burden. *The Journal of Dermatology*, *50*(10), 1227–1236. https://doi.org/10.1111/1346-8138.16908

[5] Doolittle, J., Walker, P., Mills, T., & Thurston, J. (2016). Hyperhidrosis: An update on prevalence and severity in the United States. *Archives of Dermatological Research*, *308*(10), 743–749. https://doi.org/10.1007/s00403-016-1697-9

[6] Henning, M. A. S., Barati, F., & Jemec, G. B. E. (2023). Quality of life in individuals with primary hyperhidrosis: A systematic review and meta-analysis. *Clinical Autonomic Research: Official Journal of the Clinical Autonomic Research Society*, *33*(4), 519–528. https://doi.org/10.1007/s10286-023-00954-w

[7] Kamudoni, P., Mueller, B., Halford, J., Schouveller, A., Stacey, B., & Salek, M. S. (2017). The impact of hyperhidrosis on patients' daily life and quality of life: A qualitative investigation. *Health and Quality of Life Outcomes*, *15*(1), 121. https://doi.org/10.1186/s12955-017-0693-x

[8] Mary Lenefsky, P., & Zakiya P. Rice, M. D. (2018). *Hyperhidrosis and Its Impact on Those Living With It*. *24*. https://www.ajmc.com/view/hyperhidrosis-and-its-impact--on-those-living-with-it

[9] McConaghy, J. R., & Fosselman, D. (2018). Hyperhidrosis: Management Options. *American Family Physician*, *97*(11), 729–734.

[10] Ho, Y. L. (n.d.). *Diagnosis, impact and management of hyperhidrosis including endoscopic thoracic sympathectomy*.

[11] Benson, R. A., Palin, R., Holt, P. J., & Loftus, I. M. (2013). Diagnosis and management of hyperhidrosis. *BMJ Clinical Research*, f6800. https://doi.org/10.1136/bmj.f6800

[12] Schick, C. H. (2016). Pathophysiology of Hyperhidrosis. *Thoracic Surgery Clinics*, *26*(4), 389-393. https://doi.org/10.1016/j.thorsurg.2016.06.002

[13] Lakraj, A. A., Moghimi, N., & Jabbari, B. (2013). Hyperhidrosis: anatomy, pathophysiology and treatment with emphasis on the role of botulinum toxins. *Toxins*, *5*(4), 821–840. https://doi.org/10.3390/toxins5040821

[14] Kisielnicka, A., Szczerkowska-Dobosz, A., Purzycka-Bohdan, D., & Nowicki, R. J. (2022). Hyperhidrosis: Disease etiology, classification, and management In the light of modern treatment modalities. *Postępy Dermatologii i Alergologii*, *39*(2), 251-257. https://doi.org/10.5114/ada.2022.115887

[15] Wohlrab, J., Bechara, F. G., Schick, C., & Naumann, M. (2023). Hyperhidrosis: A Central Nervous Dysfunction of Sweat Secretion. *Dermatology and Therapy*, *13*(2), 453-463. https://doi.org/10.1007/s13555-022-00885-w

[16] Henning, M. A., Pedersen, O. B., & Jemec, G. B. (2019). Genetic disposition to primary hyperhidrosis: a review of literature. *Archives of dermatological research*, *311*(10), 735–740. https://doi.org/10.1007/s00403-019-01966-1

[17] Idiaquez, J., Casar, J. C., Arnardottir, E. S., August, E., Santin, J., & Iturriaga, R. (2023). Hyperhidrosis in sleep disorders - A narrative review of mechanisms and clinical significance. *Journal of sleep research*, *32*(1), e13660. https://doi.org/10.1111/jsr.13660

[18] Pollini, M., Paladini, F., Sannino, A., & Maffezzoli, A. (2016). Development of hybrid cotton/hydrogel yarns with improved absorption properties for biomedical applications. *Materials science & engineering. C, Materials for biological applications*, *63*, 563–569. https://doi.org/10.1016/j.msec.2016.03.027

[19] Artzi, O., Loizides, C., Zur, E., & Sprecher, E. (2017). Topical Oxybutynin 10% Gel for the Treatment of Primary Focal Hyperhidrosis: A Randomized Double-blind Placebo-controlled Split Area Study. *Acta dermato-venereologica*, *97*(9), 1120–1124. https://doi.org/10.2340/00015555-2731

[20] Abels, C., Soeberdt, M., Kilic, A., Reich, H., Knie, U., Jourdan, C., Schramm, K., Heimstaedt-Muskett, S., Masur, C., & Szeimies, R. M. (2021). A glycopyrronium bromide 1% cream for topical treatment of primary axillary hyperhidrosis: efficacy and safety results from a phase IIIa randomized controlled trial. *The British journal of dermatology*, *185*(2), 315–322. https://doi.org/10.1111/bjd.19810

[21] Fujimoto, T., Abe, Y., Igarashi, M., Ishikoh, A., Omi, T., Kanda, H., Kitahara, H., Kinoshita, M., Nakasu, I., Hattori, N., Horiuchi, Y., Maruyama, R., Mizutani, H., Murakami, Y., Watanabe, C., Kume, A., Hanafusa, T., Hamaguchi, M., Yoshioka, A., Egami, Y., … Yokozeki, H. (2021). A phase III, 52-week, open-label study to evaluate the safety and efficacy of 5% sofpironium bromide (BBI-4000) gel in Japanese patients with primary axillary hyperhidrosis. *The Journal of dermatology*, *48*(8), 1149–1161. https://doi.org/10.1111/1346-8138.15927

[22] Glaser, D. A., Hebert, A. A., Nast, A., Werschler, W. P., Green, L., Mamelok, R., Drew, J., Quiring, J., & Pariser, D. M. (2019). Topical glycopyrronium tosylate for the treatment of primary axillary hyperhidrosis: Results from the ATMOS-1 and ATMOS-2 phase 3 randomized controlled trials. *Journal of the American Academy of Dermatology*, *80*(1), 128–138.e2. https://doi.org/10.1016/j.jaad.2018.07.002

[23] Pariser, D. M., Lain, E. L., Mamelok, R. D., Drew, J., & Mould, D. R. (2021). Limited Systemic Exposure with Topical Glycopyrronium Tosylate in Primary Axillary Hyperhidrosis. *Clinical pharmacokinetics*, *60*(5), 665–676. https://doi.org/10.1007/s40262-020-00975-y

[24] Stuart, M. E., Strite, S. A., & Gillard, K. K. (2020). A systematic evidence-based review of treatments for primary hyperhidrosis. *Journal of drug assessment*, *10*(1), 35–50. https://doi.org/10.1080/21556660.2020.1857149\

[25] Finkelstein, E. R., Buitrago, J., Kassira, W. M., & Thaller, S. R. (2024). Nonsurgical management of hyperhidrosis. *A Comprehensive Guide to Male Aesthetic and Reconstructive Plastic Surgery*, 515–521. https://doi.org/10.1007/978-3-031-48503-9_45

[26] Karakoç, Y., Aydemir, E. H., Kalkan, M. T., & Unal, G. (2002). Safe control of palmoplantar hyperhidrosis with direct electrical current. *International journal of dermatology*, *41*(9), 602–605. https://doi.org/10.1046/j.1365-4362.2002.01473.x

[27] Nestor, M. S., & Park, H. (2014). Safety and Efficacy of Micro-focused Ultrasound Plus Visualization for the Treatment of Axillary Hyperhidrosis. *The Journal of clinical and aesthetic dermatology*, *7*(4), 14–21.

[28] Budamakuntla, L., Loganathan, E., George, A., Revanth, B. N., Sankeerth, V., & Sarvjnamurthy, S. A. (2017). Comparative Study of Efficacy and Safety of Botulinum Toxin a Injections and Subcutaneous Curettage in the Treatment of Axillary Hyperhidrosis. *Journal of cutaneous and aesthetic surgery*, *10*(1), 33–39. https://doi.org/10.4103/JCAS.JCAS_104_16

[29] International Hyperhidrosis Society. (n.d.). *miraDry*. Retrieved November 13, 2024, from https://www.sweathelp.org/treatments-hcp/miradry.html

[30] Parrish, C., Waldbaum, B., Coleman, D., Blevins, C., Rodgers, K., Lee, B., Ober, C., Hudhud, L., Cox, S., Griffin, C., Chew, S., Chen, B., & Brock, M. (2020). Microwave thermolysis reduces generalized and social anxiety in young adults with axillary hyperhidrosis. *Lasers in Surgery and Medicine*, *52*(9), 842–847. https://doi.org/10.1002/lsm.23229

[31] Suh, D. H., Lee, S. J., Kim, K., & Ryu, H. J. (2014). Transient median and ulnar neuropathy associated with a microwave device for treating axillary hyperhidrosis. *Dermatologic surgery : official publication for American Society for Dermatologic Surgery [et al.]*, *40*(4), 482–485. https://doi.org/10.1111/dsu.12425

[32] Chang, C. K., Chen, C. Y., Hsu, K. F., Chiu, H. T., Chu, T. S., Liu, H. H., Goh, M. X., & Chen, S. G. (2017). Brachial plexus injury after microwave-based treatment for axillary hyperhidrosis and osmidrosis. *Journal of cosmetic and laser therapy : official publication of the European Society for Laser Dermatology*, *19*(7), 439–441. https://doi.org/10.1080/14764172.2017.1342039

[33] *Wearable device to treat hyperhidrosis*. Standford | Explore Technologies. https://techfinder.stanford.edu/technology/wearable-device-treat-hyperhidrosis

[34] Glaser DA, Green L, Kaminer M, Smith S, Pariser D. Outcomes from the SAHARA Clinical Study on the TAT Patch for Excessive Axillary Sweating or Primary Axillary Hyperhidrosis. Late-breaking oral presentation at: American Academy of Dermatology annual meeting; March 17-21 (presented March 18, 10:10 am CT), 2023; New Orleans, Louisiana.

[35] Vergilis-Kalner I. J. (2011). Same-patient prospective comparison of Botox versus Dysport for the treatment of primary axillary hyperhidrosis and review of literature. *Journal of drugs in dermatology : JDD*, *10*(9), 1013–1015.

[36] Heckmann, M., Ceballos-Baumann, A. O., Plewig, G., & Hyperhidrosis Study Group (2001). Botulinum toxin A for axillary hyperhidrosis (excessive sweating). *The New England journal of medicine*, *344*(7), 488–493. https://doi.org/10.1056/NEJM200102153440704

[37] Ibrahim, O., Kakar, R., Bolotin, D., Nodzenski, M., Disphanurat, W., Pace, N., Becker, L., West, D. P., Poon, E., Veledar, E., & Alam, M. (2013). The comparative effectiveness of suction-curettage and onabotulinumtoxin-A injections for the treatment of primary focal axillary hyperhidrosis: a randomized control trial. *Journal of the American Academy of Dermatology*, *69*(1), 88–95. https://doi.org/10.1016/j.jaad.2013.02.013

[38] Lueangarun, S., Sermsilp, C., & Tempark, T. (2018). Topical Botulinum Toxin Type A Liposomal Cream for Primary Axillary Hyperhidrosis: A Double-Blind, Randomized, Split-Site, Vehicle-Controlled Study. *Dermatologic surgery : official publication for American Society for Dermatologic Surgery [et al.]*, *44*(8), 1094–1101. https://doi.org/10.1097/DSS.0000000000001532

[39] Lowe, N. J., Yamauchi, P. S., Lask, G. P., Patnaik, R., & Iyer, S. (2002). Efficacy and safety of botulinum toxin type a in the treatment of palmar hyperhidrosis: a double-blind, randomized, placebo-controlled study. *Dermatologic surgery : official publication for American Society for Dermatologic Surgery [et al.]*, *28*(9), 822–827. https://doi.org/10.1046/j.1524-4725.2002.02039.x

[40] Yamashita, N., Shimizu, H., Kawada, M., Yanagishita, T., Watanabe, D., Tamada, Y., & Matsumoto, Y. (2008). Local injection of botulinum toxin A for palmar hyperhidrosis: usefulness and efficacy in relation to severity. *The Journal of dermatology*, *35*(6), 325–329. https://doi.org/10.1111/j.1346-8138.2008.00478.x

[41] Naver, H., Swartling, C., & Aquilonius, S. M. (2000). Palmar and axillary hyperhidrosis treated with botulinum toxin: one-year clinical follow-up. *European journal of neurology*, *7*(1), 55–62. https://doi.org/10.1046/j.1468-1331.2000.00014.x

[42] Grunfeld, A., Murray, C. A., & Solish, N. (2009). Botulinum toxin for hyperhidrosis. *American Journal of Clinical Dermatology*, *10*(2), 87–102. https://doi.org/10.2165/00128071-200910020-00002

[43] International Hyperhidrosis Society. (n.d.). *Treatments in development*. Retrieved November 20, 2024, from https://www.sweathelp.org/hyperhidrosis-treatments/treatments-in-development.html

[44] Candesant Biomedical. Pipeline. (2024) https://candesant.com/pipeline/

[45] Juan J. Fibla, Laureano Molins, Jose Manuel Mier, Gonzalo Vidal, Effectiveness of sympathetic block by clipping in the treatment of hyperhidrosis and facial blushing, *Interactive CardioVascular and Thoracic Surgery*, Volume 9, Issue 6, December 2009, Pages 970–972, https://doi.org/10.1510/icvts.2009.212365

[46] Adhami, M. and Bell, R. Development of a novel nomogram to predict the risk of severe compensatory sweating following endoscopic thoracic sympathectomy. *ANZ Journal of Surgery* **93**, 2370-2375 (2023).

[47] Chen, L.W.Y. *et al*. Robotic sympathetic trunk reconstruction for compensatory sweating after thoracic sympathectomy. *JTCVS Techniques* **21**, 251-258 (2023).

[48] Cervantes, J., Perper, M., Eber, A. E., Fertig, R. M., Tsatalis, J. P., & Nouri, K. (2018). Laser treatment of primary axillary hyperhidrosis: A review of the literature. Lasers in Medical Science, 33(3), 675–681. https://doi.org/10.1007/s10103-017-2434-0

[49] Leclère, F. M., Moreno-Moraga, J., Alcolea, J. M., Vogt, P. M., Royo, J., Cornejo, P., Casoli, V., Mordon, S., & Trelles, M. A. (2015). Efficacy and safety of laser therapy on axillary hyperhidrosis after one year follow-up: a randomized blinded controlled trial. Lasers in surgery and medicine, 47(2), 173–179. https://doi.org/10.1002/lsm.22324

[50] Tan, M. G., Jo, C. E., Chapas, A., Khetarpal, S., & Dover, J. S. (2021). Radiofrequency Microneedling: A Comprehensive and Critical Review. Dermatologic surgery, 47(6), 755–761. https://doi.org/10.1097/DSS.0000000000002972

[51] Glaser, D. A., Coleman, W. P., 3rd, Fan, L. K., Kaminer, M. S., Kilmer, S. L., Nossa, R., Smith, S. R., & O'Shaughnessy, K. F. (2012). A randomized, blinded clinical evaluation of a novel microwave device for treating axillary hyperhidrosis: the dermatologic reduction in underarm perspiration study. Dermatologic Surgery, 38(2), 185–191. https://doi.org/10.1111/j.1524-4725.2011.02250.x

[52] Henning, M. A. S., Barati, F., & Jemec, G. B. E. (2024). A systematic review and meta-analysis of psychiatric diseases in individuals with primary hyperhidrosis. Clinical and Experimental Dermatology, llae389. https://doi.org/10.1093/ced/llae389

[53] Klein, S. Z., Hull, M., Gillard, K. K., & Peterson-Brandt, J. (2020). Treatment Patterns, Depression, and Anxiety Among US Patients Diagnosed with Hyperhidrosis: A Retrospective

Cohort Study. Dermatology and Therapy, 10(6), 1299–1314. https://doi.org/10.1007/s13555-020-00439-y

[54] Shenefelt, P. D. (2018). Mindfulness-Based Cognitive Hypnotherapy and Skin Disorders. American Journal of Clinical Hypnosis, 61(1), 34–44. https://doi.org/10.1080/00029157.2017.1419457

[55] Nawrocki, S., & Cha, J. (2019a). The etiology, diagnosis, and management of hyperhidrosis: A comprehensive review: Etiology and clinical work-up. Journal of the American Academy of Dermatology, 81(3), 657–666. https://doi.org/10.1016/j.jaad.2018.12.071

[56] Nawrocki, S., & Cha, J. (2019b). The etiology, diagnosis, and management of hyperhidrosis: A comprehensive review: Therapeutic options. Journal of the American Academy of Dermatology, 81(3), 669–680. https://doi.org/10.1016/j.jaad.2018.11.066

[57] Hoge, E. A., Bui, E., Mete, M., Dutton, M. A., Baker, A. W., & Simon, N. M. (2023). Mindfulness-Based Stress Reduction vs Escitalopram for the Treatment of Adults With Anxiety Disorders: A Randomized Clinical Trial. JAMA Psychiatry, 80(1), 13–21. https://doi.org/10.1001/jamapsychiatry.2022.3679

[58] Smith, P. J., & Merwin, R. M. (2021). The Role of Exercise in Management of Mental Health Disorders: An Integrative Review. Annual Review of Medicine, 72, 45–62. https://doi.org/10.1146/annurev-med-060619-022943

[59] Wade, R., Rice, S., Llewellyn, A., Moloney, E., Jones-Diette, J., Stoniute, J., Wright, K., Layton, A. M., Levell, N. J., Stansby, G., Craig, D., & Woolacott, N. (2017). Interventions for hyperhidrosis in secondary care: a systematic review and value-of-information analysis. Health technology assessment (Winchester, England), 21(80), 1–280. https://doi.org/10.3310/hta21800

[60] Glaser, D. A., & Galperin, T. A. (2014). Managing hyperhidrosis: emerging therapies. Dermatologic clinics, 32(4), 549–553. https://doi.org/10.1016/j.det.2014.06.003

[61] Cervantes, J., Perper, M., Eber, A. E., Fertig, R. M., Tsatalis, J. P., & Nouri, K. (2018). Laser treatment of primary axillary hyperhidrosis: a review of the literature. Lasers in medical science, 33(3), 675–681. https://doi.org/10.1007/s10103-017-2434-0

[62] Dunford, L. J., Radley, K., McPhee, M., McDonald, L., Oliver, R. J., Alexandroff, A., Hussain, H. A., Miller, J. A., Tarpey, M., & Clifton, A. V. (2022). Setting research priorities for management and treatment of hyperhidrosis: the results of the James Lind Alliance Priority Setting Partnership. Clinical and experimental dermatology, 47(6), 1109–1114. https://doi.org/10.1111/ced.15122

[63] Brown, A. L., Gordon, J., & Hill, S. (2014). Hyperhidrosis: review of recent advances and new therapeutic options for primary hyperhidrosis. Current opinion in pediatrics, 26(4), 460–465. https://doi.org/10.1097/MOP.0000000000000108

[64] Kristensen, J. K., & Nielsen, C. (2022). Progress and lack of progress in hyperhidrosis research 2015-2020. A concise systematic review. International journal of dermatology, 61(2), 148–157. https://doi.org/10.1111/ijd.15654

[65] Wade, R., Llewellyn, A., Jones-Diette, J., Wright, K., Rice, S., Layton, A. M., Levell, N. J., Craig, D., & Woolacott, N. (2018). Interventional management of hyperhidrosis in secondary care: a systematic review. The British journal of dermatology, 179(3), 599–608. https://doi.org/10.1111/bjd.16558

Citation: *Kelly Frasier et al. Sweat Smarter, Not Harder: Fresh Approaches to Occlusive Hyperhidrosis. ARC Journal of Dermatology. 2025; 8(2):17-30. DOI: https://doi.org/10.20431/2456-0022.0802002*