Dermatologic Therapy, Vol. 26, 2013, 452–461
Printed in the United States · All rights reserved

DERMATOLOGIC THERAPY
ISSN 1396-0296

INVITED ARTICLE

Update on pediatric hyperhidrosis

JENNIFER R. S. GORDON* & SAMANTHA E. HILL*†
**Department of Dermatology, University of Texas Southwestern Austin and*
†Pediatric Dermatology, Dell Children's Medical Center, Austin, Texas

ABSTRACT: Hyperhidrosis is a common and under-recognized disease in the pediatric population that has a significant impact on quality of life. Focal and generalized forms of hyperhidrosis exist, which can be idiopathic or secondary to underlying medical conditions or medications. Treatment is tailored to the specific patient needs, characteristics and goals. These include topical preparations, iontophoresis, botulinum toxin and anticholinergic medications.

KEYWORDS: aluminum chloride, botulinum toxin, glycopyrrolate, hyperhidrosis, iontophoresis, sweating

Introduction

Hyperhidrosis is defined as perspiration in excess of the physiologic amount necessary to maintain thermal homeostasis. It is known to affect approximately 3% of the population in the United States and at least 176 million people worldwide (1). The prevalence is likely significantly higher than currently estimated because it is both underreported by patients and underdiagnosed by physicians, especially in the pediatric population. One study suggested that 1.6% of children and adolescents under 18 years of age have primary focal hyperhidrosis (1). In one survey of patients with hyperhidrosis, only one-third of patients had consulted a physician, often because of embarrassment (1). Irrespective of the etiology of hyperhidrosis, this condition causes significant emotional and social distress (2). While it is acknowledged that early diagnosis and management can significantly improve a patient's quality of life, hyperhidrosis remains widely undertreated, particularly among pediatric patients.

Address correspondence and reprint requests to: Samantha Hill, MD, Assistant Clinical Professor, Department of Dermatology, University of Texas Southwestern Austin, Austin, TX 78701, USA, or email: jrsgordon@gmail.com; shill@sfcaustin.com

Background

Hyperhidrosis is divided into primary and secondary, and can further be delineated into focal or generalized. Primary hyperhidrosis is idiopathic, whereas secondary hyperhidrosis has an association with an underlying medical condition or medication. Primary hyperhidrosis is usually focal (primary focal hyperhidrosis), bilateral and relatively symmetric (3). Axillary disease is the most common, affecting approximately one-half of patients (1,3). This is followed by palmoplantar disease, which affects up to one-third of patients (1). Patients with primary hyperhidrosis can also have generalized disease with varying degrees of severity; affecting the axillae, palms, soles, face, scalp, trunk, or other areas of the body; as well as any combination of sites. Focal hyperhidrosis typically presents at 14–25 years of age, although children with palmoplantar disease are often symptomatic as toddlers (1). Approximately

one-half of all patients report a positive family history, and a family history is more often seen in pediatric patients, where an autosomal dominant inheritance pattern has been suggested (3–5). Secondary hyperhidrosis is most often generalized, but in some cases, it can be focal.

Pathophysiology

Evaporation of eccrine sweat is the major thermoregulatory mechanism in humans. Eccrine sweat glands are found on all skin surfaces except for the external auditory canal, lips, clitoris and labia minora. They are in highest concentrations on the palms, soles and axillae. Sweating of the palms and soles can begin at birth, but axillary sweating typically does not begin in a significant amount until puberty (2). This account for the observation that isolated palmoplantar hyperhidrosis is more common in pre-pubertal onset (5). Approximately 4–5 million sweat glands exist on the body, and a well-acclimated person can secrete up to three to four liters of sweat per hour in order to maintain thermal homeostasis. These glands are innervated by postganglionic sympathetic fibers and acetylcholine is the major neurotransmitter involved (6,7).

Although the exact pathophysiology of hyperhidrosis is unknown, studies have shown that patients with the disease have glands of normal size, density, location, and histological appearance. Acetylcholinesterase is also normal with regard to quantity and function in these patients, suggesting defective clearance of acetylcholine is an unlikely mechanism of action. Many physicians and researchers believe the mechanism of hyperhidrosis to be a hyperfunction of the eccrine glands, the cause of which has not yet been elucidated (7–9).

Impact on patients

Hyperhidrosis is embarrassing, uncomfortable, anxiety-inducing, and at times disabling and isolating. It impairs the social, physical, leisure, and occupational activities of patients who suffer from the disorder. Patients avoid social interaction and physical contact, often reporting decreased self-confidence and at times depressive symptoms (1). Although emotional effects are prevalent, function limitations are also common. For example, in patients with palmoplantar hyperhidrosis, difficulties range from inability to effectively grip a pencil to difficulty operating a touchscreen. While obviously not equivalent, both can have significantly detrimental effects for the patient.

When compared using standardized and validated quality-of-life measures such as the Dermatology Life Quality Index (DLQI), the negative impact of hyperhidrosis has been shown to be similar to psoriasis, Hailey-Hailey disease, severe acne, pruritis, and atopic dermatitis (10). However, far more improvement in DLQI is seen with treatment of hyperhidrosis than other severe dermatologic diagnoses. Children and adolescents living with hyperhidrosis often experience this impact most profoundly, as the psyche is still developing during these formative years. Growing up within the confinement of this socially ostracizing disease can be extremely detrimental to a child's development of confidence and sense of self.

Differential diagnosis

A thorough history and physical exam must be performed to differentiate focal hyperhidrosis from the generalized form, as the treatments may vary depending on body site or sites involved. It is also important to consider secondary hyperhidrosis, especially in patients with generalized sweating. This may require an extended review of systems as well as a separate diagnostic evaluation. Secondary hyperhidrosis is most often related to an underlying medical condition or medication effect, as seen in Table 1. Medical conditions resulting in hyperhidrosis vary widely. In pediatrics, common associations include infection, endocrine abnormalities, and malignancies. An abnormal increase in sweating may also result from neurologic or cardiac dysfunction, as well as congenital disorders (11). There are a great number of prescription and over-the-counter medications that can lead to secondary hyperhidrosis, many of which are also commonly used among the pediatric population (11) (Table 2).

The principle diagnostic criteria of primary focal hyperhidrosis dictate that at minimum: sweating should be focal, visible, excessive, and lasting greater than 6 months without apparent cause. In order for complete diagnosis, the sweating must also meet two or more of the following criteria: bilateral and symmetric; impairing daily activity; more than one episode per week; onset before age 25 years; positive family history; and cessation during sleep (3).

Table 1. Conditions that may cause secondary sweating

Common conditions	Non-neural conditions
Acute febrile illness (e.g. infection)	Arteriovenous fistula
Alcoholism	Blue rubber bleb nevus
Diabetes mellitus	Cold erythema
Gout	Drugs
Heart failure	Glomus tumors
Hyperthyroidism	Klippel-Trenaunay syndrome
Lymphoma	Local heat
Menopause	Muffacci's syndrome
Obesity	Organoid and sudoriparous nevi
Parkinson's disease	
Pregnancy	
Rheumatoid arthritis	
Nervous system mediated conditions	Peripheral-reflexive conditions
	Drugs/medications
	Perilesional (e.g. burn)

Hypothalamic conditions (mediated by the hypothalamus)		Cortical conditions (mediated by the cerebral cortex)	
Carcinoid syndrome	Idiopathic unilateral circumscribed hyperhidrosis	Congenital autonomic dysfunction with universal pain loss	
Cardiac shock	Infantile scurvy	Congenital ichthyosiform erythroderma	
Chédiak-Higashi syndrome	Pheochromocytoma	Epidermolysis Bullosa simplex	
Chronic arsenic intoxication	POEMS syndrome	Familial dysautonomia	
Cold injury	Porphyria	Gorlin's Syndrome	
Debility	Post-encephalitis	Palmoplantar keratoderma	
Chronic infection (e.g. tuberculosis, malaria, brucellosis)	Raynaud's phenomenon or disease	Pachyonychia congenita	
	Reflex sympathetic dystrophy	Pressure and postural hyperhidrosis	
Drugs	Rickets	Medullary/spinal conditions (mediated by the medulla oblongata or spinal nerves)	
Familial dysautonomia	Stroke/cerebrovascular accident/transient ischemic attack (affecting hypothalamus)	Auriculotemporal syndrome	Encephalitis
Erythrocyanosis	Symmetric lividity of the palms and soles	Granulosis rubra nasi	Sytingomyelia
Essential hyperhidrosis	Vitiligo	Physiologic gustatory sweating	
Exercise		Post-traumatic (spinal cord transaction or thoracic sympathetic chain injury)	
Hines-Bannick syndrome			
Hyperpituitarism			
Hypoglycemia			
Hypothalamic mass			

Table 2. Medications that may cause secondary sweating

Pain medications	Antibiotics/Antivirals	Hormonal/Endocrine	Head/Neck medications
Celebrex	Acyclovir/Zovirax	Calcitonin/Fortical	Aerobid/Nasarel
Hyydrocodone/Vicodin	Rocephin/Ceftriaxone	Glucotrol/Glipizide	Claritin/ Loratadine
Toradol/Ketoralac	Cipro/Ciprofloxasin	Insulin/Humulin	Sudafed/ Psuedoephedrine
Morphine	Sustiva/Efavirenz	Synthroid/Thyroid	Aristocort/ Azmacort
Relafen/Nabumetone	Foscavir/Foscarnet	Depo-Provera	Afrin/Neo-synephrine
Naproxen/Aleve	Tequin/Gatifloxacin	Predisolone/Orapred	Zinc tablets/ Cold-EEze
Oxycodone/Roxicodone	Avelox/Moxifloxacin	Evista/Raloxifene	
Ultram/Tramadol	Ketek/Telithromycin	Gentropin/Somatropin	
Duragesic/Fentenayl	Ribavirin/Copegus	Testosterone/Angrogel	
Marinol	Retrovir/AZT	Antibodies/Tositumomab	
		Vascopressin/Pitressin	

Skin medications	Eye medications	Lung medications
Topical steroids	Phospholine Iodide	Advair/Fluticasone
Accutane/Isotretinoin	Vascon/Naphazoline	Combivent/Ipratropium
Lidocaine/Carbocaine	Alcaine/Vardenafil	Xopenex/Levalbuterol
Selsun/Selenium sulfide		Alupent/Metaproterenol

Heart/Blood Pressure		Psychiatric/Neuro Medications		Gastrointestinal	Blood/Immune System
Norvasc/Amlodipine	Hydralazine	Elavil/Amitriptyline	Aricept/Donepezil	Lomotril/Diphenoxylate	Neoral/Cyclosporine
Lotensin/Benazepril	Prinivil/Zestril/Lisinopril	Buspar/Buspirone	Cymbalta/Duloxetine	Anzemet/Dolasetron	Ferrous Fluconate/Iron
Bumex/Bumetamide	Cozaar/Losartan	Tegretol/Carbamazepine	Lexapro/Ecitalopram	Asacol/Mesalamine	Remicade/Infliximab
Coreg/Carvedilol	Lopressor/Metoprolol	Celexa/Citalopram	Lunestra/Escopiclone	Prilosec/Omeprazole	Cellcept/Mycopheolate
Digoxin/Lanoxin	Nifedipine/Procardia	Clozaril/Clozapine	Prozac/Fluoxetine	Aciphex/Rabeptrazole	Prograf/Tacrolimus
Persantine/Dipyridamole	Rythmol/Propafenone	Norpramin/Desipramine	Haldol/Haloperidol	Oncology/Cancer	Genital/Urinary
Cardura/Doxazosin	Altace/Ramipril	Adderall/Amphetamine	Sinemet/Levodopa	Aridimex/Anastozole	Cialis/Tadalafil
Vascotec/Enalopril	Calan/Verapamil	Migranal/Ergotamine	Provigil/Modafinil	Lupron/Leurolide	Levitra/Vardenafil
				Tamoxifen/Nolvadex	

Table 3. Hyperhidrosis disease severity scale (HDSS)

☒ My sweating is never noticeable and never interferes with my daily activities	Score 1
☒ My sweating is tolerable but sometimes interferes with my daily activities	Score 2
☒ My sweating is barely tolerable and frequently interferes with my daily activities	Score 3
☒ My sweating is intolerable and always interferes with my daily activities	Score 4

Evaluation

As mentioned previously, a detailed history, review of systems and physical exam are important in the evaluation of all patients to exclude secondary causes of excessive sweating. Location, duration, family history, age of onset, timing, and triggers of sweating are all important to elucidate. Typically, no laboratory studies are necessary to evaluate characteristic primary focal hyperhidrosis (3). If secondary hyperhidrosis is a consideration, screening laboratory testing may be useful, based on positive history, review of systems or physical exam findings.

It is necessary to establish the severity of a patient's sweating and assess the impact on quality of life. Several quality-of-life tools and measurements are available, but not all are suitable for routine use due to length or complexity. The most commonly utilized and most helpful to practitioners is the Hyperhidrosis Disease Severity Scale (HDSS), a disease-specific questionnaire that is a qualitative measure of severity based on patient reported effect of sweating on daily activities. The HDSS is a four-point scale, on which a score of a three or four indicates severe hyperhidrosis. This office-friendly tool has been validated and shown to correlate well with gravimetry, with a two-point improvement reflecting an 80% reduction in sweat production (12) (Table 3).

A minor starch-iodine test is another useful tool that is safe and easily performed in any office and can help evaluate specific areas of focal hyperhidrosis. In this method, a thin layer of an iodine or betadine solution is applied to the area of interest and allowed to dry, and then corn starch is brushed lightly over the area. The light brown iodine color turns dark purple when sweat is present. Starch-iodine preparation is also very helpful before botulinum toxin injection to delineate the treatment area (12). Photos of the treatment area after this application can be used to prevent erroneous injection or the need to repeat the test at subsequent visits (FIGS 1–3).

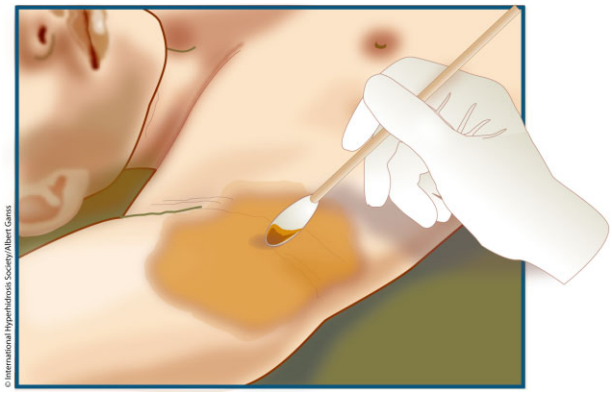

FIG. 1. Minors starch iodine test step 1: application of iodine to area of interest.

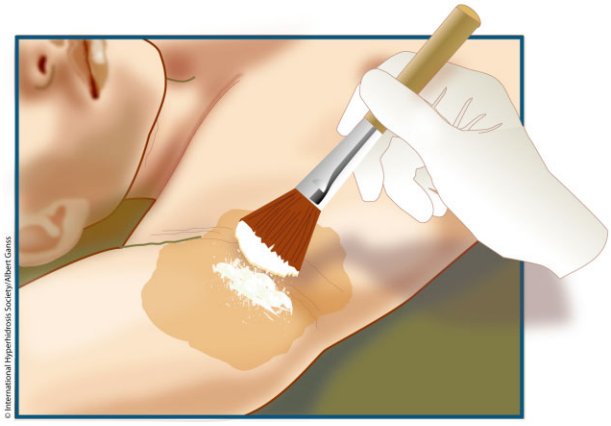

FIG. 2. Minors starch iodine test step 2: after iodine dries, apply a thin layer of cornstarch to entire area.

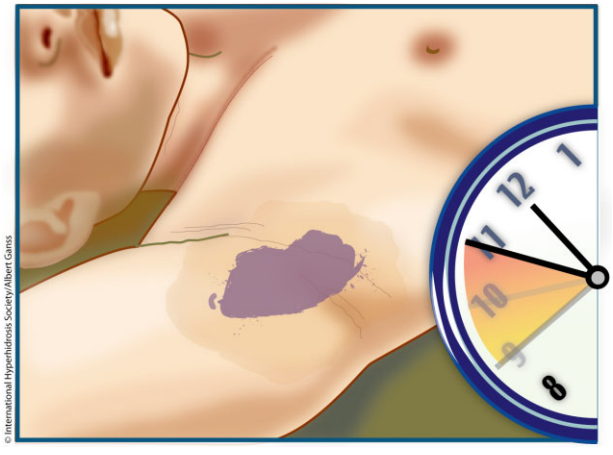

FIG. 3. Minors starch iodine test step 3: color changes from brown to purple in areas that sweat.

Management

Treatment of hyperhidrosis is best selected based on the body site or sites affected and can be classified as non-surgical and surgical. Age of the patient, previously failed treatments, and insurance coverage can also affect the modality chosen. Non-surgical therapies, which will be the focus of the remainder of this article, include topical antiperspirants, tap water iontophoresis, botulinum toxin injection, and anticholinergic medications. MiraDry microwave technology is a new therapy designed to ablate sweat glands that has been shown efficacious in adults but has not yet been reported for use in children. Surgical treatments include focal curettage or liposuction of sweat gland-containing adipose tissue and thoracic sympathectomy. One study suggested that children may tolerate thoracoscopic sympathectomy better than adults for palmar hyperhidrosis due to a lower rate of and milder compensatory sweating; yet close to 70% still suffered some form of compensatory sweating (13). Given the risks of surgery and lack of long-term data on satisfaction and recurrence, surgical intervention should only be considered after failure of standard non-surgical therapies and should be approached with caution in pediatric patients.

Topical therapies

Topical therapy is usually first-line in treatment of primary focal hyperhidrosis, especially in children. Aluminum and zirconium salts are the most common active ingredients in both over-the-counter and prescription antiperspirants. These salts are thought to mechanically obstruct the sweat pores and can be used on virtually any area of the body (14). These compounds do not alter sweat production, but rather they affect the release through the ducts, with normal sweat release returning after epidermal renewal. Aluminum chloride hexahydrate 20% solution (Drysol®, Hypercare®) is the most commonly prescribed agent. These topical antiperspirants can be very effective but can be limited by pruritis and irritation that is caused by the formation of hydrochloric acid in a chemical reaction between the aluminum chloride and moisture present on the skin surface. Application at night on a very dry, non-occluded skin surface can reduce this irritation substantially. Applied medications should also be washed off in the morning, before daytime sweating begins. Although it is generally recommended to begin with nightly application, patients are often able to decrease frequency of use once dryness is achieved (14).

There are several other topical options for patients, both prescription and over-the-counter. HydroSal®, a gel formulation containing 15% aluminum chloride and 2% salicylic acid, is available without a prescription (15). Over-the-counter clinical strength antiperspirants containing aluminum zirconium trichlorohydrox can also be effective as solitary agents for some patients with hyperhidrosis, often with less irritation. These are also most effective when applied at night, when basal sweat production is lowest, which allows maximal plugging of sweat ducts. Lastly, topical preparations containing anticholinergic medication can be acquired from Canadian pharmacies but are not available in the United States and are not approved by the Food and Drug Administration (16). These should be used with the same caution as systemic anticholinergics.

The safety profile and non-invasive nature of topical therapies favor their use in the pediatric population. They remain limited by skin irritation, compliance and potential decrease in efficacy in patients with such severe sweat production that plugs cannot form. Because plugs occur in superficial skin, they are shed with natural skin turnover, requiring daily maintenance application for efficacy. It is also important to note, when discussing aluminum salt preparations, that research has not shown an association between these compounds and Alzheimer's disease or breast cancer. In fact, many nationally recognized organizations, including the American Cancer Society and the National Institutes of Health, have released statements discounting the alleged association.

Iontophoresis

Utilized since the 1930s, the technique of tap water iontophoresis uses an electrical current to introduce ions into the body through acrosyringium, where the resistance is lowest in the skin. The mechanism of action of iontophoresis in hyperhidrosis is not well understood but likely also involves the obstruction of eccrine ducts (17). Similar to topical antiperspirants, epidermal renewal leads to return of sweat production. Due to anatomical and functional constraints, iontophoresis is most effective for palmoplantar hyperhidrosis. There are many different strategies regarding treatment regimens (17–19). In general, 20-minute treatment sessions are started at 3–5 times per week until the patient achieves dryness,

generally at 2–4 weeks. They are then spaced out slowly to longer intervals of every 7 to 10 days, in order to maintain dryness. At times, anticholinergic medications are added to the water, which has been shown to increase the duration of dryness (20). Iontophoresis has been shown effective in studies that have included pediatric patients (20,21). Reduction in sweat intensity and overall satisfaction has also been shown in a pediatric population after treatment with iontophoresis. Interestingly, although this population was receiving treatment for palmar hyperhidrosis, subjects noted decreased plantar sweating as well, suggesting a possible biofeedback mechanism (21).

Patients may elect to receive treatments in the office or with a home unit. Two units are FDA approved for use, the R.A. Fischer Galvanic Iontophoresis Unit and the Drionic Home Unit. Although there have not been any head-to-head comparisons, the Fischer unit has been shown in several studies to have an improvement rate greater than 80%, whereas the Drionic unit led to improvement of approximately 50% (22,23).

Tolerance of iontophoresis is widely variable, but side effects are generally limited to mild "pins and needles" tingling and erythema. Less commonly, painful stinging, itching, small vesicles and mild shocks can occur. Contraindications to iontophoresis include pregnancy, pacemaker or defibrillator, significant arrhythmia, and epilepsy. A metal implant or joint replacement in the path of the current can lead to a painful sensation and these should be evaluated as a potential contraindication for that extremity. Of note for the pediatric population, orthodontic braces are not generally considered a contraindication to treatment (FIG. 4).

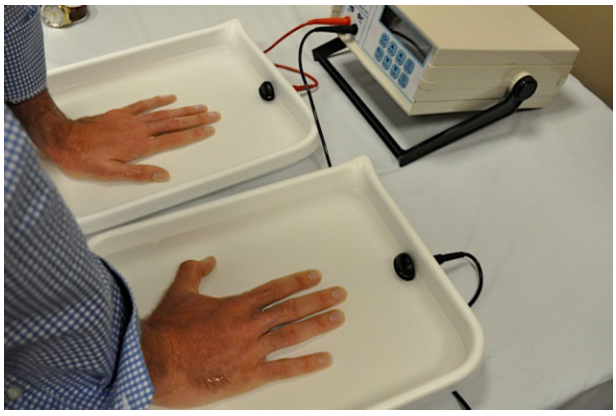

FIG. 4. Iontophoresis.

Botulinum toxin

Intradermal injection of botulinum toxin, a purified protein derived from *Clostridium botulinum*, blocks the sympathetic stimulation of sweat glands, thereby decreasing sweat production (24). Because onabotuliunum toxin A is the only injectable treatment that is FDA approved for any type of hyperhidrosis, it will be the focus of this section. Although it is only FDA approved for axillary hyperhidrosis in adults, onabotuliunum toxin A can be used for many other areas of focal hyperhidrosis, such as the palms, groin, inframammary and suprasternal area, face, scalp, and soles of the feet (25–30). It has also been used safely in pediatric patients, although use can be limited by pain from injection.

Axillary treatment is most common and generally requires 50 units per axilla, given in deep dermal injections spaced 1.5–2 cm apart. This results in approximately 10–15 sites per axilla. As previously mentioned, a minor starch iodine application can be used to help delineate the necessary treatment area. Almost half of patients experience resolution of sweating within 1 week, and the average duration of improvement is 6–8 months (31). Injection site discomfort and bruising may be encountered, but both are generally very mild.

Treatment of palmar hyperhidrosis with onabotuliunum toxin A is not FDA approved but has nonetheless been reported with relative frequency in the literature, including pediatric patients (26). Typical required doses are higher than in axillary treatment, with 100–200 units per palm often necessary. Spacing of injections is somewhat smaller, because of decreased diffusion in palmar skin, which often results in 40–50 injection sites per palm depending on the treated surface area. Onset of action is similar to axillary therapy, but duration of improvement is shorter at 4–5 months. One study in a pediatric population (mean age of 11 years) showed successful control of excess palmar sweat production for a mean duration of 7 months with improvement in quality of life (32). Transient small muscle weakness can be encountered when treating the palms; however, normal function often returns within several weeks. Every attempt should be made to remain superficial when injecting over the thenar and hypothenar eminences of the hands to prevent loss of grip strength. Injection pain is the limiting factor with this treatment and multiple different strategies have been employed including general anesthesia, nerve blocks, ice, vibration, and pressure.

Regardless of the treatment site, contraindications to the use of botulinum toxin A include pregnancy, local infection and neuromuscular junction disease such as myasthenia gravis (24–30,33). Of note, there is a black box warning for use of botulinum toxin A, associating generalized muscle weakness and respiratory difficulty resulting in hospitalization and death in children with cerebral palsy treated for muscle spasms. These significant adverse events have occurred hours to weeks after injection. It is important to note that the doses of botulinum toxin associated with these events were greater than those generally used for the treatment of hyperhidrosis.

Systemic medications

Many authors feel that it is most prudent to choose systemic therapy when hyperhidrosis is generalized or significantly includes the craniofacial area (34). Systemic medications can also be a valid option when there has been failure or intolerance of a first-line focal therapy. Oral anticholinergics are a mainstay in the treatment of hyperhidrosis, although use is based on anecdotal evidence or very small trials. The majority of evidence is based in the adult population; however, these drugs have been safely used in children for the treatment of hyperhidrosis as well as other disorders such as excessive salivation and urinary voiding dysfunction (35). As competitive antagonists of acetylcholine, anticholinergic drugs block sweat production by blocking muscarinic receptors in the sympathetic pathway (36). Unfortunately, the blockade of receptors cannot be limited to only the eccrine glands, and side effects of the medications such as dry mouth, blurred vision, urinary retention, tachycardia, and constipation may limit their use. The potential to overheat with activity must also be considered a side effect, especially in children and in patients who spend time outdoors in a warm climate. These medications should be used with caution in patients with arrhythmias, bladder outflow obstruction, and gastrointestinal disorders. They are contraindicated in patients with pyloric stenosis, paralytic ileus, myasthenia gravis and narrow-angle glaucoma. Although neither is FDA-approved for hyperhidrosis, glycopyrrolate and oxybutynin are commonly used anticholinergic medications for the treatment of hyperhidrosis in adults and children.

Glycopyrrolate is the most commonly prescribed anticholinergic medication for hyperhidrosis. Doses of glycopyrrolate necessary to control symptoms of excessive sweating vary widely. In a report of 24 adult patients treated with 2 mg, twice daily, 79% showed improvement (31). A recent study in the pediatric population showed that 90% of patients experienced improvement at a mean dosage of 2 mg per day. Improvement occurred within hours of dosing and disappeared within a day of discontinuation. Dry mouth and dry eyes were the most common side effects, seen in about 30% of patients (37). Many patients begin taking a single 1 mg tablet once daily and increase slowly over the course of several months, often to a maximum of four tablets twice daily. In the young pediatric population, glycopyrrolate should be prescribed within the standard dosing parameters of 40–100 mcg/kg/dose, and although it may be given up to four times daily, twice daily dosing is often sufficient to control symptoms (38,39). Patients should stop this dose escalation when the hyperhidrosis is adequately managed or side effects become bothersome, whichever occurs first. The highly polar quaternary ammonium group of glycopyrrolate limits its passage through the blood-brain barrier, giving it a lower risk of central nervous system side effects when compared to other medications of this class.

Oxybutynin has also been prescribed for the treatment of hyperhidrosis and a recent small prospective study of 139 patients given the drug for palmar hyperhidrosis revealed improvement in 80% of patients, which is similar to reported improvement rates for glycopyrrolate (40). There have been no controlled studies in children. Recommended dosing varies between 5 mg once daily to a maximum of 10 mg twice daily in adults. For pediatric patients younger than 5 years of age, oxybutynin 5 mg/5 mL suspension is dosed at 0.1 mg/kg/dose, given up to three times daily. For children over the age of 5 years, 5 mg may be given up to three times daily (41). Dosing of extended release tablets is not equivocal and practitioners must take caution to prescribe the appropriate formulation of the medication.

Both oxybutynin and glycopyrrolate have been used safely in children; however, oxybutynin is the overall more commonly prescribed oral anticholinergic medication in the pediatric population when all indications are considered. Safe dosing standards for these medications in children have generally been adapted from non-dermatologic practices and have not been evaluated in controlled trials for children with hyperhidrosis. Both medications are generally started at a single, low daily dose and increased very slowly in order to appropriately assess both improvements in sweating as well as potential side effects.

Conclusion

Hyperhidrosis is a relatively common disorder that is a substantial burden to affected patients, interfering with daily activities and causing social embarrassment. These daily challenges can be especially detrimental in the pediatric population. With increased awareness of the diagnosis of hyperhidrosis and available treatment options, clinicians have the unique opportunity to change lives. Topical antiperspirants, iontophoresis, botulinum toxin A and anticholinergic medications have all been successful in the management of pediatric hyperhidrosis and are suggested before considering surgical intervention.

Websites for organizations such as the International Hyperhidrosis Society (http://www.sweathelp.org) can be extremely helpful resources, and patients in some geographical areas may have access to providers and clinics that focus specifically on the treatment of hyperhidrosis.

References

1. Strutton DR, Kowalski JW, Glaser DA, et al. US prevalence of hyperhidrosis and impact on individuals with axillary hyperhidrosis: results from a national survey. J Am Acad Dermatol 2004: **51**: 241–248.
2. Bellet JS. Diagnosis and treatment of primary focal hyperhidrosis in children and adolescents. Semin Cutan Med Surg 2010: **29**: 121–126.
3. Hornberger J, Grimes K, Naumann M, et al. Recognition, diagnosis, and treatment of primary focal hyperhidrosis. J Am Acad Dermatol 2004: **51**: 274–286.
4. Hamm H, Naumann MK, Kowalski JW, et al. Primary focal hyperhidrosis: disease characteristics and functional impairment. Dermatology 2006: **212**: 343–353.
5. Lear W, Kessler E, Solish N, et al. An epidemiological study of hyperhidrosis. Dermatol Surg 2007: **33**: S69–S75.
6. Sato K, Kang WH, Saga K, Sato KT. Biology of sweat glands and their disorders. I. Normal sweat gland function. J Am Acad Dermatol 1989: **20**: 537–563.
7. Sato K, Kang WH, Saga K, Sato KT. Biology of sweat glands and their disorders. II. Disorders of sweat gland function. J Am Acad Dermatol 1989: **20**: 713–726.
8. Lowe N, Campanati A, Bodokh I, et al. The place of Botulinum toxin type A in the treatment of focal hyperhidrosis. Br J Dermatol 2004: **151**: 1115–1122.
9. Haider A, Solish N. Focal hyperhidrosis: diagnosis and management. CMAJ 2005: **172**: 9–75.
10. Swartling C, Naver H, Lindberg M. Botulinum A toxin improves life quality in severe primary focal hyperhidrosis. Eur J Neurol 2001: **8**: 247–252.
11. Leung AK, Chan PY, Choi MC. Hyperhidrosis. Int J Dermatol 1999: **38**: 561–567.
12. Solish N, Bertucci V, Dansereau A, et al. A comprehensive approach to the recognition, diagnosis, and severity-based treatment of focal hyperhidrosis: recommendations of the Canadian Hyperhidrosis Advisory Committee. Dermatol Surg 2007: **33**: 908–923.
13. Steiner Z, Cohen Z, Kleiner O, Mtar I, Mogilner J. Do children tolerate throracoscopic sympathectomy better than adults? Pediatr Surg Int 2008: **24** (3): 343–347.
14. Brandup F, Larsen PO. Axillary hyperhidrosis: local treatment with aluminum chloride hexahydrate 25% in absolute ethanol. Acta Derm Venereol 1978: **58** (5): 461–465.
15. Flanagan KH, Glaser DA. An open-label trial of the efficacy of 15% aluminum chloride in 2% salicylic acid gel base in the treatment of moderate-to-severe primary axillary hyperhidrosis. J Drugs Dermatol 2009: **8** (5): 477–480.
16. Luh JY, Blackwell TA. Craniofacial hyperhidrosis successfully treated with topical glycopyrrolate. South Med J 2002: **95** (7): 756–758.
17. Hill AC, Baker GF, Jansen GT. Mechanism of action of iontophoresis in the treatment of palmar hyperhidrosis. Cutis 1981: **28**: 69–70.
18. Anliker MD, Kreyden OP. Tap water iontophoresis. Curr Probl Dermatol 2002: **30**: 48–56.
19. Levit F. Treatment of hyperhidrosis by tap water iontophoresis. Cutis 1980: **26**: 192–194.
20. Doliantits C, Scarff CE, Kelly J, Sinclair R. Iontophoresis with glycopyrrolate for the treatment of palmoplantar hyperhidrosis. Australas J Dermatol 2004: **45** (4): 208–212.
21. Dahl JC, Glent-Madsen L. Treatment of hyperhidrosis manuum by tap water iontophoresis. Acta Derm Venereol 1989: **69** (4): 346–348.
22. Karakoc Y, Ayemir EH, Kalkan MT, Unal G. Safe control of palmoplantar hyperhidrosis with direct electrical current. Int J Dermatol 2002: **41** (9): 602–605.
23. Akins DL, Meisenheimer JL, Dobson RL. Efficacy of the Drionic unit in the treatment of hyperhidrosis. J Am Acad Dermatol 1987: **16** (4): 828–832.
24. Huang W, Foster JA, Rogachefsky AS. Pharmacology of botulinum toxin. J Am Acad Dermatol 2000: **43**: 249–259.
25. Glaser DA, Hebert AA, Pariser DM, Solish N. Facial hyperhidrosis: best practice recommendations and special considerations. Cutis 2007: **79** (5 Suppl.): 29–32.
26. Glaser DA, Hebert AA, Pariser DM, Solish N. Palmar and plantar hyperhidrosis: best practice recommendations and special considerations. Cutis 2007: **79** (5 Suppl.): 18–28.
27. Glaser DA, Hebert AA, Pariser DM, Solish N. Primary focal hyperhidrosis: scope of the problem. Cutis 2007: **79** (5 Suppl.): 5–17.
28. Grunfeld A, Murray CA, Solish N. Botulinum toxin for hyperhidrosis. Am J Clin Dermatol 2009: **10** (2): 87–102.
29. Barankin B, Wasel N. Treatment of inguinal hyperhidrosis with Botulinum toxin type A. Int J Dermatol 2006: **45** (8): 985–986.
30. Kim WO, Kil HK, Yoon KB, Noh KU. Botulinum toxin: a treatment for compensatory hyperhidrosis of the trunk. Dermatol Surg 2009: **35** (5): 833–838.
31. Bajaj V, Langtry JA. Use of oral glycopyrronium bromide in hyperhidrosis. Br J Dermatol 2007: **157**: 118–121.
32. Coutinho dos santos LH, Gomes AM, Giraldi S, Abagge KT, Marinoni LP. Palmar hyperhidrosis: long-term follow-up of nine children and adolescents treated with botulinum toxin type A. Pediatr Dermtol 2009: **26** (4): 439–444.
33. Lowe NJ, Glaser DA, Eadie N, Daggett S, Kowalski JW, Lai PY. Botulinum toxin type A in the treatment of primary axillary hyperhidrosis: a 52-week multicenter double-blind, randomized, placebo-controlled study of efficacy and safety. J Am Acad Dermtol 2007: **56** (4): 604–611.
34. Solish N, Bertucci V, Dansereau A, et al. A Comprehensive approach to the recognition, diagnosis, and severity-based treatment of focal hyperhidrosis: recommendations of the

Canadian Hyperhidrosis Advisory Committee. Dermatol Surg 2001: **33**: 908–923.
35. Gelbard CM, Epstein H, Hebert A. Primary pediatric hyperhidrosis: a review of current therapeutic options. Pediatr Dermatol 2008: **25** (6): 591–598.
36. Böni R. Generalized hyperhidrosis and its systemic treatment. Curr Probl Dermatol 2002: **30**: 44–47.
37. Paller AS, Shah PR, Silverio AM, Wagner A, Chamlin SL, Mancini AJ. Oral glycopyrrolate as second-line treatment for primary pediatric hyperhidrosis. J Am Acad Dermatol 2012: **67** (5): 918–923.
38. Jongerius PH, van Tiel P, van Limbeek J, et al. A systematic review for evidence of efficacy of anticholinergic drugs to treat drooling. Arch Dis Child 2003: **88**: 911–914.
39. Ayan S, Topsakal K, Gokce G, et al. Efficacy of combined anticholinergic treatment and behavioral modification as a first line treatment for nonneurogenic and nonanatomical voiding dysfunction in children; a randomized controlled trial. J Urol 2007: **177**: 2325–2328.
40. Wolosker N, de Campos JR, Kauffman P, et al. An alternative to treat palmar hyperhidrosis: use of oxybutynin. Clin Auton Res 2011: **21** (6): 389–393.
41. Cartwright PC, Coplen DE, Kogan BA, Volinn W, Finan E, Hoel G. Efficacy and safety of transdermal and oral ovybutynin in children with neurogenic detrusor overactivity. J Urol 2009: **182** (4): 1548–1554.