

The Society of Thoracic Surgeons Expert Consensus for the Surgical Treatment of Hyperhidrosis

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Executive Summary

Significant controversies surround the optimal treatment of primary hyperhidrosis of the hands, axillae, feet, and face. The world's literature on hyperhidrosis from 1991 to 2009 was obtained through PubMed. There were 1,097 published articles, of which 102 were clinical trials. Twelve were randomized clinical trials and 90 were nonrandomized comparative studies. After review and discussion by task force members of The Society of Thoracic Surgeons' General Thoracic Workforce, expert consensus was reached from which specific treatment strategies are suggested.

These studies suggest that primary hyperhidrosis of the extremities, axillae or face is best treated by endoscopic thoracic sympathectomy (ETS). Interruption of the sympathetic chain can be achieved either by electrocautery or

clipping. An international nomenclature should be adopted that refers to the rib levels (R) instead of the vertebral level at which the nerve is interrupted, and how the chain is interrupted, along with systematic pre and postoperative assessments of sweating pattern, intensity and quality-of-life.

The recent body of literature suggests that the highest success rates occur when interruption is performed at the top of R3 or the top of R4 for palmar-only hyperhidrosis. R4 may offer a lower incidence of compensatory hyperhidrosis but moister hands. For palmar and axillary, palmar, axillary and pedal and for axillary-only hyperhidrosis interruptions at R4 and R5 are recommended. The top of R3 is best for craniofacial hyperhidrosis.

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Hyperhidrosis is defined as a pathologic condition of excessive sweating in amounts greater than phys-

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An expert consensus document is *an opinion* of a panel of experts regarding management strategies and treatment of a disease. Although based on experience and review, these documents are not formal recommendations or guidelines.

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ologically needed for thermoregulation. It may develop secondary to a variety of medical disorders or it may be primary or cryptogenic, with symptoms such as focal hyperhidrosis usually affecting the palms, axillae, or the feet [1]. Additionally, some patients have craniofacial hyperhidrosis, or excessive blushing that is associated with severe emotional, occupational, and social distress. Patients who are overweight (a body mass index of ≥ 28), have full-body hyperhidrosis, or patients who have secondary causes such as hyperthyroidism, hypertension, diabetes mellitus, infections, brain lesions, and other systemic medical conditions represent some of the conditions that should be diagnosed and treated medically and should not be treated with endoscopic thoracic sympathectomy (ETS).

The incidence of hyperhidrosis depends on the culture, on the climate, and on several subjective definitions. It is believed that idiopathic focal hyperhidrosis affects 1% to 3% of the population, with a predominance in countries such as Taiwan that are near the Equator [2, 3]. Hyperhidrosis affects both sexes equally and affects predominantly adolescents or young adults. Characteristically, the palmar symptoms start in early childhood, axillary symptoms in adolescence, and craniofacial symptoms in adulthood, and often worsen with puberty.

There remains significant controversy concerning the optimal surgical therapy for primary hyperhidrosis. That is partially due to the poor definitions of the terms used for both the diagnosis of the problem and for the surgical therapy applied. For instance, video-assisted thoracic surgical sympathectomy goes by other names, such as sympathotomy or ETS. Some of the terms are not synonymous. Sympathectomy and ganglionectomy refer to total ablation or removal of a segment of the sympathetic chain and ganglia, or both. Sympathectomy and sympathotomy refer to interruption or simple transection of the sympathetic chain. Sympathetic block refers to a potentially reversible procedure such as clipping of the sympathetic chain or anesthetic injections of the nerve. Selective sympathectomy refers to preservation of the sympathetic chain with ramicotomy (division of the rami communicante). In the following expert consensus document, we provide clinically useful anatomic definitions and standard metrics for symptomatic assessments before and after intervention, from which we generate specific treatment strategies regarding sympathectomy for distinct patterns of hyperhidrosis.

Pathogenesis

Eccrine sweat glands are responsible for hyperhidrosis (although some researchers believe that a mixture of the two [apo/eccrine] glands may play a role in axillary hyperhidrosis) [4]. Eccrine glands are innervated by the sympathetic nervous system but utilize acetylcholine as the primary neurotransmitter. Thermal sweating is controlled by the hypothalamus, whereas emotional sweating is regulated by the cerebral cortex. A sympathetic signal is carried to sweat glands by cholinergic autonomic neurons. In patients with idiopathic (focal) hyperhidrosis, the sweat glands are usually histologically and functionally normal. Although the pathophysiology remains unknown, the cause of hyperhidrosis appears to be an abnormal central response to emotional stress, but it can also occur spontaneously and intermittently.

Additionally, there is evidence for a genetic component to hyperhidrosis, and it can be seen in family members [5, 6]. A genetic analysis suggests that an allele for hyperhidrosis may be present in 5% of the population, and that 25% of people with one or two copies of the allele will have hyperhidrosis, whereas fewer than 1% of people with two normal alleles will have it.

Types of Hyperhidrosis

Patients with focal or primary hyperhidrosis have sweating involving the face, palms, soles, or axillae. Generalized sweating suggests a secondary etiology. The most common causes of generalized sweating are excessive heat and obesity. Other causes include systemic diseases such as infections, endocrine disorders, neuroendocrine tumors, malignancy, neurologic disorders, toxins, and previous spinal cord injuries. These sweating episodes can be due to an autonomic dysreflexia, orthostatic hy-

potension, or posttraumatic syringomyelia. Hyperhidrosis can be attributed to autonomic dysreflexia, which is often triggered by an exaggerated autonomic response to normal stimuli such as bowel and bladder distention or skin irritation. Pathologic gustatory sweating may be caused by sympathetic nerve damage, either due to invasion (Pancoast tumor), diabetic neuropathy, herpes zoster of the preauricular region, or misdirection of autonomic nerve fibers after parotid surgery (Frey's syndrome). Unlike primary hyperhidrosis, patients with generalized, secondary hyperhidrosis usually present as adults and have excessive sweating that occurs both while awake and asleep.

Nonsurgical Treatment

Prescription strength antiperspirants, which are thought to work by mechanically obstructing the eccrine sweat gland ducts or by causing atrophy of the secretory cells [7, 8] can be tried for patients who do not respond to over-the-counter antiperspirants. These include antiperspirants with 20% aluminum chloride in ethanol (Drysol) or 6.25% aluminum tetrachloride (Xerac). Systemic medical regimens may also be employed in the treatment of hyperhidrosis: anticholinergic agents (glycopyrrolate, propantheline, oxybutinin) are sometimes used; however, the dosage required to reduce sweating also causes development of side effects such as dry mouth, blurred vision, or urinary retention [9]. In patients with hyperhidrosis triggered by specific emotional events, beta-blockers or benzodiazepines may be useful for reducing the emotional stimulus that leads to the excessive sweating [10]. Drawbacks to using these agents include discoloration of the skin, a high rate of contact dermatitis, and necessity of continuous use.

Iontophoresis is the introduction of ionized substances through intact skin by the application of direct current. Iontophoresis is most often used for palmar or plantar hyperhidrosis, but a special axillary electrode can be used to treat axillary hyperhidrosis as well. Although there are only limited data from randomized trials, iontophoresis appears to alleviate symptoms in approximately 85% of patients with palmar or plantar hyperhidrosis and is safe and simple to perform [11, 12]. The drawback is that it is often irritating to the skin, leaves a "pins and needles" feeling, and may cause scaling and fissuring [13], and it is very labor intensive.

Botulinum toxin type A (Botox) and type B (Myobloc) have been shown to be effective for axillary and palmar hyperhidrosis [14, 15]. Botox blocks the release of neuronal acetylcholine from the presynaptic junction of both neuromuscular and cholinergic autonomic neurons and temporarily can reduce sweat production. Usually it lasts for 3 to 4 months; however, it can last as long as 7 months, until the sudomotor nerve fibers have regenerated [16, 17]. Drawbacks include local pain (20 to 40 injections are needed), a temporary effect or abbreviated response, transient weakness of the small hand muscles, and repeated, costly procedures.

Surgical Treatment

Nomenclature for Sympathetic Surgery

Over the past year, both the International Society on Sympathetic Surgery (ISSS) and The Society of Thoracic Surgeons (STS) General Thoracic Task Force on Hyperhidrosis decided that an internationally agreed upon nomenclature was needed. It has often been unclear exactly where and how a surgeon interrupted the chain, which has made it almost impossible to compare techniques and results. The nomenclature needs to include the location where the sympathetic chain was interrupted and the method of how it was interrupted. Various anatomic landmarks exist to guide the surgeon in determining the exact level where to divide or clip the chain or ganglia for a sympathectomy. The ISSS and STS committees' consensus was to use a rib- oriented nomenclature. This decision was based on too many patients having mediastinal fat that can obscure clear identification of the specific ganglia and because there are many anatomical variations in the ganglion anatomy. The surgeon may add the ganglia that are interrupted to the operative note as well. In addition, the committees agreed that a description of the type of interruption is required denoting whether the chain was clipped, cut, or cauterized, or a segment removed.

An operation can, therefore, be abbreviated as an R2 or an R3 (R referring to rib, and the number referring to which rib). If the chain is clipped on top of the fifth rib, the abbreviation for the operative note would be "clipped R5, top." If the chain is cauterized on the top and bottom of the fourth rib, the operative note would be "cauterized, top R4, bottom R4." Using this standardized nomenclature allows surgeons from all over the world to better communicate with one another. In this manuscript, all interruptions that are referred to or recommended are meant to occur on the top of the rib.

Review of Published Literature

The literature on sympathectomy for hyperhidrosis must be interpreted cautiously as the definitions are not the same in most papers. Some studies use objective data such as hand temperature postoperatively to determine success, whereas others simply rely on subjective reporting by the patient. Not all studies assess compensatory hyperhidrosis (CH) similarly, or at the same point postoperatively, or quantify the degree of compensatory hyperhidrosis. Standardized preoperative and postoperative questionnaires are needed to objectify the improvement of these patients. An example of the data collection sheets used by de Campos and associates [1] in an effort to standardize results can be found at http://www.sts.org/sites/default/files/documents/pdf/expertconsensus/Hyperhidrosis_Suggested_Forms_for_Data_Collection.pdf. The committee recommends that all sites that plan to perform research in this area implement similar data collection, making all subsequent studies more easily interpreted. In addition, because follow-up is a critical part of any research in this field, it is recommended that patients have follow-up appointments or surveys at 1

month, 6 months, 1 year, and yearly thereafter for at least 5 years if possible.

For this review, the PubMed database was searched for the terms hyperhidrosis/surgery/VATS sympathectomy and/or endoscopic thoracic sympathectomy/sympathotomy. The time frame was restricted to articles published between 1990 and June 2009. Endoscopic thoracic sympathectomy for any disorder other than hyperhidrosis was omitted. The databases returned 1,097 references, of which 629 were case reports or series, 102 were clinical trials or comparative studies, 120 were review articles, and 12 were randomized clinical trials pertaining to surgical technique. All of the non-case report articles were reviewed. Selected randomized studies [18-25] and comparative studies [26-29] are presented in Table 1. More than half of these reports were eliminated because of the lack of specific details of the operation or of clear-cut definitions regarding the degree of hyperhidrosis preoperatively or postoperatively.

Patient Selection for Endoscopic Thoracic Sympathectomy for Hyperhidrosis Treatment

The bulk of the randomized trials and nonrandomized comparisons identified the "ideal candidates" for ETS as those who have onset of hyperhidrosis at an early age (usually before 16 years of age), are young at the time of surgery (usually less than 25 years old), have an appropriate body mass index (<28), report no sweating during sleep, are relatively healthy (no other significant comorbidities), and do not have bradycardia (resting heart rate <55 beats per minute).

Only a small percentage of patients should be considered for surgical treatment. Surgical consultation should include the secure diagnosis of primary focal hyperhidrosis, the anatomic locations involved and the amount of hyperhidrosis, and full discussion of the options to surgery and potential complications. The patients should be made aware that the most satisfied patients are those with palmar or palmar-axillary hyperhidrosis, or both. Finally, patients should also be told of the success and failure rates, and long-term results [30]. Often, we offer the patient the option to discuss the procedure and its side effects with another patient who has already undergone the surgery. This is done by a conference call under the Health Insurance Portability and Accountability Act (HIPPA) guidelines, or face to face at the patient's request.

Location of Interruption of Sympathetic Chain Based on Patient's Distribution of Sweating

PALMAR HYPERHIDROSIS. Even among patients with palmar hyperhidrosis alone, there remains some controversy. For those who are willing to accept a higher risk of CH because they want their hands to be completely dry, it is suggested that two interruptions in the sympathetic chain are made, at R3 and R4. However, based on the prospective randomized study in 2009 by Liu and associates [19] and the study in 2007 by Yang and colleagues [20], an R-4 alone interruption may be acceptable for these patients because it limits the degree of CH (although it may lead to moister hands). The patients

Table 1. Review of Selected Studies

Author, Year [Ref], Journal (No. of Patients)	Study Type (Levels Cut)	Palmar	Axilla	Facial	Immediate Success Rate	Rate of Compensatory Hyperhidrosis ^a	Mean Follow-Up ^b (Months)
Yazbek, 2009 [28], Clinics (59)	Randomized clinical trial (R2 vs R3)	X			100% R2, 97% R3	6 months postoperative, 67% R2, 90% R3 (but significantly less severe CH)	20
Liu, 2009 [19], Eur JCTS (141)	Randomized clinical trial (R3 vs R4)	X			100% R3, 94% R4	77% R3, 56% R4	18
Li, 2008 [22], Ann Thorac Surg (232)	Randomized clinical trial (R3 vs R2-R4)	X			100%	10% R2-R4, 3% R3	
Katara, 2007 [23], Surg Endosc (25)	Randomized clinical trial (cross-over, same patients received R2-R3 ablation unilaterally, then R2 ablation on other side)	X			100%	80% in both groups; no difference in CH	
Chang, 2007 [24], Ann Surg (234)	Retrospective (R2, R3, and R4 compared)	X			Not reported	92% R3, 92% R3, 80% R4	47
Yang, 2007 [20], Chin Med J (163)	Randomized clinical trial (R3 v. R4)	X			100%	23.1% R3, 7.1% R4	13.8
Yazbek, 2005 [29], J Vasc Surg (60)	Randomized clinical trial (R2 vs R3)	X			100% R3, 97% R2	86% R2, 90% R3 (but significantly less severe)	6
Munia, 2008 [18], Clinics (64)	Randomized clinical trial (R3-4 vs R4)		X		100%	100% R3-R4, 42% R4	12
Munia, 2007 [21], J Vasc Surg (62)	Randomized clinical trial (R3-R4 vs R4)		X		100%	90% R3-R4, 56% R4	
Gossot, 2003 [27], Ann Thorac Surg (382)	Prospective (various levels cut)	X	X		100%	86.4%	45.6
Lin, 2002 [25], Neurosurgery (2000)	Retrospective (R2 palmar, R3-R4 axillary)	X	X		99%	1,720 (86%)	51.7
Chou 2006 [26], Surg Endosc (464)	Prospective (facial R2 vs R3; palmar R4; axillary R5)	X	X	X	100%	Facial 43% R2, 27% R3; axillary 0%	17

^a Most series report moderate to severe compensatory hyperhidrosis (CH).^b Not provided in all studies.

should be counseled about these differences and participate in the decision-making process. For these reasons, we also recommend the top of R3 sympathectomy alone for patients with isolated palmar hyperhidrosis.

Patients with palmar and plantar hyperhidrosis represent a different challenge. Again, two operations can be performed. An R4 interruption alone may reduce the incidence of CH; alternatively, an R4 and R5 intervention is a reasonable option, but leads to drier feet, and hence, is our consensus treatment of choice.

AXILLARY HYPERHIDROSIS. Endoscopic thoracic sympathectomy for axillary hyperhidrosis is often less successful and has higher “regret rates” than ETS for palmar hyperhidrosis. A qualitative review shows a trend of lower incidence of CH with fewer interruptions, even when the interruptions are fairly low on the chain [31–34]. In a randomized, prospective study of patients with axillary hyperhidrosis, Munia and colleagues [18] in 2008 showed that all (100%) patients who underwent R3/R4 ETS experienced greater incidence and severity of CH

compared with patients who underwent R4 ETS alone (42%) 1 year after surgery. A study by Chou and associates [26] of patients with axillary hyperhidrosis, found that patients who underwent R5 clipping alone experienced no CH, and none regretted having the surgery. Therefore, for patients who have palmar-axillary, palmar-axillary-plantar, or pure axillary hyperhidrosis, an R4 and R5 transection is suggested.

CRANIOFACIAL HYPERHIDROSIS. Patients with cranial and facial sweating present a more complicated problem compared with patients who have hyperhidrosis that affects the lower part of their body. Chou and colleagues [26], in 2006, reported an experience with R3 interruption of the chain in 33 patients with craniofacial sweating. They found that only 3 patients (9%) regretted the procedure, and 9 (27%) reported CH. In this same series, Chou and colleagues also performed R2 interruption in 54 patients with facial blushing. More than 40% of these patients experienced CH, and 16.7% of patients regretted having the operation. Licht and coworkers [35], in 2006, com-

pared R2 versus R2 and R3 interruption in 173 patients with facial blushing. They found a significantly higher CH rate in the group that underwent the R2 and R3 transection (95%), as compared with the R2 group (83%). Craniofacial sweating must be distinguished from blushing. Based on the findings of these and other series, an R3-alone interruption is suggested for craniofacial sweating, because it reduces the risk of CH and the risk of Horner's when compared with R2 or an R2 and R3 transection.

Type of Interruption

Should the sympathetic chain be transected, resected, ablated with a cautery, or divided with a harmonic scalpel, or should clips be used? No clear differences have been demonstrated among the different techniques; if the correct level division was achieved, the results are good and reproducible. The most important concept about nerve disruption is that there is enough separation between the ends of the chain so that regrowth is impossible. By just ablating the nerve, it is more than likely to regrow, and symptoms could reoccur. Despite initial enthusiasm, the presumption that the patient can return for "surgical reversal" by removing the clip appears dubious. Most authors report approximately 50% of patients have resolution of their craniofacial sweating and improvement in their initial hyperhidrosis. The reason for the failure of reversibility is more than likely related to the perineural damage of the nerve by the clips, which is usually irreversible.

Complications and Treatment

Because the goal of this procedure is to improve quality of life, complications should be minimal and essentially eliminated. The primary side effects of hyperhidrosis surgery include CH, bradycardia, and Horner's syndrome. It is important for patients to be aware, however, of all of the possible complications that can occur. In general, "the higher the level of blockade on the chain, the higher is the expected regret rate" [26].

The most common side effect is CH, which occurs in the literature from 3% to 98% [36, 37]. This wide variability in the incidence of CH may be attributable to heterogeneous patient populations, different surgical procedures, or more importantly, to a variety of definitions of CH. The clinical presentation of CH can be classified as mild, moderate, or severe [19]. "Mild" CH is sweating that occurs in small amounts, is triggered by ambient heat, psychological stress, or physical exercise. The sweat that forms does not flow, is tolerable, and does not cause embarrassment or the need to change clothes. "Moderate" CH is when sweating occurs in moderate amounts, is triggered by ambient heat, psychological stress, or physical exercise. The sweat coalesces into droplets that flow, although not necessitating a change of clothes. Therefore, the sweating, although uncomfortable, does not embarrass the patient. "Severe" or intense CH is when sweating occurs in large amounts, and is triggered with low or without ambient heat, psychological stress, or physical exercise. The sweat droplets that form flow profusely, requiring a change of clothes one or more times a day.

Therefore, the sweating is uncomfortable and causes embarrassment to the patient. The percentage of patients with severe CH is much lower and generally coincides with exercise or a hot environment. If the patient is already experiencing increased sweating in the trunk, groin region, or upper thighs, then the patient should be warned that they are at increased risk of developing CH, and the patient should think twice about proceeding with the procedure.

The most common risk factor cited in the literature for moderate to severe CH includes T2 ganglion interruption (R2, R3) [20, 21, 30]. The number of levels interrupted has been inconclusive as a risk factor. Some techniques have been described to help predict or minimize the degree of CH. Some surgeons utilize a "clipping method" of sympathetic chain interruption as a potentially reversible technique, whereby the clip can be removed if the patient is dissatisfied owing to severe CH. Although the hope is that the nerve will recover to the point where the severe CH is ameliorated, recent data indicate some improvement in symptoms several months later. At this point, the patient should be advised that regardless of the method of surgery, the clip procedure should be considered irreversible [38]. Preoperative testing has been described to try to identify patients with a higher risk of developing severe CH by injecting bupivacaine hydrochloride as a test to reversibly achieve sympathetic nerve blockade and observe for CH [30]. If the patient does not have bothersome CH and has cessation of the hyperhidrosis, then nerve destruction is performed. Other options to help treat patients with CH include use of medication (Ditropan or other anticholinergic medications) in escalating doses and liposuction of the axillary sweat glands. Gustatory sweating may also occur, but rarely, in less than 0.1% of patients.

Horner's syndrome is another side effect that has been reported to occur at a rate between 0.7% and 3% after ETS. The possibility of Horner's syndrome should be addressed in patients with craniofacial hyperhidrosis, as direct injury by cautery, traction, or surrounding inflammation can occur owing to improper localization of the second rib. In all series, inadequate localization decreases with surgical experience. The risk of this complication may be minimized with procedures performed below the second rib (R2), although indirect injury may still result. Misidentification of the operative level can occur; some recommend that an intraoperative radiograph be performed if the anatomy is uncertain. Anatomically, the stellate ganglion can be lower on the left side down to R3.

Permanent bradycardia has been reported after surgery for hyperhidrosis as well [30, 39]. This issue needs to be fully discussed with patients who come in with a resting heart rate less than 55 or 50 beats per minute as there have been reports of patients who may require a pacemaker. Patients who are highly competitive athletes who may require compensatory increase in heart rate or vascular tone with exercise should be told that their exercise capacity could theoretically be reduced and should be encouraged to drink large quantities of electrolyte-containing fluids during sports.

Other less common complications include pneumotho-

rax requiring chest tube drainage (1%), pleural effusion (1%), acute bleeding or delayed hemothorax (1%), chylothorax, and persistent intercostal neuralgia (<1%). Bleeding and pain complications can be reduced by careful port placement. Pneumothorax can also be minimized with careful attention to avoiding parenchymal injury during initial port placement as well as to the technique of reinflation.

Recurrent hyperhidrosis is another potential side effect from hyperhidrosis surgery. Incidence rates vary considerably and have been described as 0% to 65% [27, 29]. This wide variability may be a result of the differences in the techniques used, the levels of the sympathetic chain interrupted, the definitions used, and the length of follow-up. The primary reason for failure is inadequate surgery. That can be attributed to an anatomic variation in the sympathetic chain, failure of surgical technique, intense pleural adhesion, presence of vessels overlying the sympathetic chain or aberrant venous arch drainage, abundant adipose tissue, and possible reinnervation, especially in children who grow after the procedure. Resympathicotomy has been advocated and successfully performed, mainly for immediate failures. Adhesions after the first operation have been the most frequently reported reason for avoiding resympathicotomy. Asking for the previous medical records and operative notes are essential before performing the second operation.

Other Surgical Treatments for Hyperhidrosis

Other surgical therapies for axillary hyperhidrosis are the removal of the axillary sweat glands by means of curettage [40] or liposuction [41]. Complications include wound infection, scar formation, skin necrosis, and skin discolorations. The VASER (Sound Surgical Technologies, Louisville, CO) is a third-generation Food and Drug Administration-approved ultrasound device that allows emulsification of axillary tissue and glands. Primary side effects include transient dysesthesia, indurations, seroma, and ecchymosis [42]. All of these procedures take about an hour to perform and can be performed in the office. Table 2 compares the various treatments for hyperhidrosis.

T2

Conclusions

Endoscopic thoracic sympathectomy with interruption of the sympathetic chain is the treatment of choice for patients with primary hyperhidrosis. The results are contingent on the surgical technique used and also on patients' perceptions of their symptoms of hyperhidrosis both before and after surgery. It is also dependent on the weather, climate, physical and work activities, psychological aspects, and other various conditions of the patient and the patient's environment. Interruption of the chain can be achieved by cauterizing, cutting, or clipping the sympathetic chain. Although the level of interruption, based on the patient's distribution of the hyperhidrosis, remains controversial, expert consensus based on a standardized anatomic classification and careful literature review provides the framework for our suggested treatment strategies.

For palmar hyperhidrosis, the optimal operation is an R3 interruption (cauterizing or clipping the sympathetic chain on top of the third rib) because it yields the driest hands; however, an R4 interruption is also reasonable. The patient should be aware of the differences and the slightly higher risk of CH with an R3 but the risk of moister hands with an R4. An R4 and R5 sympathetic chain interruption should be used for palmar-axillary, palmar-axillary-plantar, or axillary hyperhidrosis alone. An R5 interruption alone is also a viable option for patients who have axillary hyperhidrosis only. Finally, an R3 interruption is suggested for patients with craniofacial hyperhidrosis without blushing. An R2 and R3 procedure may be performed for these patients, but it may lead to a higher incidence of CH, and it increases the risk of Horner's syndrome, especially on the left side.

Worldwide adoption of our suggested, standardized anatomic approach to ETS, as well as consistent systematic assessments of symptoms and quality of life before and after surgery, should allow these treatment strategies derived from expert consensus to evolve toward evidence-based clinical practice guidelines.

Table 2. Comparison of Therapies for Primary Hyperhidrosis

Treatment	Cost ^a	Side Effects
Topical, 20% to 35% aluminum chloride	\$288+/year	Skin irritation, localized burning, stinging, desquamation, poor efficacy, temporary (lasts about 48 hours per application)
Iontophoresis (usually 20 mA 3 to 4 treatments a week for 30 to 40 minutes each)	\$500/device	Irritation, dryness or peeling of skin, burning or stinging during therapy, temporary (one treatment lasts 1 to 4 weeks). Not recommended for women who are pregnant or for persons with pacemakers or substantial implants (eg, joint replacements)
Oral therapy (glycopyrrolate, atropine, acetylcholine inhibitors)	\$240+/year	Dry mouth, dry eyes, constipation, mydriasis, difficulty urinating, blurry vision
Botulinum toxin (Botox A or B)	\$2,250/session	Pain from injections, muscle weakness, headache, hematoma, swelling, need for repeat procedures
Liposuction/VASER	\$3,000/session	Hematoma, superficial skin erosion, alopecia, paresthesia
Endoscopic thoracic sympathectomy	\$15,000	Compensatory hyperhidrosis, bradycardia, pneumothorax, postoperative pain, Horner's syndrome

^a Approximate cost in US dollars.

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