

# HYPERHIDROSIS AFTER SYMPATHECTOMY

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Alexander is a second-year medical student studying at the Royal Lancaster Infirmary (RLI). This article is a review of the effectiveness and side effects of sympathectomy for hyperhidrosis, completed as part of his Year Two studies.

## INTRODUCTION

Endoscopic thoracic sympathectomy (ETS) is a surgical procedure used to treat excessive sweating (hyperhidrosis). It involves severing the sympathetic chain, usually at the level of the second to fourth thoracic vertebrae. One reported side effect of sympathectomy is compensatory-hyperhidrosis (CHH), which in most patients is an acceptable side effect of the procedure. However, in some patients the severity of compensatory sweating can be more severe than the original hyperhidrosis, leading to a decreased quality of life. But how common is this seemingly trivial side effect? What treatments are available for compensatory sweating? This review will attempt to answer these questions.

## HYPERHIDROSIS: DEFINITIONS AND CLINICAL PRESENTATION

Hyperhidrosis (HH) is defined as excessive sweating, even at rest. The sweating can occur all over the body (generalised) or only in parts of the body (focal); regions affected commonly are the facial, palmar, axillary and plantar regions. HH is either primary or secondary. The mechanism by which primary HH is caused is not understood; it is thought to be caused by a mixture between genetic and environmental factors. Secondary HH can be caused by many disorders, such as acromegaly, anxiety conditions, glucose control disorders, hyperthyroidism, Parkinson's, Pheochromocytoma, spinal cord injury and many infections.<sup>(1)</sup> Secondary HH can be cured by treating the underlying disorder, therefore primary HH and its treatments will be focused upon in this review.

### How common is hyperhidrosis?

Compared to the vast amount of literature on the treatment of primary HH, there is little research reporting on the epidemiological rates of this condition. Reported prevalence rates range from 2%<sup>(2)</sup> to 2.9%<sup>(3)</sup>. Interestingly, prevalence rates in Japan have been reported to 'occur 20 times more frequently' in palmoplantar HH than in European ethnic groups.<sup>(4)</sup> A study in 2003 reported that 86% of patients started experiencing HH during infancy, 71.5% of patients with HH were female and 47.5% had a family history of HH.<sup>(5)</sup> More epidemiological research could aid advances in finding the pathological root of this condition.

HH (especially primary) is characterised by excessive sweating, more than required to maintain homeostatic

temperature regulation.<sup>(1)</sup> The 2003 study of 338 patients reported that 96.4% of patients had palmar HH, 80.7% reported plantar HH, 71.3% reported axillary HH; the paper also recorded that HH in other parts of the body (including plantar HH) were 'less frequent'.<sup>(5)</sup>

Diagnosis of HH is mostly based on the symptoms of the patient. Before primary HH is diagnosed the secondary causes must be ruled out. If examination and routine tests suggest no secondary cause, the possibility of primary HH can then be investigated.

### The symptoms of primary hyperhidrosis

Excessively sweaty palms and feet while resting and calm  
Sweat dripping from hands and/or feet constantly  
Patient expresses inability to carry out normal daily activities without embarrassment or anxiety due to sweating  
Excessive sweating isn't exacerbated or suppressed by emotional or lifestyle influences

An iodine-starch test can be used in the diagnostic stages, but this only identifies the location and extent of the sweating: an iodine solution is applied to the areas affected by HH, after this has dried starch is added to the area; the starch will turn dark blue where there is excessive sweat.

There are various treatments available for HH. These include:

- use of anticholinergics, such as oxybutynin, propantheline and glycopyrronium
- topical application of a metal salt, such as aluminium chloride, onto the affected area in aerosol form
- subcutaneous injection of botulinum toxin A or B into the skin of the affected area
- iontophoresis – the patient submerges their hands or feet into a shallow dish of slightly charged water. There is a low potential difference across the water; this is thought to 'short circuit' the nerve endings that supply the sweat glands of the integument, decreasing sweat output

### What is sympathectomy?

Sympathectomy is a surgical treatment used to treat HH sufferers who have not responded adequately to treatment. The operation severs the sympathetic chain between the levels of vertebrae T2-T5. The nerves that supply the apocrine and eccrine sweat glands of the skin derive from the sympathetic chain; therefore, severing the chain will inhibit neural stimulation of the sweat glands. The procedure involves entering the thoracic cavity endoscopically and severing the sympathetic chain by removing/destroying the sympathetic ganglion and the superior and inferior trunks

(although the extent to which the ganglia are destroyed can differ according to the extent of HH).

The sympathetic chains lie on the posterior wall of the thoracic cavity deep to the parietal pleura. The sympathetic chain is a gangliated cord that runs parallel to the vertebral column. The sympathetic chain distributes the sympathetic neurons to their level of innervation. The preganglionic sympathetic neurons will synapse with its postganglionic sympathetic neuron in the ganglia of the sympathetic chain. The rationale behind severing the sympathetic chain is thus: some of the postganglionic sympathetic neurons that leave the sympathetic chain enter the peripheral nervous system and eventually innervate sweat glands of the skin. If the chain is severed at a certain level, no sympathetic neurons will join the peripheral nervous system to innervate the area afflicted with HH, almost completely inhibiting sweating.

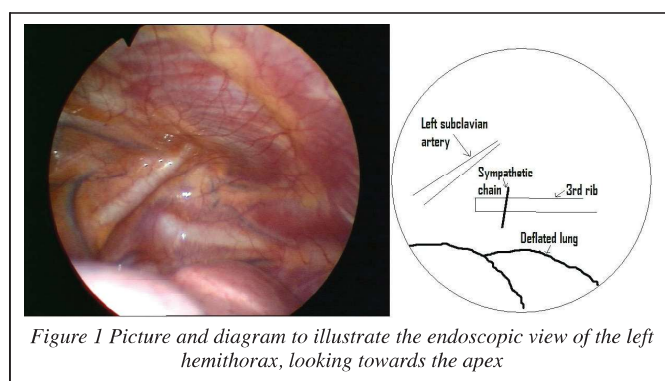
The sympathectomy will usually take place in the following way:

1. The patient is anaesthetised with a double-lumen tube (to allow for single lung deflation) and placed in a supine position with arms abducted to 60-70°.
2. Two 5mm incisions over the 2nd and 3rd or 4th ICS mid axillary line are made.
3. An artificial pneumothorax is made with the insufflation of carbon dioxide into the pleural cavity.

#### Risks of single-lung anaesthesia

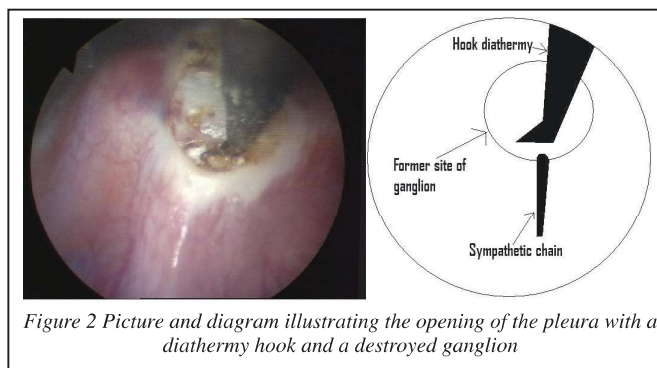
- Dislodgement of ventilating tube in bronchus
- Development of a pneumothorax on ventilated side
- Hypoxia – caused by development of a right to left shunt

4. Through the 3rd/4th ICS, a 5mm thoracoscope is inserted through a cannula.
5. The 2nd, 3rd and 4th ribs are identified.

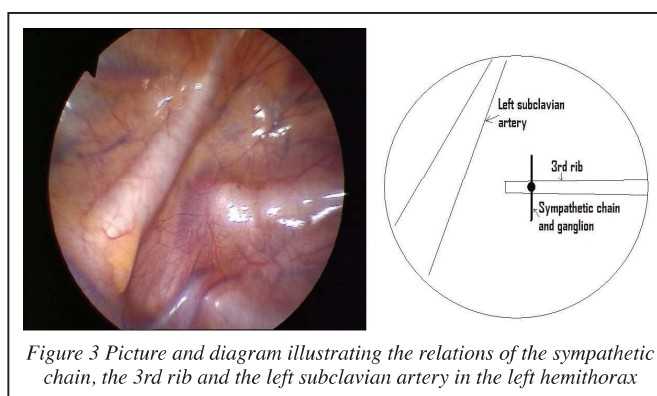


6. A diathermy device is inserted through the 2nd ICS incision via a cannula.
7. The sympathetic chain and ganglia are identified by their glistening appearance and by gently 'rubbing' over the expected site and identifying the chain above and below moving together.
8. The highest ganglion to be operated on first is diathermised (avoids Horner's syndrome).

9. The overlying pleura is diathermised to reveal the ganglion.
10. The ganglion is diathermised (as much as is possible).
11. If any of the ganglion still remains, the hook of the diathermy device is used to 'lift' the ganglion away from the posterior thoracic cavity. The ganglion is diathermised to sever the chain.



12. If preferred, the superior and/or the inferior sympathetic trunks can be diathermised too (any surrounding vascular or nervous structures must be avoided as excessive bleeding or damage can occur).
13. The remaining ganglia to be operated on can be cut or diathermised (medial to the right chain is the large azygos vein and medial to the left chain are the intercostal veins; take care not to damage this as excessive bleeding will occur).
14. The scissors and cannula are removed, and then the lung is re-inflated by the anaesthetist.
15. A chest X-ray radiograph is performed to note any remaining residual pneumothorax.
16. If stable, the patient can be discharged the next day.



A side effect following sympathectomy is CHH (excessive sweating) in other parts of the body. Although the actual aetiology of compensatory sweating is unknown, there are some theories on its mechanism. One theory is that primarily, the patient has an overactive sympathetic nervous system that is only 'expressed' in the integumentary sweat glands, maybe due to increased acetylcholine in the post or preganglionic neurones (thus leading to the presentation of HH); after the ETS procedure the increased acetylcholine and an overactive

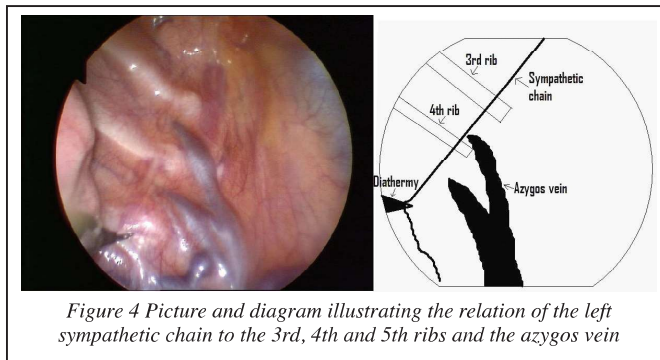


Figure 4 Picture and diagram illustrating the relation of the left sympathetic chain to the 3rd, 4th and 5th ribs and the azygos vein

sympathetic system are 'diverted' from the palmar and axillary regions to the trunk, leading to increased stimulation of the trunk's eccrine sweat glands.

## RATES AND CHARACTERISTICS OF CHH

There is much research on the rates of CHH following ETS; however, the research fails to arrive at an agreed rate (the rates vary considerably from 0%<sup>(6)</sup> to 98.6%<sup>(7)</sup>). It has been reported that CHH occurs more commonly in women and patients who had more severe cases of HH before the sympathectomy. Is the CHH a reaction to the sympathectomy or is it merely a diversion of sympathetic activity? Large studies may provide an insight into this link. It could be that the wide-ranging levels of CHH reported are due to there being no international definition of CHH, making comparison of reported levels difficult.

A correlation between the level of ETS and rates of CHH has been reported. One study reported that patients who had a sympathectomy at the level of T2 had a 43% rate of CHH, whereas the patients that had a sympathectomy at the level of T5 had a rate of 0% for CHH.<sup>(8)</sup> Other studies have also come to the same conclusion – one reported that of 72 patients who underwent a T2-T3 sympathectomy, 71 (98.6%) reported CHH.<sup>(7)</sup> However, a rate of 22% has been reported.<sup>(9)</sup> Could sympathectomies at a lower level reduce the risk of CHH? Studies concentrating on this subject could be very useful.

Although there is substantial literature available on the rates of CHH following ETS, it seems as if the data on the location of CHH on the patient is minimal. It has been reported that 50% of CHH occurs on the trunk,<sup>(10)</sup> agreeing with other available research. What does this suggest about the pathology behind CHH? Studies suggest that CHH is a cause of dissatisfaction in patients who have undergone ETS. Overall, there is a high satisfaction rate of patients following ETS: in one study, 11 (93%) of patients were satisfied with the results.<sup>(11)</sup> The patients who aren't satisfied (usually around 10%) report to be dissatisfied due to CHH.

Depression seems to be a feature associated with CHH. Clinical depression from CHH, described as being 'more disabling than his previous condition as it affected a larger body surface area', has been reported.<sup>(12)</sup> CHH must certainly decrease a patient's quality of life, but to what extent? Do the patients simply feel dissatisfied or do a large proportion of CHH sufferers become depressed? A large study into this aspect of the treatment would surely benefit the psychological treatment of this class of patients.

With the available literature it is possible to deduce various methods to avoid the development of CHH in a patient

presenting with HH by carefully administering various treatments.

In terms of avoiding CHH by altering the technique of ETS, there are variations of the procedure that have been reported to decrease the rate of CHH occurrence. Although there are some papers that report no correlation between ETS level and different rates of CHH,<sup>(6)</sup> many papers have reported a lower rate of CHH with a sympathectomy at a lower level. Therefore, if surgeons were to first only operate on the T4 ganglion for palmar and axillary HH, then operate again if the HH hasn't been reduced, a decrease in CHH occurrence rates may be obtained. Another alternative is if only one ganglion is destroyed between T2 and T4. If the sympathectomy is less extensive, then the rate of CHH occurrence is lower.

It has been reported that a raminectomy (division of the rami communicantes) leads to a lower rate of CHH occurrence in patients than a sympathectomy of the whole ganglion. The studied patients who underwent a raminectomy experienced less, but still satisfactory, reduction in their original sweating but significantly lower rates of CHH (15.5%) than the T2 sympathectomy group (43.3%).<sup>(13)</sup>

Recently, reports regarding the role of the nerve of Kuntz in CHH have emerged. The Kuntz nerves run from the 2nd, 3rd and 4th sympathetic chain to the brachial plexus; these have been reported to be present in 48.1% of patients.<sup>(14)</sup> It may be that these nerves (if present and intact after ETS) form another route through which postganglionic sympathetic fibres can travel, thus innervating the regions supplied by sympathetic fibres running through the T2-T4 ganglia. Studies into their resection and CHH rates may prove useful towards finding a mechanism for CHH.

CHH could be avoided by cutting the sympathetic trunks of a ganglion only and leaving the corresponding ganglion intact (sympathotomy). This method was described in a study that found there was no reported CHH, but still there was 100% reduction of palmar HH in varying extents (55% complete cessation, 40% marked reduction, 5% decreased sweating).<sup>(15)</sup> This would be a straight forward modification to the usual sympathectomy method employed by many surgeons.<sup>(15)</sup>

In 2003, ETS was banned in Sweden (where the procedure was invented) due to influence from many pressure groups that based their complaints on the occurrence of CHH; if definitive methods aren't found to reduce the risk of CHH after ETS the procedure may fall into disrepute in many other countries too, denying many HH sufferers relief from their condition.

## TREATMENTS OF CHH

At the moment, no commonly used methods exist tailored to specifically treat CHH. Therefore, the same treatments used to treat primary HH are used to treat CHH (except for iontophoresis, due to practical applications to the trunk).

### Medications

Anticholinergic drugs such as propantheline and glycopyrronium have had reported use to treat CHH with variable rates of efficacy. In general use this class of drugs brings the risk of serious side effects such as dry mouth, blurred vision, impaired speech, urinary retention,

constipation and palpitations. Two patients with generalised HH (one with CHH following ETS) experienced reduced sweating with 2.5mg of oxybutynin three times a day.<sup>(16)</sup> Therefore, although the literature is very scarce on the subject of oxybutynin treatment for HH and CHH, it may prove useful for a longterm research study to be carried out into the subject.

There is very little available research into the use and efficacy of oral propantheline. Two cases of quadriplegic patients who experienced profuse sweating had this condition controlled (decreased frequency of episodes and severity) by daily propantheline (the doses were not reported).<sup>(17)</sup> Again, this is too little material on which to form a conclusion of this treatment; larger studies must be used to investigate propantheline as a possible treatment for CHH.

Two milligrams of oral glycopyrronium can lead to a decrease in the patient's HH with minimal side effects (xerostomia in only one patient).<sup>(18)</sup> This study shows that there may be a potential for glycopyrronium as an effective treatment for HH and CHH, therefore more studies on the same subject are needed.

Thus, pharmacological treatments have been reported to be effective in treating HH, therefore there is a possibility of using medications to treat CHH following ETS; however, without a sizeable body of research on the subject no definite conclusions can be made.

#### Antiperspirant sprays

Antiperspirant aerosols containing metal salts, such as aluminium chloride, have been used to treat HH and CHH. The sprays function by the metal salts blocking the sweat pores after being topically applied to the affected area. Another accepted mechanism by which this treatment functions is that the metal salt combines with the intraductal keratin of the eccrine gland, thus leading to a fibrillar contraction effectively blocking the duct. The antiperspirants usually contain 20% metal salt with 80% alcohol.<sup>(19)</sup> Application usually leads to irritation and eventual damage to the surrounding skin.<sup>(19)</sup> Of the available research, it seems as if the effectiveness of this treatment is overshadowed by the side effects (most notably skin irritation) and longterm ineffectiveness.

#### Botulinum toxin

Botulinum (A and B) has only been used to treat focal HH in recent years; however, there is a great deal of available literature regarding its effectiveness. Botulinum injections can be either carried out while under anaesthetic (usually for larger areas, such as the trunk) or even while the patient is awake (for palmar or axillary HH). The botulinum toxins work by binding to protein complexes, SNARE complexes – proteins in the membrane of the presynaptic knob that allow vesicle exocytosis. This will lead to a reduction in sympathetic stimulation of the surrounding sweat glands and sweat release. Botulinum injections are usually indicated for axillary HH, although injections can of course be administered anywhere on the body where excessive sweating (idiopathic or CHH) occurs.

Available research shows that botulinum A injections give patients a reduction of 70-80% in axillary regions, with this effect lasting for around 4-16 months.<sup>(20)</sup> Although botulinum injections seem like an appealing and convenient solution to excessive sweating, the cost (£128.93 for one 100-unit vial)

and the pain of the frequent injections and no prospect of a permanent cure can urge patients towards considering surgical options.

Therefore, with regards to available treatments for CHH, it seems as if the non-pharmaceutical options are the most effective, with botulinum toxin injections having the best results. It would therefore be advised that patients presenting with CHH should be treated with antiperspirants and then botulinum toxin injections if the first treatment isn't effective.

## CONCLUSION

Research indicates that CHH is a serious side effect to sympathectomy; serious due to its implications for the patient as opposed to the incidence rates. Research suggests that there are some operative methods to reduce the rates of CHH occurrence, although more research is required in this field. The available treatments are effective, but further research may lead to enhancement and removal of side effects. Therefore, if sympathectomy is considered for any patient, the possibility of HH should be explained fully to the patient, to make their decision fully informed.

## ACKNOWLEDGEMENTS

Pictures and diagrams reproduced with kind permission of Mr P. Wilson.

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## Tutor of the Year Award

The *MBMJ* prize for the *Tutor of the Year* is a newly established prize which is intended to go to a senior doctor (consultant or SpR) who has significantly contributed to the educational and/or personal development of the Foundation doctors. The winner is decided by the trainee doctors through a nomination process carried out by themselves. This year's nomination is Dr Chris Till, by what we understand was a considerable margin. Described by the trainees as 'a man with commitment, energy and ability', 'a very entertaining and informative teacher, who has a broad base of knowledge', and 'has a genuine concern for the individual welfare of the junior doctors and is always approachable', Chris has added success in his role as Foundation Tutor to his other educational roles within the Department of Anaesthesia and the Royal College of Anaesthetists. The editor hopes that the establishment of this award – currently priced, though valued more, as a bottle of wine – will encourage dialogue between postgraduate trainee doctors and their tutors.



Man at the helm: Foundation Tutor, Dr Chris Till

The editor thanks Dr Abdulkani Yusuf for organising this prize.