DOI: 10.1111/pde.14273

Pediatric Dermatology WILEY

Thoracoscopic sympathicotomy for the treatment of intolerable palmar and axillary hyperhidrosis in children is associated with high recurrence rates

Arjan J. F. P. Verhaegh MD[1] | Michiel Kuijpers MD[1] | Maartje Boon MD, PhD[2] | Mike J. L. DeJongste MD, PhD[3] | Wobbe Bouma MD, PhD[2] | Massimo A. Mariani MD, PhD[1] | Theo J. Klinkenberg MD, PhD[1]

[1]Department of Cardiothoracic Surgery, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

[2]Department of Neurology, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

[3]Department of Cardiology, University of Groningen, University Medical Center Groningen, Groningen, The Netherlands

Correspondence
Arjan J. F. P. Verhaegh, MD, University Medical Center Groningen (UMCG), Hanzeplein 1, P.O. Box 30001, 9700 RB Groningen, The Netherlands.
Email: a.j.f.p.verhaegh@umcg.nl

Abstract

Background: Treatment of palmar and axillary primary focal hyperhidrosis (PFH) in children up to 16 years using thoracoscopic sympathicotomy is supported by scarce evidence. Therefore, this study aimed to summarize the results of our standardized bilateral, one-stage, single-port sympathicotomy (BOSS) in children up to 16 years of age.

Methods: Consecutive children (n = 14) up to 16 years of age undergoing BOSS between October 2011 and June 2015 in our institution were included in this retrospective study.

Results: Recurrence of primary hyperhidrosis was noted in seven patients (50.0%), of whom five patients (35.7%) underwent reoperation. Reoperations were associated with placement of additional thoracoscopic ports (n = 1; 12.5%), intraoperative placement of pleural drains (n = 2; 25%), and prolonged air leak (n = 1; 12.5%). Despite the high recurrence and reoperation rates, overall patient satisfaction was high with a median satisfaction score of 7.5 (interquartile range of 1.75; range: 4-9).

Conclusion: Although the overall patient satisfaction score in our cohort was good, BOSS for the treatment of intolerable palmar and axillary PFH in children up to 16 years of age is associated with a high recurrence and reoperation rate.

KEYWORDS
children, complications, primary focal hyperhidrosis, recurrence rate, reoperation, thoracoscopic sympathicotomy

1 | INTRODUCTION

Primary hyperhidrosis is a dermatologic condition characterized by excessive sweating beyond that needed for physiologic thermoregulation, without an underlying systemic condition.[1] Primary hyperhidrosis usually affects one or more distinct body sites and, therefore, is also referred to as primary focal hyperhidrosis (PFH).[2] PFH has a wide range of reported estimated prevalence,[3-5] with the most widely cited population prevalence estimate of 2.8%.[4] A recent study estimated population prevalence at 1 to 1.6% for patients

seeking treatment of hyperhidrosis.[6] Men and women are affected equally, and in the majority of patients, the condition starts during childhood or adolescence.[1,2]

Although PFH is considered a benign disorder, it is often detrimental to a patient's social, professional, psychologic, and physical well-being with severe impairment of health-related quality of life.[7-9] Moreover, constant wetness of the skin can lead to physical effects, including skin infections.[10] Nonsurgical treatment options, such as topical solutions, iontophoresis, anticholinergic medications, and botulinum toxin injections, have been proven helpful to offer temporary relief of PFH. However, these treatments require a high level of adherence due to the necessity for repeated application and strain health care resources because of their temporary effect. Therefore, thoracoscopic sympathicotomy has become a well-established treatment modality in the treatment of palmar and axillary PFH.[11-14]

However, little is known about the results and prognosis of thoracoscopic sympathicotomy in children, especially as PFH often reveals itself during childhood.[15-17] Recently, a retrospective analysis of bilateral thoracoscopic sympathicotomy in "children" aged 11 to 19 years showed good results with no recurrence of PFH during follow-up and advocated bilateral thoracoscopic sympathicotomy as a safe and effective treatment for palmar PFH in children.[17] Because the impact of PFH on the developing life of minors may even be greater and neuroregeneration by Schwann cell plasticity is especially seen in young children, we used an age limit of 16 years.[18,19] This study aimed to summarize the results of our standardized bilateral, one-stage, single-port sympathicotomy (BOSS) in children up to 16 years of age in the treatment of intolerable palmar and axillary PFH.

2 | MATERIALS AND METHODS

2.1 | Study sample and data collection

Between October 2011 and June 2015, all children up to 16 years of age undergoing a BOSS procedure at the University Medical Center Groningen were included in this study. A diagnosis of primary focal hyperhidrosis was made according to the diagnostic criteria described by Hornberger et al.[20] The Hyperhidrosis Disease Severity Scale (HDSS) was used for adequate selection of patients preoperatively (Figure 1). In our practice, severe interference of PFH with daily life and a preoperative HDSS of 4, classifying PFH as intolerable, were mandatory to qualify for surgery. All children and parents were extensively informed regarding the potential side effects of the procedure such as wound infection (including pleural empyema), pneumothorax and prolonged air leak (requiring pleural drainage), bleeding/pleural effusion, Horner syndrome, pain, and compensatory hyperhidrosis.

The hospital records of all included children undergoing BOSS were retrospectively reviewed to compile a comprehensive database including preoperative, intraoperative, and postoperative data. Moreover, telephone follow-up was performed in 2019 to identify any post-discharge problems and collect both HDSS, compensatory hyperhidrosis (CH), and overall satisfaction rates. The medical ethics committee of the hospital waived the need for informed consent because these data were collected as part of routine medical care in our hospital.

2.2 | Study objective

The objective of this study was to assess the intra/postoperative morbidity and efficacy of BOSS in the treatment of intolerable palmar and axillary PFH in a group of consecutively treated children up to 16 years old. Intraoperative complications, such as bleeding, placement of additional thoracoscopic ports, or conversion to thoracotomy, were assessed. Moreover, postoperative morbidity, including pleural effusion, wound-related problems or infections, pneumothorax requiring pleural drainage, prolonged air leak (more than 5 days after surgery), and Horner syndrome, was analyzed. Efficacy was measured using postoperative HDSS, CH, and recurrence rates of PFH, including necessity for reoperation.

2.3 | Surgical technique

Our surgical technique (Figure 2) has been previously published in detail, and operations were performed by two surgeons (MK and TJK).[14] Patients were placed in beach chair or semi-Fowler's position, in which the patient was seated at a 45° angle above the horizontal plane with outstretched arms. General anesthesia was administered, and a single lumen endotracheal tube was placed. Following local anesthetic infiltration with bupivacaine, a 7-mm incision was made in the anterior axillary line and third intercostal space. After initiation of apnea, a 5-mm inner diameter trocar was inserted. CO_2 insufflation was used only when spontaneous collapse of the lung proven to be insufficient. A 5-mm scope (KARL STORZ, Tuttlingen, Germany) and cautery hook were then introduced. The first and second ribs,

HDSS class

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

FIGURE 1 Hyperhidrosis Disease Severity Scale (HDSS)

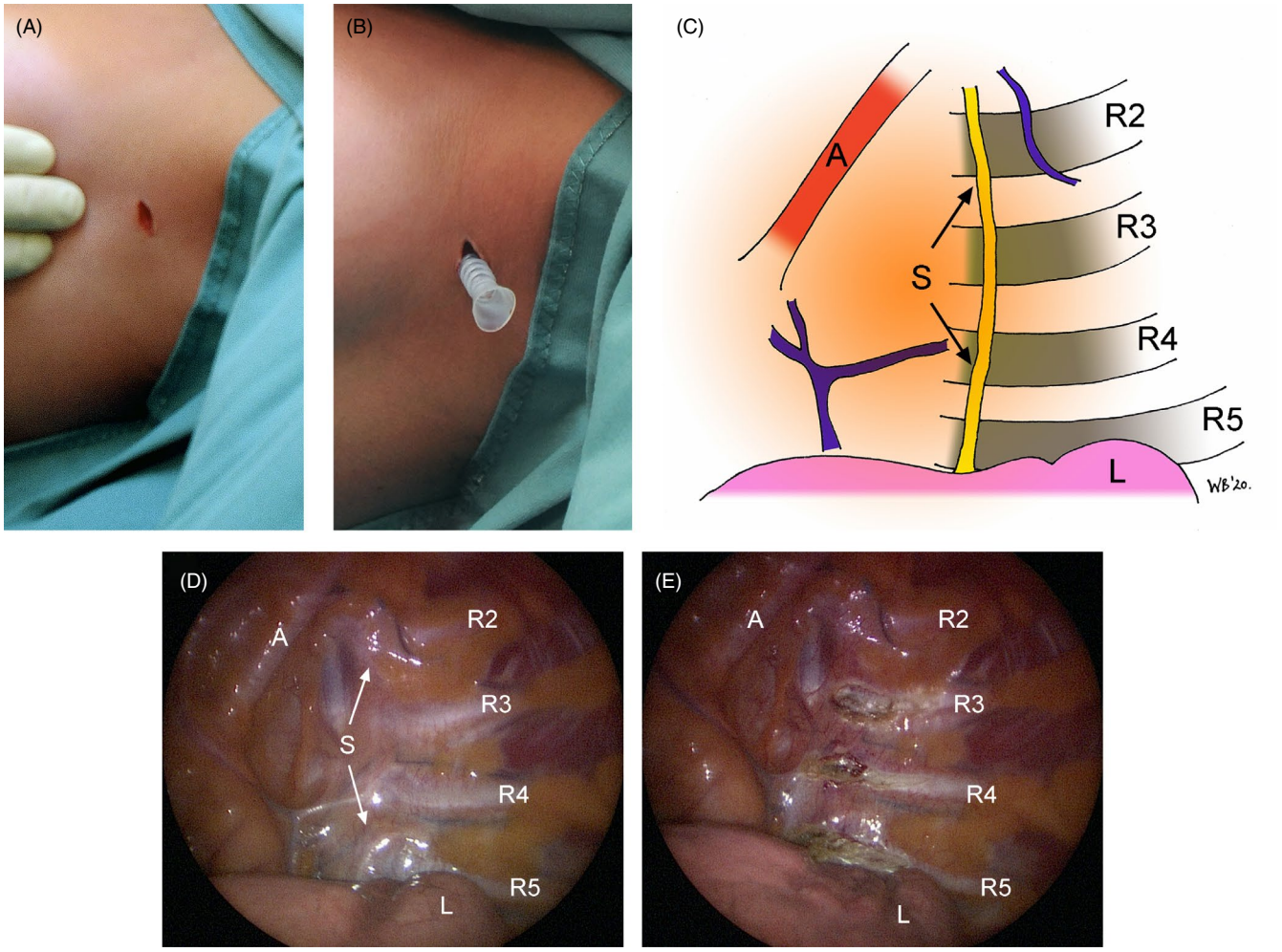

FIGURE 2 Intraoperative pictures and schematic overview of bilateral, one-stage, single-port sympathicotomy (BOSS). A, Left axillary incision (7 mm) for BOSS. B, Thoracoscopic port (5 mm inner diameter) placement for BOSS. C, Schematic overview of the left subclavian artery (A), the sympathetic chain (S) running along the neck of the ribs (R), and a collapsed left lung (L). D, Thoracoscopic view of the left subclavian artery (A), the sympathetic chain (S) running along the neck of the ribs (R), and a collapsed left lung (L). E, Thoracoscopic view after completion of a R3-R5 sympathicotomy

as well as the sympathetic chain running along the necks of the ribs, were identified. The part of the sympathetic chain overlying the rib (R-level) was transected by diathermy on a high costal level, theoretically sparing the sympathetic ganglia. A R3 sympathicotomy was performed for isolated palmar PFH and a R3-R5 sympathicotomy for isolated axillary or combined palmar/axillary PFH. Accessory nerve fibers, including Kuntz's nerves, reach the brachial plexus without passing through the sympathetic trunk and are thought to be responsible for poor surgical outcome. So, in all cases the transection was extended 2 cm laterally over the costal surface to transect accessory nerve fibers, including Kuntz's nerves, to improve surgical outcome. After completion of the surgical procedure, the absence of parenchymal damage was ascertained by inspection of the collapsed lung and an 8 French thoracic drain was inserted through the same access port. Re-insufflation and recruitment of the collapsed lung were performed under direct vision. The thoracic drain was removed under positive end-expiratory pressure (30 cmH_2O). A thoroughly placed subcutaneous purse-string suture ensured airtight incision sealing. The skin was closed with an intracutaneous suture. The same procedure was repeated on the left side.

2.4 | Statistical analysis

Quantitative results were presented as median and interquartile range (IQR), while categorical data were expressed as numbers and percentages (%). All statistical analyses were performed using IBM SPSS Statistics 22 software (IBM Inc, Armonk, NY, USA).

3 | RESULTS

3.1 | Demographics and baseline characteristics

Between October 2011 and June 2015, fourteen consecutive children up to 16 years of age underwent a BOSS procedure at the

TABLE 1 Overview of pre- and intraoperative baseline characteristics

Variable	Value
Female	11 (78.6%)
Age at operation (years)	14.5 (2.25)[a]
Prior thoracic surgery	2 (14.3%)
Form of primary focal hyperhidrosis (PFH)	
Isolated palmar	9 (64.3%)
Isolated axillary	2 (14.3%)
Combined palmar and axillary	3 (21.4%)
Preoperative HDSS	
Class 1	0 (0.0%)
Class 2	0 (0.0%)
Class 3	0 (0.0%)
Class 4	14 (100.0%)
Level of sympathicotomy	
R3	9 (64.3%)
R3-R5	5 (35.7%)

Note: Prior thoracic surgery included a right-sided thoracotomy for esophageal repair (n = 1) and a left-sided thoracotomy for coarctectomy and pulmonary artery banding (n = 1).

[a] The data that are presented as median and interquartile range (IQR).

University Medical Center Groningen. Table 1 depicts patient demographics for this patient cohort. Female patients (n = 11; 78.6%) were overrepresented in this cohort, and median age at operation was 14.5 years (with an interquartile range of 2.25 years). Most children (n = 9; 64.3%) suffered from isolated palmar PFH, and therefore, the predominant level of sympathicotomy was R3.

3.2 | Intra- and postoperative outcome measurements

As shown in Table 2, conversion to a thoracotomy or placement of additional thoracoscopic ports was not required in any patient. Severe complications, such as bleeding or Horner syndrome, were not observed either. In one patient (7.1%), a pleural drain was placed intraoperatively due to the need for extensive right-sided adhesiolysis (due to prior right-sided thoracotomy for esophageal repair) and kept in situ for one day. Postoperative pneumothorax requiring pleural drainage did not occur. One patient (7.1%) developed a superficial wound infection requiring antibiotic treatment. The median hospital stay was one day (interquartile range of 0.0 days; range: 1-2 days) with three "day-care" procedures.

3.3 | Long-term follow-up and recurrence

Recurrence of PFH was noted in seven patients (50.0%), of whom five patients (35.7%) were reoperated (Table 3). In total, eight

TABLE 2 Overview of intra- and postoperative outcome measurements

Variable	Value, n = 16 (100%)
Placement of additional thoracoscopic ports	0 (0.0%)
Conversion to thoracotomy	0 (0.0%)
Intraoperative bleeding	0 (0.0%)
Postoperative pleural effusion	0 (0.0%)
Postoperative pleural drainage	1 (7.1%)
Pneumothorax	0 (0.0%)
Wound-related problems	1 (7.1%)
Horner syndrome	0 (0.0%)
Hospital length of stay (days)	1 (0.0)[a]
Day-care procedures	3 (21.4%)

[a] The data that are presented as median and interquartile range (IQR).

TABLE 3 Long-term follow-up data

Variable	Value
Postoperative HDSS	
Class 1	5
Class 2	4
Class 3	1
Class 4	0
Compensatory hyperhidrosis (CH)	
None	4
Mild	5
Moderate	1
Severe	0
Intolerable	0
Satisfaction (0-10)	7.5 (1.75)[a]
Recurrence	
Total	7 (50.0%)
R3 (n = 9)	5 (55.6%)
R3-R5 (n = 5)	2 (40.0%)
Pattern of recurrence	
Unilateral	1 (14.3%)
Bilateral	6 (85.7%)
Reoperation	
Number of patients with reoperation	5 (35.7%)
Number of reoperations	8
Hospital length of stay (days)	1 (0.75)
Postoperative pleural drainage	2 (25%)
Prolonged air leak	1 (12.5%)

Note: Data on postoperative HDSS, compensatory hyperhidrosis (CH), and overall patient satisfaction were missing in four patients. In total, eight reoperations were performed in five patients (two patients with multiple reoperations).

[a] The data that are presented as median and interquartile range (IQR).

reoperations were performed. Three patients were reoperated once, one patient was reoperated twice, and one patient was reoperated three times. In one reoperation procedure, an additional thoracoscopic port had to be placed to perform extensive adhesiolysis. In two reoperation procedures, a pleural drain was placed intraoperatively due to the need for extensive adhesiolysis. One drain was kept in situ for one day, whereas the other drain was kept in situ for 25 days due to prolonged air leak. Complications, such as bleeding, wound-related problems, and Horner syndrome, were not seen in reoperations. The median hospital stay was one day (interquartile range of 0.75 days; range: 1-26 days).

Long-term follow-up data (Table 3) were missing in four patients (28.6%). At postoperative telephone follow-up, five patients were in HDSS class 1 (one patient after reoperation), four patients in HDSS class 2 (three patients after one or more reoperation[s]), and one patient in HDSS class 3 (patient declined reoperation despite bilateral recurrence). Thus, patients with recurrence of hyperhidrosis, regardless of reoperation, report higher postoperative HDSS in comparison with patients not experiencing recurrent hyperhidrosis. No patients remained in HDSS class 4. Subsequently, nine patients reported a ≥2-point reduction in HDSS and one patient a 1-point reduction in HDSS associated with a 50% reduction in sweat production.

CH was rated absent in four patients, as mild by five patients and as moderate by one patient. No severe or intolerable CH was reported. Affected body areas were lower back in three patients, legs/feet in one patient, face in one patient, and anal cleft in one patient. Despite the high recurrence and reoperation rates, overall patient satisfaction was high with a median satisfaction score of 7.5 (interquartile range of 1.75; range: 4-9).

4 | DISCUSSION

Although considered a benign disorder, PFH severely impairs a patient's well-being with a negative effect on health-related quality of life.[7-9] The impact of PFH on the developing life of minors may even be greater. Thoracoscopic sympathicotomy plays an indispensable role in the treatment of palmar and axillary PFH.[11-13] However, the evidence concerning results and efficacy of thoracoscopic sympathicotomy in children up to 16 years of age is scarce if not absent.[15-17]

In this study, we found a high recurrence rate with the need for reoperations in children up to 16 years of age who underwent BOSS for the treatment of intolerable palmar and axillary PFH. Reoperations were associated with placement of additional thoracoscopic ports, intraoperative placement of pleural drains, and prolonged air leak. Despite the high recurrence and reoperation rates, overall patient satisfaction was high with a median satisfaction score of 7.5.

The high recurrence and reoperation rates following thoracoscopic sympathicotomy in children up to 16 years of age, as found in our study, are not consistent with the previous research. Three previous studies concerning thoracoscopic sympathicotomy in children showed good results with no recurrence of PFH and low rates of CH during follow-up advocating early surgical treatment in children with PFH.[15,17,21] However, these studies included "children" with ages up to 17, 19, and 21 years, respectively. We hypothesize that the high recurrence rate of PFH following thoracoscopic sympathicotomy in children, as found in our study, might be attributed to so-called neuroplasticity and neuroregeneration by Schwann cell plasticity, which is especially seen in (young) children.[18,19] This hypothesis might also explain, why recurrence of PFH was seen to a lesser extent in previous studies including "children" with ages up to 17, 19, and 21 years, respectively, and our adult cohort. The predominantly found bilateral recurrence pattern (n = 6; 85.7%) supports this neuroregeneration hypothesis as well. Technical inadequacy is possible, but regarded unlikely, since an exactly similar operative technique (BOSS) provided excellent results in our adult cohort.[14]

Owing to its retrospective nature and nonrandomized design, our study could be hampered by information and selection bias. Nevertheless, all data were collected in a comprehensive database using established definitions. In addition, the study sample size was relatively small, as a logical consequence of our reticence to operate on children up to 16 years of age for the treatment of palmar and axillary PFH due to high recurrence and reoperation rates. Although a larger number of patients would be preferable to guarantee more indisputable evidence, our study shows interesting long-term results in the absence of large, prospective, and randomized-controlled comparisons.

Ideally, surgical treatment of palmar and axillary PFH using BOSS is postponed to the age of 17 years or older in our institution, especially in view of the excellent results of BOSS for the treatment of palmar and axillary PFH in adults.[14] Therefore, we advocate great caution when considering sympathetic denervation in children up to 16 years of age for the treatment of palmar and axillary PFH.

ETHICAL APPROVAL

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

ORCID

Arjan J. F. P. Verhaegh https://orcid.org/0000-0002-8486-5217

REFERENCES

1. Stashak AB, Brewer JD. Management of hyperhidrosis. *Clin Cosmet Investig Dermatol*. 2014;7:285-299.
2. Benson RA, Palin R, Holt PJ, Loftus IM. Diagnosis and management of hyperhidrosis. *BMJ*. 2013;347:f6800.
3. Stefaniak T, Tomaszewski KA, Proczko-Markuszewska M, Idestal A, Royton A, Abi-Khalil C. Is subjective hyperhidrosis assessment sufficient enough? Prevalence of hyperhidrosis among young Polish adults. *J Dermatol*. 2013;40(10):819-823.

4. Strutton DR, Kowalski JW, Glaser DA, Stang PE. US prevalence of hyperhidrosis and impact on individuals with axillary hyperhidrosis: results from a national survey. *J Am Acad Dermatol*. 2004;51(2):241-248.
5. Wohl Y, Freidman T, Brenner S, Bar DY. Screening for common dermatologic disorders amongst Israeli adolescents. *Int J Dermatol*. 2007;46(10):1046-1049.
6. Ricchetti-Masterson K, Symons JM, Aldridge M, et al. Epidemiology of hyperhidrosis in 2 population-based health care databases. *J Am Acad Dermatol*. 2018;78(2):358-362.
7. Amir M, Arish A, Weinstein Y, Pfeffer M, Levy Y. Impairment in quality of life among patients seeking surgery for hyperhidrosis (excessive sweating): preliminary results. *Isr J Psychiatry Relat Sci*. 2000;37(1):25-31.
8. Gross KM, Schote AB, Schneider KK, Schulz A, Meyer J. Elevated social stress levels and depressive symptoms in primary hyperhidrosis. *PLoS One*. 2014;9(3):e92412.
9. Kouris A, Armyra K, Christodoulou C, Karimali P, Karypidis D, Kontochristopoulos G. Quality of life in patients with focal hyperhidrosis before and after treatment with botulinum toxin A. *ISRN Dermatol*. 2014;2014:308650.
10. Walling HW. Primary hyperhidrosis increases the risk of cutaneous infection: a case-control study of 387 patients. *J Am Acad Dermatol*. 2009;61(2):242-246.
11. Ahn SS, Wieslander CK, Ro KM. Current developments in thoracoscopic sympathectomy. *Ann Vasc Surg*. 2000;14(4):415-420.
12. Cerfolio RJ, De Campos JRM, Bryant AS, et al. The Society of Thoracic Surgeons expert consensus for the surgical treatment of hyperhidrosis. *Ann Thorac Surg*. 2011;91(5):1642-1648.
13. Milanez de Campos JR, Kauffman P, de Campos Werebe E, et al. Quality of life, before and after thoracic sympathectomy: report on 378 operated patients. *Ann Thorac Surg*. 2003;76(3):886-891.
14. Kuijpers M, Klinkenberg TJ, Bouma W, DeJongste MJ, Mariani MA. Single-port one-stage bilateral thoracoscopic sympathicotomy for severe hyperhidrosis: prospective analysis of a standardized approach. *J Cardiothorac Surg*. 2013;8:216.
15. Laje P, Rhodes K, Magee L, Klarich MK. Thoracoscopic bilateral T3 sympathectomy for primary focal hyperhidrosis in children. *J Pediatr Surg*. 2017;52(2):313-316.
16. Sinha CK, Kiely E. Thoracoscopic sympathectomy for palmar hyperhidrosis in children: 21 years of experience at a tertiary care center. *Eur J Pediatr Surg*. 2013;23(6):486-489.
17. Vasconcelos-Vastro S, Soares-Oliveira M, Tuna T, Borges-Dias M. Thoracoscopic sympathotomy for palmar hyperhidrosis: How young is too young? *J Pediatr Surg*. 2019;S0022-3468(19)30887-5. https://doi.org/10.1016/j.jpedsurg.2019.11.024
18. Jessen KR, Mirsky R, Lloyd AC. Schwann cells: development and role in nerve repair. *Cold Spirng Harb Perspect Biol*. 2015;7(7):a020487.
19. Painter M, Brosius Lutz A, Cheng Y-C, et al. Diminished Schwann cell repair responses underlie age-associated impaired axonal regeneration. *Neuron*. 2014;83(2):331-343.
20. Hornberger J, Grimes K, Naumann M, et al. Recognition, diagnosis and treatment of primary focal hyperhidrosis. *J Am Acad Dermatol*. 2004;51(2):274-286.
21. Imhof M, Zacherl J, Plas EG, Herbst F, Jakesz R, Függer R. Long-term results of 45 thoracoscopic sympathicotomies for primary hyperhidrosis in children. *J Pediatr Surg*. 1999;34(12):1839-1842.

How to cite this article: Verhaegh AJFP, Kuijpers M, Boon M, et al. Thoracoscopic sympathicotomy for the treatment of intolerable palmar and axillary hyperhidrosis in children is associated with high recurrence rates. *Pediatr Dermatol*. 2020;37:987–992. https://doi.org/10.1111/pde.14273