

Shall We Score? The SHALL-WE Score for Optimizing Sclerotherapy in Superficial Lymphatic Malformations

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Abstract

Purpose

No standardized tool guides the decision of when to escalate beyond sclerotherapy in lymphatic malformations (LMs). We developed the SHALL-WE score (Severity, Histology, And Location – Lymphatic malformation: When to Escalate) to define the optimal sclerotherapy threshold in superficial LMs.

Methods

We analyzed 709 patients with superficial LMs from a nationwide survey in Japan. Multivariable logistic regression identified predictors of treatment success, used to construct the SHALL-WE score (0–3 points): head and neck location, non-cystic histology, and severe disease (1 point each). The optimal threshold was the session count beyond which success rates fell below the overall mean (63.0%).

Results

Treatment success rates decreased with increasing score (score 0: 71.6%, 1: 64.1%, 2: 43.6%, 3: 20.0%; $p < 0.001$). Optimal thresholds were two sessions for score 0, one for score 1, and early escalation for scores 2–3. Patients managed within thresholds had higher success rates (71.9% vs. 51.2%; adjusted OR 1.921, 95% CI 1.340–2.753, $p < 0.001$).

Conclusion

The SHALL-WE score defines when sclerotherapy is unlikely to succeed and treatment escalation should be considered. Prospective external validation is warranted.

Introduction

Lymphatic malformations (LMs) are congenital vascular anomalies that frequently present in childhood and can cause cosmetic deformities, functional impairment, or local symptoms depending on their size, location, and extent[1]. In Japan, sclerotherapy, surgical excision, and pharmacotherapy – including sirolimus (approved for intractable lymphatic malformations in 2021) and Kampo medicine such as eppikajutsuto – are available under the National Health Insurance system and widely used in clinical practice [2, 3].

Sclerotherapy is commonly selected as the initial treatment because of its minimally invasive nature and favorable safety profile[4]. However, its effectiveness varies according to lesion characteristics, and repeated sessions are often required[5, 6]. When sclerotherapy fails to achieve satisfactory outcomes, clinicians must consider treatment escalation, which may include surgical excision, pharmacotherapy, or

a combination of modalities. Surgical excision can achieve rapid and definitive volume reduction but carries a higher risk of complications, including nerve injuries, particularly in pediatric patients. Pharmacotherapy with sirolimus has emerged as an additional option for refractory cases, although its use in Japan was approved for intractable lymphatic diseases under the National Health Insurance only in 2021[2]. Consequently, determining when to discontinue sclerotherapy and escalate treatment remains a clinical challenge.

Despite the widespread use of multiple modalities, no consensus currently exists regarding the optimal number of sclerotherapy sessions or the criteria for treatment escalation in patients without life-threatening complications such as airway obstruction or major vascular involvement[7, 8]. The most recent Japanese Clinical Practice Guidelines for Vascular Anomalies (2022) explicitly state that "it is impossible to recommend optimal timing of surgery" for soft tissue/superficial LMs, emphasizing the need for individualized decision-making (CQ27)[2]. Consequently, treatment decisions remain largely dependent on individual physician experience and institutional practice.

To address this gap, we analyzed data from a nationwide survey of patients with LMs conducted in 2015 as part of the Research Project for Intractable Diseases by the Ministry of Health, Labour, and Welfare. This study aimed to identify factors independently associated with treatment completion and to develop a simple, clinically applicable scoring system – the SHALL-WE score (Severity, Histology, And Location – Lymphatic malformation: When to Escalate) – to define the optimal sclerotherapy threshold and guide treatment escalation decisions in patients with superficial LMs.

Methods

Study design and data source

This retrospective observational study analyzed data obtained from a nationwide survey of LMs conducted in 2015 as part of the Research Project for Intractable Diseases by the Ministry of Health, Labour, and Welfare[9]. The survey collected anonymized clinical information from multiple institutions across Japan using an extensive web-based questionnaire comprising 273 items, including demographic characteristics, age at onset and diagnosis, perinatal history, symptoms, lesion size and site, radiographic and pathological findings, treatment details, complications, clinical course, and outcomes.

This study was approved by the Ethics Committee of Keio University School of Medicine (approval number: 20120437), which waived the requirement for individual informed consent owing to the retrospective analysis of anonymized nationwide survey data.

Study population

The analysis included patients with only superficial LMs without any deep lesions of the head and neck, thorax, or abdomen, and who underwent therapeutic intervention among registered cases. Patients with

missing outcome data were excluded.

Variables and outcome definition

The primary outcome was treatment success, defined as clinician-assessed improvement sufficient to warrant discontinuation of active treatment (i.e., a status of "no further treatment required" at the time of survey completion). This outcome reflects the treating physician's judgment that meaningful clinical improvement had been achieved, consistent with the definition used in prior analyses of this nationwide dataset[9].

Explanatory variables included the total number of treatment sessions (sclerotherapy and surgery combined), number of sclerotherapy sessions, initial disease severity (mild, moderate, or severe as assessed by the treating clinician), age at first presentation, lesion histological subtype (cystic vs. non-cystic), and lesion location (head and neck, trunk, or extremities). Disease severity was not defined by standardized criteria but rather by the treating clinician's overall assessment at initial presentation, reflecting the real-world clinical judgment that typically drives treatment planning.

Statistical analysis

Multivariable logistic regression analysis was performed to identify factors independently associated with treatment completion. Age at presentation was converted to months: prenatal detection was coded as 0 months, the neonatal period as 0.1 months, ages reported in years were multiplied by 12, and ages reported in days were converted assuming 30 days per month. Missing values were handled using complete-case analysis.

Treatment frequency, originally recorded in categorical ranges (3–5, 6–10, and > 10 times), was converted into numeric variables using the lower bound of each category (3, 6, and 11). Sensitivity analyses using midpoint values yielded consistent results. Histological subtypes were dichotomized into cystic and non-cystic (including mixed, cavernous, and hemangiolympangioma). Lymphangiomatosis (n = 5) and other rare subtypes (n = 2) were retained in the non-cystic group for the primary analysis; a sensitivity analysis excluding these seven cases confirmed consistent results. Initial disease severity was analyzed both as a three-category variable (mild, moderate, severe) and a dichotomized variable (severe vs. non-severe); the latter was used for score construction after confirming minimal loss of model fit. Lesion location was recorded as the presence or absence of head and neck, trunk, and extremity involvement.

Based on the identified predictors, we constructed a simple scoring system, the SHALL-WE score. The score assigns 1 point each for head and neck location, non-cystic subtype, and severe disease, yielding a total score of 0–3 points.

To define the optimal sclerotherapy threshold, we identified, for patients with a score of 0, the inflection point at which success rates declined below the overall mean (63.0%). The recommended threshold was

then adjusted by reducing the allowable number of sessions by one for each additional point in the score. Exceeding the score-specific threshold was considered an indication for treatment escalation, which may include surgical excision, pharmacotherapy, combined multimodal approaches, or continued observation depending on clinical circumstances.

The association between threshold adherence and treatment success was evaluated using chi-square tests, the Cochran–Armitage trend test, and multivariable logistic regression adjusted for age at presentation and SHALL-WE score. Sensitivity analyses were performed by varying the reference threshold by ± 1 session.

All statistical analyses were performed using IBM SPSS Statistics for Windows, version 30.0 (IBM Corp., Armonk, NY, USA). Statistical significance was set at $p < 0.05$.

Results

Patient characteristics

A total of 709 patients with superficial LMs met the inclusion criteria and were included in the analysis. The overall treatment success rate was 63.0% (447/709). Most lesions were classified as mild (527; 74.3%), followed by moderate (148; 20.9%) and severe (34; 4.8%). Regarding histological subtype, cystic (macroscopic) lesions were the most common (487; 68.7%), followed by mixed (130; 18.3%), cavernous (microcystic) (68; 9.6%), hemangiolympangioma (17; 2.4%), lymphangiomatosis (5; 0.7%), and others (2; 0.3%). Head and neck lesions were present in 338 patients (47.7%), trunk lesions in 285 (40.2%), and extremity lesions in 231 (32.6%); lesion location categories were not mutually exclusive. The median number of sclerotherapy sessions was 1 (range, 0–11) and of surgical procedures was 0 (range, 0–6). Treatment frequency data were available for 689 patients (97.2%), while age at presentation data were available for 681 patients (96.1%). The detailed descriptive statistics are presented in Table 1. The final multivariable logistic regression model included 667 patients with complete data for all covariates.

Factors associated with treatment completion

Multivariable logistic regression analysis identified the total number of treatment sessions (odds ratio [OR] 0.773, 95% confidence interval [CI] 0.698–0.855, $p < 0.001$), age at presentation (OR 0.997, 95% CI 0.995–0.999, $p = 0.010$), cystic subtype (OR 1.954, 95% CI 1.358–2.812, $p < 0.001$), and severe initial severity (OR 0.217, 95% CI 0.083–0.564, $p = 0.002$) as factors independently associated with treatment completion (Table 2).

Head and neck location did not reach statistical significance after adjusting for other covariates (OR 1.067; 95% CI 0.757–1.504; $p = 0.712$). This is likely because head and neck and trunk involvement were nearly mutually exclusive in our cohort (only 18 of 709 patients [2.5%] had both), and much of the prognostic influence of location was captured by histological subtype, given that cystic lesions were

more prevalent in the head and neck region (73.4%) than in other locations (64.4%). Nevertheless, head and neck location was retained for score construction based on its established clinical relevance as a determinant of treatment complexity (see Discussion).

When severity was analyzed as a three-category variable, the OR for severe versus mild disease was 0.188 (95% CI 0.072–0.495; $p < 0.001$), whereas moderate versus mild was not statistically significant (OR 0.687; 95% CI 0.451–1.045; $p = 0.079$), supporting the dichotomization into severe versus non-severe with minimal loss of model fit (Nagelkerke R^2 0.170 vs. 0.164).

Construction and distribution of the SHALL-WE score

The SHALL-WE score distributed patients as follows: score 0 ($n = 236$; 33.3%), score 1 ($n = 362$; 51.1%), score 2 ($n = 101$; 14.2%), and score 3 ($n = 10$; 1.4%). Treatment success rates decreased progressively with increasing score: 71.6%, 64.1%, 43.6%, and 20.0% for scores 0, 1, 2, and 3, respectively (Cochran–Armitage trend test, $p < 0.001$; Table 3).

Determination of optimal sclerotherapy thresholds

Success rates according to the number of sclerotherapy sessions within each score group are presented in Table 4 and Fig. 1. Among patients with a score of 0, success rates remained above the overall mean (63.0%) for up to two sessions (82.9%, 76.9%, and 66.7% for zero, one, and two sessions, respectively) but declined to 51.9% at three sessions. In patients with a score of 1, success rates remained above the overall mean for up to one session (72.4% for zero sessions and 68.8% for one session). Although the rate at two sessions (68.5%) also remained above the mean, the threshold for score 1 was set at one session based on the principle of reducing the allowable sessions by one for each additional score point, consistent with the stepwise decline in overall success rates across score groups. Success rates fell below the mean at three sessions (53.6%).

In patients with a score of 2, success rates remained below the overall mean regardless of the number of sclerotherapy sessions (range, 0%–55.0%). Although a modest increase was observed from zero sessions (36.4%) to one or two sessions (51.7% and 55.0%, respectively), these rates remained consistently below 63.0% and declined sharply with further sessions (46.2% at three sessions and 14.3% at six sessions). Patients with a score of 3 ($n = 10$) had uniformly poor outcomes across all treatment intensities.

Based on these observations, we established the following thresholds: the maximum recommended number of sclerotherapy sessions was set at two for score 0 and reduced by one session for each additional point (one session for score 1). For scores 2–3, success rates did not exceed the overall mean at any number of sessions, indicating that early treatment escalation – rather than prolonged sclerotherapy – should be considered. The treatment algorithm is presented in Fig. 2.

Algorithm adherence and treatment success

When patients were classified according to adherence to the proposed algorithm, those managed within the recommended thresholds (adherent group, $n = 406$, 57.3%) had a higher treatment completion rate than those exceeding the thresholds (71.9% vs. 51.2%, $p < 0.001$). After adjustment for age at presentation and SHALL-WE score, adherence remained associated with treatment completion (OR 1.921, 95% CI 1.340–2.753, $p < 0.001$). However, because the thresholds were derived from and tested against the same dataset, this analysis represents internal verification rather than independent validation; its primary purpose is to demonstrate the magnitude of the difference associated with threshold adherence. Full results are presented in Supplementary Table 1.

Sensitivity analyses

To confirm the robustness of the proposed threshold, sensitivity analyses were performed by varying the reference number of sclerotherapy sessions for score 0. When the threshold was increased to three sessions, the adherent group still showed higher success rates (69.3% vs. 43.7%; adjusted OR 2.337; 95% CI 1.569–3.481; $p < 0.001$). When the threshold was reduced to one session, the difference remained significant but was attenuated (74.6% vs. 57.4%; adjusted OR 1.635; 95% CI 1.098–2.434; $p = 0.015$). The two-session threshold was selected as the primary recommendation because it corresponded to the inflection point observed in score 0 patients and provided a balanced adherent proportion (57.3%) suitable for practical application (Supplementary Table 2).

A sensitivity analysis excluding lymphangiomatosis ($n = 5$) and other rare subtypes ($n = 2$) from the non-cystic group yielded consistent results across all analyses (data not shown).

Discussion

The present study, based on a nationwide survey of 709 patients with superficial lymphatic malformations in Japan, demonstrated that the SHALL-WE score — a simple three-item scoring system incorporating lesion location, histological subtype, and initial disease severity — can identify the number of sclerotherapy sessions beyond which continued treatment is unlikely to succeed. Patients managed within the score-recommended thresholds achieved a treatment success rate of 71.9%, compared with 51.2% among those exceeding the threshold, and this association remained significant after multivariable adjustment.

Predictors of treatment success

Multivariable logistic regression identified the total number of treatment sessions, age at presentation, cystic histological subtype, and severe disease at presentation as independently associated with treatment success. These findings are consistent with prior literature. Cystic (macroscopic) lesions respond favorably to sclerotherapy, with reported success rates exceeding 80% in some series, attributable to the effective accumulation of sclerosing agents within well-defined cystic cavities[10, 11].

Conversely, non-cystic (microcystic or cavernous) lesions lack such structural compartments and tend to respond poorly to sclerotherapy[12]. The strong negative association of severe disease at presentation (OR, 0.217) underscores the inherent difficulty in achieving therapeutic success in patients with extensive disease, regardless of the treatment modality[13].

Rationale for including head and neck location

Despite its well-recognized clinical importance, head and neck location did not reach statistical significance as an independent predictor in our multivariable analysis (OR 1.067; $p = 0.712$). This finding warrants careful interpretation. Head and neck and trunk involvement were nearly mutually exclusive in our cohort, with only 18 of 709 patients (2.5%) showing both. In a separate exploratory analysis, trunk location emerged as significant when entered individually into the model (OR 1.801; $p = 0.025$), whereas head and neck did not, likely reflecting the complementary nature of these variables. Furthermore, the prognostic influence of location appeared to be partially captured by histological subtype, given that cystic lesions were more prevalent in the head and neck region (73.4%) than elsewhere (64.4%).

Nevertheless, we retained head and neck location in the SHALL-WE score for several reasons. First, the decision to escalate treatment is fundamentally influenced by anatomical considerations — surgical complexity, proximity to vital structures, and complication risks vary substantially by site. Second, head and neck involvement is consistently reported as a risk factor for treatment difficulty in prior studies[14, 15]. Third, anatomical location is among the first clinical parameters available to treating physicians and serves as an intuitive anchor for treatment planning. Inclusion of this variable enhances the clinical face validity and practical applicability of the score.

Defining the sclerotherapy threshold

A key finding of the present study is the identification of a score-dependent inflection point beyond which additional sclerotherapy sessions do not improve treatment success. In patients with a score of 0 (non-head and neck, cystic, non-severe), success rates remained above the overall mean for up to two sessions but declined sharply thereafter. This inflection point shifted toward fewer sessions with increasing score: one session for score 1, with no session count achieving the overall mean for scores 2–3.

For patients with scores of 2–3, success rates remained below the overall mean (63.0%) at all sclerotherapy session counts. A modest increase was observed from zero to one or two sessions in score 2 patients (36.4% to 55.0%), suggesting that a limited trial of sclerotherapy may still provide incremental benefit in selected cases. However, the consistently suboptimal success rates across all treatment intensities, combined with the sharp decline observed beyond two sessions, indicate that these patients are unlikely to achieve satisfactory outcomes through sclerotherapy alone. Early multidisciplinary treatment planning — which may include surgical excision, combined approaches, or pharmacotherapy — should be considered rather than prolonged sclerotherapy.

The selection of two sclerotherapy sessions as the reference threshold for score 0 was validated by sensitivity analyses. Increasing the threshold to three sessions yielded a larger adjusted OR for adherence (2.337 vs. 1.921), largely attributable to the smaller and more treatment-resistant non-adherent group. Reducing the threshold to one session produced a smaller but still significant effect (OR 1.635; $p = 0.015$). The two-session threshold strikes an appropriate balance: it corresponds to the empirically observed inflection point, yields a clinically meaningful difference in success rates (20.7 percentage points), and classifies a reasonable proportion of patients (57.3%) as adherent.

Impact of repeated sclerotherapy on subsequent treatment

An important clinical consideration is whether repeated ineffective sclerotherapy may adversely affect subsequent surgical outcomes. Sclerotherapy induces local inflammation and tissue fibrosis, which can obliterate tissue planes and increase surgical difficulty[13]. Several authors have reported that prior sclerotherapy is associated with increased intraoperative bleeding, prolonged operative time, and higher rates of incomplete resection in head and neck LMs[7, 13]. The SHALL-WE score addresses this concern by explicitly limiting the number of sclerotherapy sessions, thereby potentially preserving a favorable surgical window for patients who require treatment escalation.

Comparison with existing classification systems and predictive tools

Several classification systems and scoring tools have been proposed for LMs. The de Serres staging system classifies head and neck LMs into five stages based on anatomical extent, with higher stages predicting greater complication rates[16]. However, it is limited to head and neck lesions and does not incorporate histological subtype or guide treatment selection. The Cologne Disease Score (CDS) quantifies morbidity in pediatric head and neck LMs on a 0–10 scale, providing a longitudinal measure of disease burden but not a treatment decision tool[17]. Wu et al. developed a nomogram for predicting sclerotherapy response in children, incorporating lesion morphology, size, and appearance, with an AUC of 0.885[18]. Their model focuses exclusively on sclerotherapy response prediction and requires imaging-derived variables that may not be universally available at initial consultation.

The SHALL-WE score differs from these tools in several respects. First, it is not limited to a specific anatomical region but applies to all superficial LMs. Second, it provides an explicit, actionable recommendation – the maximum number of sclerotherapy sessions – rather than a prognostic estimate alone. Third, it requires only three readily assessable clinical parameters, facilitating point-of-care application without specialized imaging or calculations. The trade-off is a coarser risk stratification compared with more complex models; however, the simplicity of the SHALL-WE score may enhance adoption in diverse clinical settings.

Treatment landscape and the role of pharmacotherapy

The nationwide survey analyzed in this study was conducted in 2015, prior to the approval of sirolimus for intractable lymphatic diseases under the Japanese National Health Insurance system in 2021.

Consequently, pharmacotherapy was not a treatment option for the vast majority of patients in our cohort. In the current treatment landscape, sirolimus represents an important additional modality for refractory LMs, particularly those with diffuse or microcystic components that respond poorly to both sclerotherapy and surgery[3]. The SHALL-WE score defines when sclerotherapy alone is insufficient; the subsequent choice among surgery, pharmacotherapy, combined approaches, or watchful waiting should be individualized based on lesion characteristics, patient factors, and institutional expertise. The score is designed to complement — rather than replace — multidisciplinary clinical judgment.

Limitations

This study has several limitations. First, severity classification was based on the treating clinician's overall assessment rather than a standardized scoring system, introducing potential inter-institutional variability. However, this reflects the real-world clinical judgment that drives actual treatment decisions and enhances the practical applicability of the score. Second, the retrospective observational design precludes causal inference, and unmeasured confounders may influence the observed associations. Third, the temporal sequence of treatments was not recorded in the survey; we assumed that sclerotherapy preceded surgery when both were performed, but the reverse may have occurred in some cases. Notably, patients with zero sclerotherapy sessions who achieved treatment success likely represent those managed primarily with surgical excision; 111 of 709 patients (15.7%) received no sclerotherapy but underwent at least one other therapeutic intervention, as the inclusion criteria required at least one treatment session, and patients managed with observation alone were not included in this analysis. Their inclusion in the threshold analysis reflects the composite nature of this dataset rather than the efficacy of sclerotherapy per se. This limitation should be considered when interpreting session-specific success rates. Fourth, the algorithm thresholds were derived from and evaluated against the same cohort, which constitutes a circular analytical structure. Accordingly, the observed difference in success rates between adherent and non-adherent groups should be interpreted as internal verification of threshold consistency rather than as independent prognostic validation. External validation in a separate cohort is essential before clinical implementation. Fifth, treatment success was based on clinician judgment at survey completion and may vary across institutions. Sixth, treatment frequency data were recorded as categorical ranges for higher session counts, necessitating conversion to numerical values. Seventh, the small number of patients with scores of 2 ($n = 101$) and 3 ($n = 10$) limited the precision of estimates in these subgroups and precluded robust subgroup-specific threshold determination. Finally, this study focused exclusively on superficial lesions; the SHALL-WE score is not applicable to patients with deep or visceral involvement, for whom treatment considerations differ substantially.

Conclusions

The SHALL-WE score is a practical three-factor tool incorporating lesion location (head and neck), histological subtype (non-cystic), and initial disease severity (severe) to define the number of sclerotherapy sessions beyond which continued sclerotherapy is unlikely to succeed in patients with

superficial LMs. For patients exceeding the score-specific threshold, treatment escalation — including surgery, pharmacotherapy, or multidisciplinary combined approaches — should be considered in a shared decision-making framework. Although prospective external validation is required, the SHALL-WE score may assist clinicians in avoiding both premature and excessively delayed treatment escalation, ultimately improving outcomes for patients with superficial lymphatic malformations.

Declarations

Competing interests

The authors have no relevant financial or nonfinancial interests to disclose.

Ethics approval

This study was approved by the Ethics Committee of Keio University School of Medicine (approval number: 20120437), which waived the requirement for individual informed consent owing to the retrospective design and analysis of anonymized nationwide survey data.

Consent to participate

The requirement for individual informed consent was waived by the Ethics Committee of Keio University School of Medicine owing to the retrospective design and use of anonymized survey data.

Consent to publish

Not applicable.

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Author Contribution

H. Takei: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Software, Visualization, and Writing – original draft. M. Kato: Writing – review & editing. S. Yamagishi: Writing – review & editing. Y. Yamada: Writing – review & editing. M. Kano: Writing – review & editing. Y. Kinoshita: Resources and Methodology. M. Ozeki: Resources and Methodology. S. Nosaka: Resources and Methodology. T. Hirabayashi: Resources and Methodology. N. Kawakubo: Resources and Methodology.

T. Hishiki: Resources and Methodology. K. Terui: Resources and Methodology. T. Taguchi: Resources and Methodology. S. Ueno: Resources and Methodology. A. Fujino: Conceptualization, Resources, Methodology, Supervision, and Writing – review & editing. All authors read and approved the final manuscript.

Data Availability

The data analyzed in this study were obtained from a nationwide survey conducted as part of the Research Project for Intractable Diseases supported by the Ministry of Health, Labour and Welfare of Japan. The dataset is not publicly available owing to restrictions imposed by the data provider to protect patient privacy. Requests for data access may be directed to the corresponding author and are subject to approval by the relevant authorities.

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Tables

Table 1 Demographic and clinical characteristics of 709 patients with superficial lymphatic malformations

	Category	N	%	
Treatment completion	Yes	447	63	
	No	262	37	
Severity at presentation	Mild	527	74.3	
	Moderate	148	20.9	
	Severe	34	4.8	
Histological subtype	Cystic	487	68.7	
	Mixed	130	18.3	
	Cavernous	68	9.6	
	Hemangiolymphangioma	17	2.4	
	Lymphangiomatosis	5	0.7	
	Other	2	0.3	
Lesion location (not mutually exclusive)	Head & neck	338	47.7	
	Trunk	285	40.2	
	Extremity	231	32.6	
Binary variables for analysis	Cystic (vs non-cystic)	487	68.7	
	Severe (vs non-severe)	34	4.8	
Total treatment count	Valid N (missing)	Mean $\pm$ SD	Median	Range

Total treatment count	667 (42)	2.19 ± 1.95	1	1–11
Sclerotherapy sessions	667 (42)	1.79 ± 1.67	1	0–11
Surgical excisions	667 (42)	0.38 ± 0.70	0	0–6
Age at presentation (months)	667 (42)	48.8 ± 82.1	16	0–778

Continuous variables (total treatment count, sclerotherapy sessions, surgical excisions, and age at presentation) are based on 667 patients for whom all four variables were available.

Table 2 Multivariable logistic regression analysis for treatment completion

Variable	OR (Exp B)	95% CI	p
Total treatment count	0.773	0.698–0.855	<0.001
Age at presentation (months)	0.997	0.995–0.999	0.01
Head & neck location	1.067	0.757–1.504	0.712
Cystic subtype	1.954	1.358–2.812	<0.001
Severe disease	0.217	0.083–0.564	0.002
Constant	2.395	—	<0.001

odds ratio; CI, confidence interval. Model fit: Hosmer-Lemeshow $\chi^2 = 5.068$, df = 8, p = 0.750; Nagelkerke R² = 0.164.

Table 3 SHALL-WE score: distribution and treatment completion

Score	N (%)	Success n (%)	Failure n (%)
0	236 (33.3%)	169 (71.6%)	67 (28.4%)
1	362 (51.1%)	232 (64.1%)	130 (35.9%)
2	101 (14.2%)	44 (43.6%)	57 (56.4%)
3	10 (1.4%)	2 (20.0%)	8 (80.0%)
Total	709 (100%)	447 (63.0%)	262 (37.0%)

Score = Head/Neck (1 point) + Non-cystic (1 point) + Severe (1 point); range 0–3.

Score 0 = non-head/neck, cystic, non-severe (most favorable profile).

Pearson $\chi^2 = 32.005$, df = 3, $p < 0.001$ (linear-by-linear association $\chi^2 = 28.131$, $p < 0.001$).

1 cell (12.5%) has expected count < 5 (minimum expected count = 3.70).

Figures

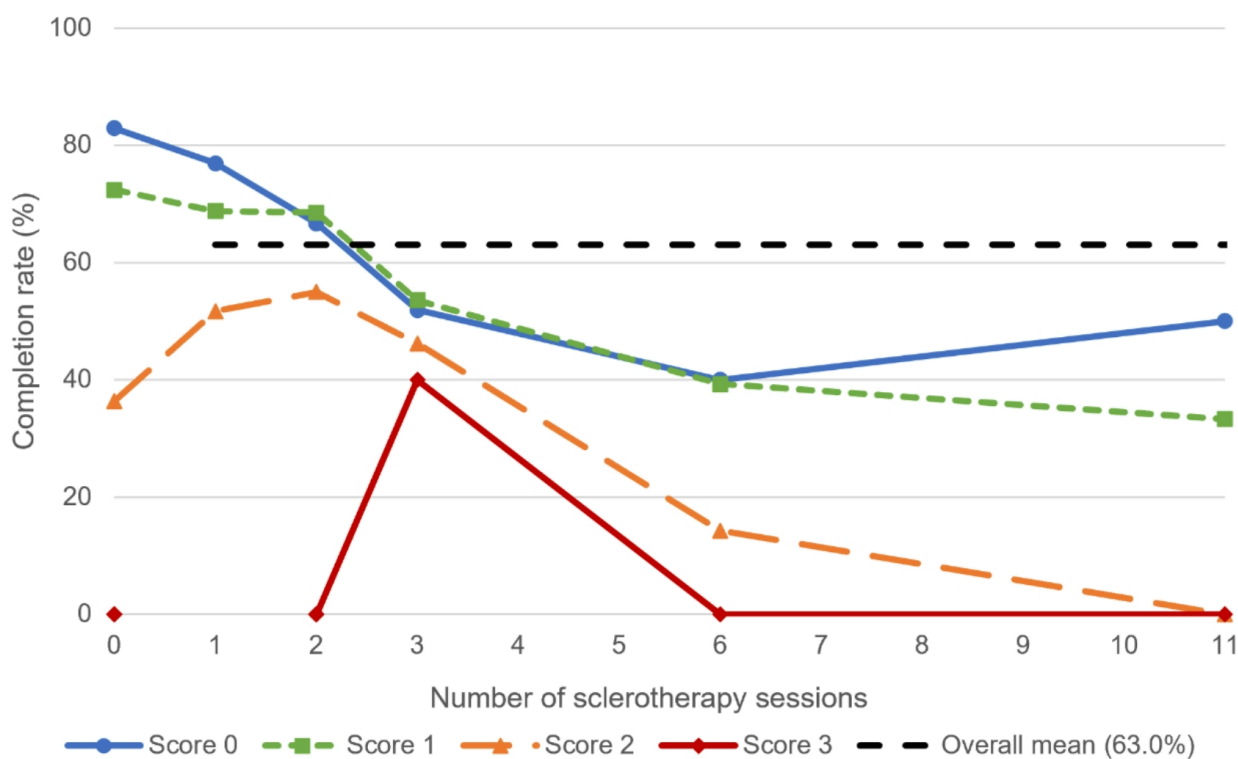


Figure 1

Treatment success rates according to the number of sclerotherapy sessions stratified by SHALL-WE score. The horizontal dashed line indicates the overall mean success rate (63.0%)

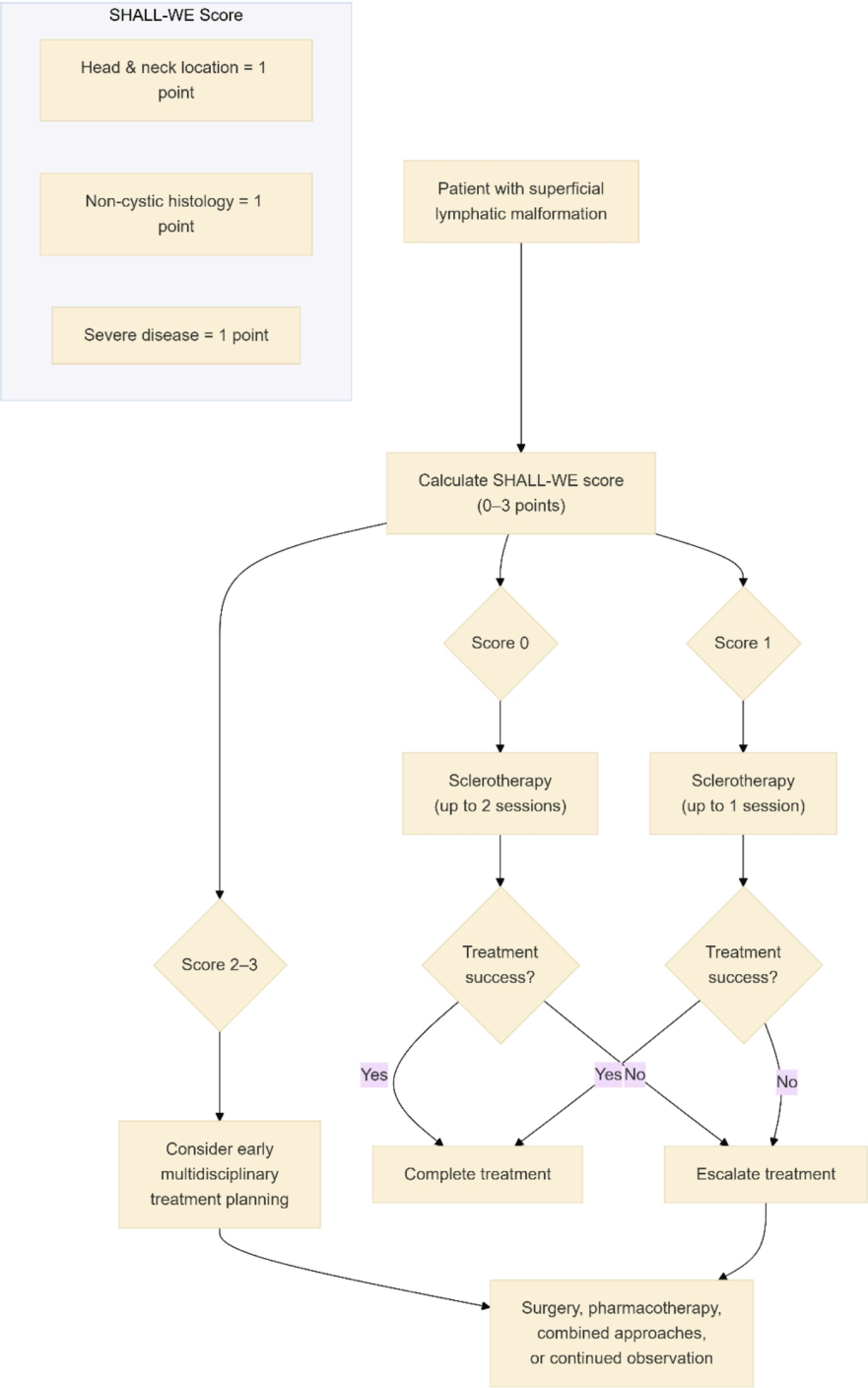


Figure 2

Treatment algorithm based on the SHALL-WE score. Treatment escalation includes surgical excision, pharmacotherapy (e.g., sirolimus), combined multimodal approaches, or continued observation, individualized according to lesion characteristics, patient factors, and institutional expertise

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [SupplementaryTables.docx](#)