## Appendix 1 CEAP (Clinical-Etiology-Anatomy-Pathophysiology) full classification. [5]

| **Summary of clinical (C) classifications** | |
|---|---|
| **C class** | Description |
| **C0** | No visible or palpable signs of venous disease |
| **C1** | Telangiectasias or reticular veins |
| **C2** | Varicose veins |
| **C2r** | Recurrent varicose veins |
| **C3** | Oedema |
| **C4** | Changes in skin and subcutaneous tissue secondary to CVD |
| **C4a** | Pigmentation or eczema |
| **C4b** | Lipodermatosclerosis or atrophie blanche |
| **C4c** | Corona phlebectatica |
| **C5** | Healed |
| **C6** | Active venous ulcer |
| **C6r** | Recurrent active venous ulcer |
| CVD. Chronic venous disease<br>Each clinical class sub-characterised by a subscript indicating the presence (symptomatic, s) or absence (Asymptomatic, a) of symptoms attributable to venous disease. | |

| **Summary of etiology/aetiology (E) classifications** | |
|---|---|
| **E class** | Description |
| **Ep** | Primary |
| **Es** | Secondary |
| **Esi** | Secondary – intravenous |
| **Ese** | Secondary – extravenous |
| **Ec** | Congenital |
| **En** | No cause identified |

| **Summary of anatomic (A) classifications** | | | |
|---|---|---|---|
| **A Class** | Description | | |
| **As** | Superficial | | |
| | Old | New[a] | Description |
| | 1 | Tel | Telangiectasia |
| | 1 | Ret | Reticular veins |
| | 2 | GSVa | Great saphenous vein above knee |
| | 3 | GSVb | Great saphenous vein below knee |
| | 4 | SSV | Small saphenous vein |
| | | ASV | Anterior saphenous vein |
| | 5 | NSV | Non-saphenous vein |
| **Ad** | Deep | | |
| | Old | New[a] | Description |
| | 6 | IVC | Inferior vena cava |
| | 7 | CIV | Common iliac vein |
| | 8 | IIV | Internal iliac vein |
| | 9 | EIV | External iliac vein |
| | 10 | PELV | Pelvic veins |
| | 11 | CFV | Common femoral vein |
| | 12 | DFV | Deep femoral vein |
| | 13 | FV | Femoral vein |
| | 14 | POPV | Popliteal vein |
| | 15 | PRV | Peroneal vein |
| | 15 | ATV | Anterior tibial vein |
| | 15 | PTV | Posterior tibial vein |
| | 16 | MUSV | Muscle veins |
| | 16 | SOV | Soleal vein |
| **Ap** | Perforator | | |
| | Old | New[a] | Description |
| | 17 | TPV | Thigh perforator vein |
| | 18 | CPV | Calf (leg) perforator vein |
| **An** | No venous anatomic location identified | | |

[a] New specific anatomic location(s) to be reported under each P (pathophysiologic) class to identify anatomic location(s) corresponding to P class.

| Summary of pathophysiologic (P) classification | |
|---|---|
| **Pr** | Reflux |
| **Po** | Obstruction |
| **Pr.o** | Reflux and obstruction |
| **Pn** | No pathophysiology identified |
| ** New abbreviation for specific A anatomic location(s) to be reported under each P Pathophysiologic class to identify anatomic location(s) corresponding to P class. | |

## Appendix 2: How the clinical practice guideline was developed

A general plan developed to create clinical practice guidelines for sonographers was used to guide the development of this guideline (Figure APP2.1). Key features of the plan were 1) to develop questions that the guideline would answer, 2) draw on existing evidence-based guideline to inform the guideline, 3) undertake literature searches when existing guidelines have deficits, and 3) consult with stakeholders.

The decision to draw on existing guidelines, rather than developing a de novo guideline, was regarded as more efficient due to the time consuming and expensive nature of de novo guideline development, which requires teams of methodologists and experts to search, critique and debate the evidence base. This approach also enabled review of existing evidence-based guidelines developed for other professional groups involved in the care of patients with chronic venous disease (CVD), to avoid this guideline contradicting any existing guidelines used by those professional groups.

Table APP 2.1 provides a timeline of key guideline development activities.

## Guideline Working Group

A Guideline Working Group was established to develop questions the guideline would address, to advise on stakeholder groups, to source underpinning evidence, to categorise and grade evidence and to draft and write. Members of the Vascular Special Interest Group of the ASA were initially invited. Additional members known to this group with relevant expertise were also invited. Table APP 2.2 summarises the members of the guideline working group and their affiliations.

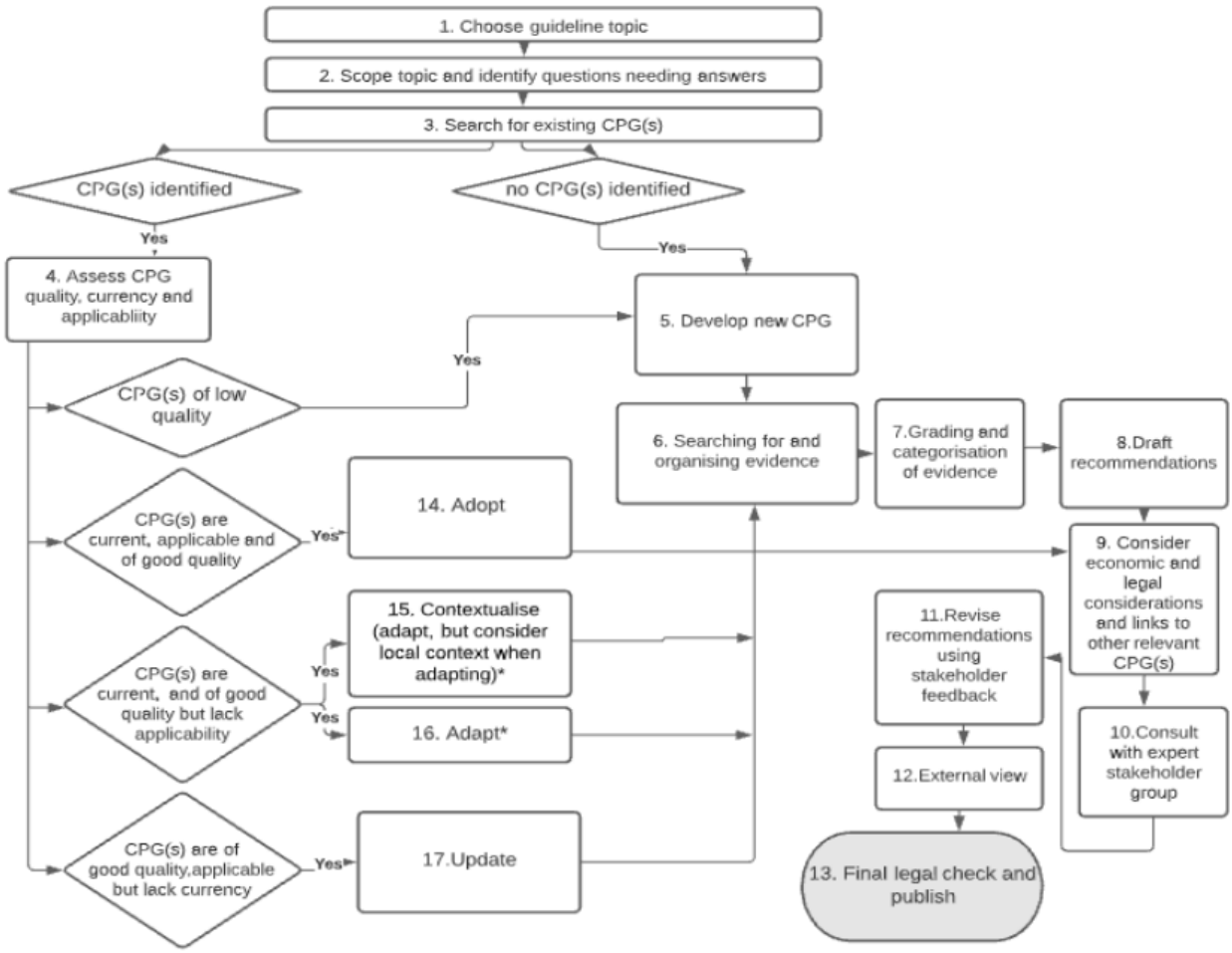


Figure APP2.1 Flow diagram of general plan of clinical guideline development.

Key: CPG; clinical practice guideline.

Table APP 2.1: Calendar of key guideline development activities

| Date | Activity |
|---|---|
| 1.2.23 | Initial meeting, discussions around scope and questions to be answered. Followed up with email discussions. Actions: to look at evidence methodology and how to rate evidence, source existing guidelines, expand group by invitation. |
| 17-19 Feb 23 | Search for existing, relevant guidelines performed. |
| 22.3.23 | Meeting: Discussion about structure of guideline and methodology to be used. |
| 21.6.23 | Meeting: Discussion on section on anatomy and pathophysiology |
| 26.6.23 | Guideline group invited feedback on Glossary and Anatomy section for the guideline from Vascular surgeons and radiology/phlebology colleagues, RANZCR |
| 27.11.23 | Meeting: Discussion on draft recommendations for 'technical considerations' |
| 1 12.23 | Worksheet distributed to guideline group members to grade evidence for draft recommendations on technical considerations. |
| 5.2.24 | Meeting: Discussion on collated results on technical considerations |
| 19.2.24 | Meeting: Discussion on diameter measurements of veins, discussion summarised and added to existing evidence sources to inform group survey. |
| 4.3.24 | Meeting: Discussion on draft relating to vein diameter, B-mode, spectral and colour Doppler. |
| 9.3.24 | Survey distributed to group members on measuring vein diameter |
| 18.3.24 | Meeting: Discussion on developed sections addressing assessments for specific veins |
| 2.4.24 | Meeting: Discussion on Section F (general considerations) |
| 12.4-27.4 | Reflux time survey and sonographer qualifications survey |
| 15.4.24 | Meeting: Section E discussed (performing and interpreting ultrasound examination) |
| 29.4.24 | Meeting: Complications table (Section E) discussed |
| 13.5.24 | Meeting: Discussion reflux times, complications table, sonographer qualifications, reporting section |
| 10. 6.24 | Reporting section developed |
| July-mid September 24 | Drafts of all sections finalised, distributed to guideline working group members. Discussion points tabled for next meeting. |
| 15.10.24 | Meeting: Discussion of final draft documents |
| | <public consultation and revisions to be added> |

Table APP 2.2: Guideline working group members and affiliations

| Member | Affiliations |
|---|---|
| Daniel Rae | Sunshine Coast Vascular |
| Vanessa Weiley | Vascular Diagnostics (Liverpool) |
| Donna Oomens | Western Sydney University, Western Sydney Vascular Services |
| Gaorui Liu | Western Sydney Vascular, Nepean Hospital, The University of Sydney |
| Matt Adams | Vascular bites<br>Western Sydney University |
| Kate Lamb | University of South Australia |
| Kerry Thoirs | Australasian Sonographers Association<br>University of South Australia |
| Dr Peter Paraskevas | Australasian College of Phlebology |
| Chris Bevan | SKG and Arteries and Veins Pty Ltd |
| Martin Necas | Waikato Hospital, Health New Zealand \| Te Whatu Ora |
| Anna Graves | |
| Yana Parsi | Sydney Skin and Vein Clinic |

## Guideline questions

A series of questions and topics to be addressed in the guideline was developed. For each question, existing recommendations within relevant guidelines on ultrasound and CVD management were accessed and assessed for content and level of evidence to inform the guideline (*see section Identification of relevant, existing clinical practice guidelines*). If existing guidelines did not fully inform the question, then a literature search was undertaken to fill these gaps.
Consensus decisions made based on either via working group discussions or anonymous web-based surveys. Table APP 2.3 demonstrates the clinical questions relevant to the guideline topic and which were used as the foundation of this guideline.

## Identification of relevant, existing clinical practice guidelines

A literature search for relevant existing guidelines was conducted. For a guideline to be eligible, it had to be available in English and refer to or make recommendations on ultrasound assessment for CVD; specifically the techniques and anatomical nomenclature that should be used when making ultrasound assessments, recording/reporting those assessments, and/or indicating when it is appropriate to perform a diagnostic duplex ultrasound examination (US) for CVD.

## Search methods and results

Search results are summarized in Figure APP 2.2

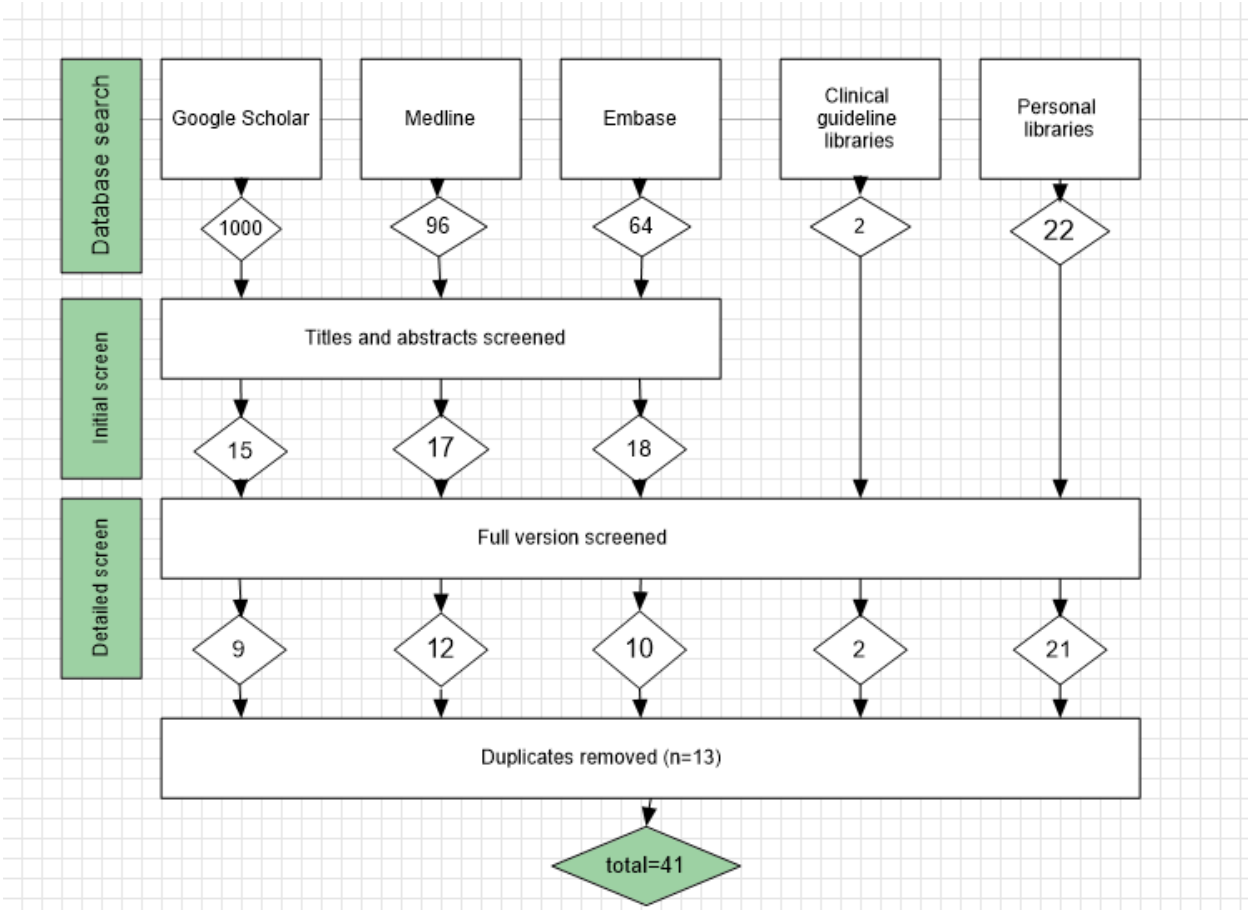


Figure APP 2.2: Flow chart of results of literature search to identify existing relevant clinical practice guidelines

Search strategies and search results are summarised below for each database:

- Google scholar was searched on 17th February 2023 using the search terms: varicose veins OR guideline OR statement OR venous insufficiency. The search was limited by dates (2000-2023) and the first 1000 results. An initial screen for eligibility, performed using the title and the first two lines in the descriptor paragraph, revealed 15 eligible articles. The full guideline of these 15 eligible articles were retrieved to perform a detailed screen of the full guideline. Nine guidelines were deemed eligible.
- Titles in the Embase database was searched on 19th February 2023 using the search terms: (venous insufficiency or varicose vein* or vein insufficiency) and (guideline or standard or statement). The search was limited by dates (2000-current) and by English language and Human. The search revealed 64 hits. An initial screen for eligibility, performed using the title and the abstract, revealed 18 eligible articles. The full guideline of these 18 potentially eligible articles were retrieved to perform a detailed screen of the full guideline. Ten guidelines were deemed eligible.
- Titles in the Medline database was searched on 19th February 2023 using the search terms: (venous insufficiency or varicose vein* or vein insufficiency) and (guideline or standard or statement). The search was limited by dates (2000-current) and by English language and Human. The search revealed

96 hits. An initial screen for eligibility, performed using the title and the abstract, revealed 17 eligible articles. The full guideline of these 17 potentially eligible articles were retrieved to perform a detailed screen of the full guideline. Twelve guidelines were deemed eligible.

- Guideline libraries were searched on 17th February 2023 to identify relevant guidelines. Searches of the Department of Health and Aged Care (Australian Government), Agency for Clinical Innovation (NSW) and National Institute of Health revealed no relevant guidelines. A search of the GIN National guidelines library, and NICE found 2 identical relevant guidelines.
- Additional searches of the reference lists of identified relevant guideline, and the personal libraries of guideline development group members revealed 21 additional guidelines.

After screening for duplicates, a total of 41 CPGs were deemed relevant to inform the new guideline (Table APP 2.4). These were used as core resources to develop the CPG.

## Critical appraisal of identified, existing and relevant guidelines

Quality assessment of the 41 identified guidelines was performed using Domain 3 (Rigour of Development) of the Agree II tool. [201] Each guideline was critically appraised using this tool by four members of the guideline working group. Each guideline was analysed by different appraisers, excepting for one appraiser who reviewed every guideline. Exceptions to this methodology were made for 10 guidelines, which is explained in note below.

A scaled domain score was calculated using the equation below:

$$\frac{\text{Obtained score* (Domain 3)} - \text{Minimum possible score (Domain 3)}}{\text{Maximum possible score (Domain 3)} - \text{Minimum possible score (Domain 3)}} * 100$$

**sum of scores of the individual items in Domain by 4 appraisers*

The minimum possible score was 32 (1(minimum score for domain 3)* 8(items in domain 3)*4 (appraisers))
The maximum possible core was 224 ((maximum score for domain 3)* 8 (items in domain 3)* 4 (appraisers))

Scaled domain scores were graded as good if ≥ 80%, acceptable if 60%–79%, low if 40%–59% and very low if <40%.
The intraclass correlation coefficient used to test agreement of the means of scores between appraisers of the means of scores was 0.614. Table APP 2.4 summarises the scaled rating scores for each identified CPG. Only 6/41 were acceptable or good.
*Note: Exceptions to critical appraisal methodology. Critical appraisal scores for domain 3 for 10 guidelines were published by Liu et al. [201] These scores were used to assess the quality of each of these guidelines using 4 appraisers, and calculated the same way as described above.*

Of the 41 identified guidelines, only four stated recommendations that were directly relevant to the questions posed for this CPG (Table APP 2.5)

Table APP 2.3 Questions used to develop evidence based clinical practice guideline: Duplex ultrasound examination for the assessment of the lower limb for chronic venous insufficiency.

| | |
|---|---|
| **Section B: What background information should be covered in this guideline?** | • Definition of chronic venous disorder, chronic venous disease.<br>• Contributing risk factors<br>• Signs and symptoms<br>• Pathophysiology<br>• Prevalence and socioeconomic burden<br>• The role of duplex ultrasound in chronic venous disease |
| **Section C: What venous anatomy is relevant to CVI ultrasound examination?** | • General terminology<br>• Deep System (i.e. FV vs SFV)<br>• Superficial Systemv<br>• Perforating Veins (including topographic classifications)<br>• Anatomical variations (e.g. SFJ, SPJ) |
| **Section D: Pre-examination considerations (for different clinical scenarios, ie primary varices, secondary varices, recurrent varices, post-operative)** | • What is the purpose of venous insufficiency ultrasound examination?<br>• What are the indications, contraindications and limitations of duplex ultrasound to investigate chronic venous disease?<br>• What patient preparation is required?<br>• What explanation should be provided to the patient prior to the examination?<br>• What medical and surgical patient history should the sonographer collect?<br>• How should the sonographers perform clinical assessment prior to the examination? |
| **Section E: Performing and interpreting the venous insufficiency ultrasound examination** | • What information does the vascular care provider need?<br>• Scanning protocol for VI ultrasound examination (includes general guidance and guidance for specific veins in how to assess and interpret images using B-mode, colour and spectral Doppler, vein diameter measurement, cutoff values for duration of reverse flow to diagnose venous reflux, considerations for pre-and post-treatment assessment and when to extend the examination).<br>• Differential diagnosis |
| **Section F: General considerations** | • What qualification or training is required for sonographers performing duplex ultrasound to investigate chronic venous disease?<br>• What are the potential limitations and difficulties that may be encountered in the examination?<br>• Are there any ethical concerns?<br>• When do should a bilateral examination be performed?<br>• What instrumentation and settings are required to perform the exam?<br>• How long should the venous insufficiency ultrasound examination take?<br>• What are relevant safety issues, and risk of injuries? How should they be mitigated?<br>• How should the venous insufficiency examination be reported/recorded?<br>• What criteria should be used to triage patients by urgency for performing and reporting the duplex ultrasound examination? |
| **Section G: Technical considerations** | • What time of the day should the venous insufficiency ultrasound examination be performed?<br>• What position should the patient be in during the venous insufficiency ultrasound examination?<br>• What manoeuvres should be used to elicit venous reflux? |

Table APP 2.4: Ratings for identified, relevant, existing Clinical Practice Guidelines

| **Clinical practice guideline** | **Agree II scaled rating domain score (Domain 3)** | **Agree II grading (Domain 3)** | **Addresses:** | | |
|---|---|---|---|---|---|
| | | | **Treatment and manage-ment** | **Anatomy and nomen-clature** | **DUS examin-ation** |
| 1. Sclerotherapy in the treatment of varicose veins: S2k guideline of the Deutsche Gesellschaft für Phlebologie (DGP) in cooperation with the following societies: DDG, DGA, DGG, BVP [80] | 44.8 | Low | Yes | No | No |
| 2. Clinical and duplex ultrasound evaluation of lower extremities varicose veins–a practical guideline [45] | 45.3 | Low | No | Yes | Yes |
| 3. The wound/burn guidelines–5: Guidelines for the management of lower leg ulcers/varicose veins [30] | 54.2 | Low | Yes | Yes | Yes |
| 4. Guidelines of the first international consensus conference on endovenous thermal ablation for varicose vein disease–ETAV consensus meeting 2012 [79] | 62.5 | Acc | Yes | Yes | Yes |

| | | | | | |
|---|---|---|---|---|---|
| 5. Diagnosis and management of varicose veins in the legs: summary of NICE guidance [203] | 73.4 | Acc | Yes | No | Yes |
| 6. The care of patients with varicose veins and associated chronic venous diseases: clinical practice guidelines of the Society for Vascular Surgery and the American Venous Forum [8] | 74.5 | Acc | Yes | Yes | Yes |
| 7. Importance of ultrasound evaluation in the diagnosis of venous insufficiency: guidelines and techniques [48] | 18.2 | Very low | No | Yes | Yes |
| 8. Multi-society consensus quality improvement guidelines for the treatment of lower-extremity superficial venous insufficiency with endovenous thermal ablation from the Society of Interventional Radiology, Cardiovascular Interventional Radiological Society of Europe, American College of Phlebology and Canadian Interventional Radiology Association [21] | 51.6 | Low | Yes | Yes | No |
| 9. Recommended reporting standards for endovenous ablation for the treatment of venous insufficiency: joint statement of the American Venous Forum [92] | 41.1 | Low | Yes | No | No |
| 10. Guidelines for Sclerotherapy of Varicose Veins [204] | 41.7 | Low | Yes | No | No |
| 11. Investigation of chronic venous insufficiency: a consensus statement [44] | 20.8 | Very low | Yes | No | Yes |
| 12. European College of Phlebology guideline for truncal ablation [72] | 25 | Very low | Yes | Yes | No |
| 13. Consensus statement on the symptom-based treatment of chronic venous diseases [78] | 53.6 | Low | Yes | No | No |
| 14. AIUM Practice Parameter for the Performance of a Peripheral Venous Ultrasound Examination [205] | 34.9 | Very low | No | No | Yes |
| 15. ACR–AIUM–SPR–SRU Practice Parameter for the performance of Peripheral Venous Ultrasound Examination [83] | 53.1 | Low | No | No | Yes |
| 16. Duplex ultrasound investigation of the veins of the lower limbs after treatment for varicose veins–UIP consensus document [20] | 47.4 | Low | Yes | No | Yes |
| 17. Consensus for the treatment of varicose vein with radiofrequency ablation [106] | 47.4 | Low | Yes | No | Yes |
| 18. Varicose Veins of the Lower Extremity: Doppler US Evaluation Protocols, Patterns, and Pitfalls [40] | 31.8 | Very low | No | Yes | Yes |
| 19. Diagnosis and treatment of varicose veins in the legs[46] | 88.5 | Good | Yes | No | No |
| 20. Varicose Veins in the Legs: The Diagnosis and Management of Varicose Veins [41] | 56.3 | Low | Yes | No | No |
| 21. Editor's choice–European Society for Vascular Surgery (ESVS) 2022 clinical practice guidelines on the management of chronic venous disease of the lower limbs [42] | 57.8 | Low | Yes | Yes | Yes |
| 22. The 2022 Society for Vascular Surgery, American Venous Forum, and American Vein and Lymphatic Society clinical practice guidelines for the management of varicose veins of the lower extremities. Part I. Duplex scanning and treatment of superficial truncal reflux [9] | 50 | Low | Yes | No | Yes |
| 23. Position Statement Respective roles for endothermal ablation, Foam UGS, Cyanoacrylate Adhesive Closure and Surgery in the management of incompetent saphenous veins and their major tributaries. [206] | 37 | Very low | Yes | No | No |
| 24. Diagnose venous disease and treat superficial venous incompetence with Endovenous Laser Ablation under Ultrasound Guidance [207] | 31.3 | Very low | Yes | No | Yes |
| 25. CP - 'Endovenous Laser Ablation - Clinical procedure' [110] | 42.7 | Low | Yes | No | Yes |
| 26. Cyanoacrylate closure for peripheral veins: Consensus document of the Australasian College of Phlebology [99] | 42.7 | Low | Yes | No | No |
| 27. Lower Extremity Venous Duplex Evaluation for Insufficiency [85] | 42.7 | Low | No | No | Yes |
| 28. Duplex Ultrasound Imaging Of Lower Extremity Veins in Chronic Venous Disease, Exclusive of Deep Venous Thrombosis: Guidelines for Performance and Interpretation of Studies [175] | 32.3 | Very low | Yes | No | Yes |
| 29. American College of Phlebology Guidelines–Treatment of refluxing accessory saphenous veins [61] | 20.8 | Very low | Yes | No | No |
| 30. Duplex ultrasound in the assessment of lower extremity venous insufficiency [34] | 46.8 | Low | No | Yes | Yes |
| 31. Duplex ultrasound investigation of the veins in chronic venous disease of the lower limbs–UIP Consensus Document. Part I: Basic principles [81] | 70.3 | Acc | No | Yes | Yes |
| 32. Duplex ultrasound investigation of the veins in chronic venous disease of the lower limbs-UIP Consensus Document. Part II: Anatomy [38[] | 70.3 | Acc | No | Yes | Yes |
| 33. Peripheral Venous Ultrasound [109] | 21.4 | Very low | No | No | Yes |
| 34. Lower Limb Venous Reflux Duplex Ultrasound Examination [82] | 7.8 | Very low | No | No | Yes |

| | | | | | |
|---|---|---|---|---|---|
| 35. Treatment of Superficial Venous Disease of the Lower Leg [60] | 53.1 | Low | Yes | No | No |
| 36. Recommendations for the referral and treatment of patients with lower limb chronic venous insufficiency [208] | 19.3 | Very low | Yes | No | No |
| 37. Application of Clinical Practice Guidelines for the Management of Varicose Veins and Chronic Venous Disease to Canadian Practice [47] | 52.1 | Low | No | No | Yes |
| 38. ACCF/ACR/AIUM/ASE/IAC/SCAI/SCVS/SIR/SVM/SVS/SVU 2013 appropriate use criteria for peripheral vascular ultrasound and physiological testing part II: testing for venous disease and evaluation of hemodialysis access: a report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force [84] | 37.5 | Low | Yes | No | No |
| 39. Venous insufficiency evaluation with duplex scanning [86] | 26 | Very low | No | No | No |
| 40. Duplex ultrasound evaluation of patients with chronic venous disease of the lower extremities [68] | 39.1 | Very low | No | No | No |
| 41. Duplex ultrasound technical considerations for lower extremity venous disease [113] | 40.6 | Low | No | No | Yes |

Shaded cells represent clinical guidelines assessed for quality as reported by Liu et al,[201] mean of four reviewers
Acc; Acceptable, DUS; Duplex ultrasound.

Table APP 2.5: Existing clinical practice guidelines providing recommendations directly relevant to questions posed in this Clinical Practice Guideline.

| CPG Number (refer Table APP 2.4) | Recommendation | Published evidence rating | Range of available ratings published in the CPG |
|---|---|---|---|
| 6. [8] | We recommend that the four components of a complete duplex scanning examination for chronic venous disease should be visualisation, compressibility, venous flow, including measurement of duration of reflux, and augmentation | 1A | Grade of recommendation<br>1 strong<br>2 weak<br>Strength of evidence<br>A, B, C |
| | We recommend that reflux to confirm valvular incompetence in the upright position of the patients be elicited in one of two ways: either with increased intraabdominal pressure using a Valsalva manoeuvre to assess the common femoral vein and the saphenofemoral junction, or for the more distal veins, use of manual or cuff compression and release of the limb distal to the point of examination. | 1A | |
| | We recommend a cutoff value of 1 second for abnormally reversed flow (reflux) in the femoral and popliteal veins and of 500ms for the great saphenous vein, the small saphenous vein, the tibial, deep femoral, and the perforating veins. | 1B | |
| | We recommend that in patients with chronic venous insufficiency, duplex scanning of the perforating veins is performed selectively. We recommend that the definition of "pathologic" perforating veins includes those with an outward flow of duration of 500ms, with a diameter of 3.5 mm and a location beneath healed or open venous ulcers (CEAP class C5-C6). | 1B | |
| 21. [42] | For patients with suspected suprainguinal venous obstruction, in addition to full leg duplex assessment, ultrasound of the abdominal and pelvic veins should be considered as part of the initial assessment. | 2aC | Classes of recommendation:<br>1, 2a, 2b, 3<br>Levels of evidence<br>A,B,C |
| | For patients presenting with symptomatic varicose veins where there may be a pelvic origin, specific duplex ultrasound assessment of pelvic escape points is recommended. | 2aB | |
| | For female patients with suspected pelvic venous disorders, abdominal and/or transvaginal ultrasound should be considered to confirm the presence of venous pathology | 2aB | |
| 22. [9] | Reflux is defined as a minimum value> 500ms of reversed flow in the superficial truncal veins (great saphenous vein, small saphenous vein, anterior saphenous vein, posterior accessory great saphenous vein) and in the tibial, deep femoral, and perforating veins. A minimum value >1 second of reversed flow is diagnostic of reflux in the common femoral, femoral, and popliteal veins. | Implement-ation remarks | |
| | Axial reflux is defined as uninterrupted retrograde venous flow from the groin to the calf. Retrograde flow can occur in the superficial or deep veins, with or without perforating veins. Junctional reflux will be limited to the saphenofemoral or saphenopopliteal junction. Segmental reflux occurs in a portion of a superficial or deep truncal vein. | | |
| | A definition of "pathologic" perforating veins in patients with varicose veins (CEAP [Clinical Class, Etiology, Anatomy, Pathology] clinical class C2) includes those with an outward flow duration of 500ms and a diameter of 3.5mm on duplex ultrasound. | | |
| | We recommend that evaluation of reflux with duplex ultrasound be performed in an Intersocietal Accreditation Commission or American College of Radiology accredited vascular laboratory by a credentialed ultrasonographer, with the patient standing whenever possible. A sitting or reverse Trendelenburg position can be used if the patient cannot stand. | | |

| | | | |
|---|---|---|---|
| | We recommend that for evaluation of reflux with duplex ultrasound, we use either a Valsalva manoeuvre or distal augmentation to assess the common femoral vein and saphenofemoral junction and distal augmentation with either manual compression or cuff deflation for evaluation of more distal segments. Superficial reflux must be traced to its source, including the saphenous junctions, truncal or perforating veins, or pelvic origin varicose veins. The study should be interpreted by a physician trained in venous duplex ultrasound interpretation. | Ungraded good practice statement | |
| | We recommend that a complete duplex ultrasound scanning examination for venous reflux in the lower extremities should include transverse greyscale images without and with transducer compression of the common femoral, proximal, mid, and distal femoral and popliteal veins, saphenofemoral junction, and great and small saphenous veins. | | |
| | We recommend that a complete duplex ultrasound scanning examination for venous reflux in the lower extremities should include measurement of the spectral Doppler waveform using calipers. Reflux at baseline and in response to a Valsalva manoeuvre or distal augmentation in the common femoral vein and at the saphenofemoral junction and in response to distal augmentation in the mid-femoral and popliteal vein, the great saphenous vein at the proximal thigh and knee, the anterior saphenous vein and small saphenous vein, and at sapheno-popliteal junction or proximal calf should be documented. | | |
| | We recommend that a complete duplex ultrasound scanning examination for venous reflux in the lower extremities should include diameter measurements in patients with the leg in the dependent position, from the anterior to the posterior wall, at the saphenofemoral junction, in the great saphenous vein at the proximal thigh and at the knee, in the anterior saphenous vein,and in the small saphenous vein at the saphenopopliteal junction or proximal calf. Images of both normal and abnormal findings should be documented in the records of the patient. | | |
| 35. [60] | We recommend all patients being considered for treatment must have a duplex ultrasound of the superficial venous system and, at a minimum, evaluation of the common femoral vein and popliteal vein for patency and competence. The exam should ideally be done in the standing position. | Grade 1A | Strength of recommendation: 1,2<br>Level of evidence A,B,C |
| | We suggest all noninvasive vascular diagnostic studies be per formed by a qualified physician or by a qualified technologist under the general supervision of a qualified physician. | Grade 1C | |
| | We recommend that named veins (Great Saphenous Vein (GSV), Small Saphenous Vein (SSV), Anterior Saphenous Vein (ASV), Posterior Accessory of the Great aphenous Vein (PAGSV), Intersaphenous Vein (Vein of Giacomini)) must have a reflux time > 500 msec, regardless of the reported vein diameter. | Grade 1A | |
| | We suggest treatment of incompetent perforating veins located beneath a healed or open venous ulcer. They should have outward flow of 500 ms, with a diameter of 3.5 mm. | Grade 2B | |

Key: CPG; Clinical practice guideline

## Methodology used to develop *educative content* and *general clinical guidance*

Drafts of *educative content* and *general clinical guidance* were developed by two authors using information from existing literature and relevant guidelines. The drafts were reviewed and discussed by guideline working group members at web-based meetings and by email circulation of the documents until approved by the group and accepted as final versions.

## Methodology used to develop *recommendations*

For guideline questions that could be answered succinctly via recommendations the following steps were followed.

**Step 1:** An information sheet relating to each specific recommendation was drafted by two guideline working group members. This information sheet included a suggested recommendation with an evidence-based supporting evidence which included any explicit and relevant evidence graded recommendations published in existing guidelines (if available) and summaries of relevant studies identified in the literature. A summary statement to support the recommendation was also drafted and included in the worksheet.

**Step 2:** The information sheet was presented and discussed at a web-based meeting of the guideline working group. If necessary, amendments were made to the worksheet based on discussions.

**Step 3:** An online survey tool was used to elicit confidential and anonymous feedback on the recommendations and its summary statement from the guideline working group.

In the online survey, for each recommendation, each guideline working group member was asked to:

- Vote (yes/no) to the wording of the recommendation. They were also given the opportunity to suggest alternate wording or provide justifications for their voting response.

- Rate the recommendation for its level of evidence. They could refer to information in the worksheet to see evidence ratings from existing guidelines and any identified relevant research studies.
  The ratings were as follows:
    - A (strong): Data derived from multiple randomized clinical trials or meta-analyses (I have attempted to identify if studies in the summary table are RCTs or not)
    - B (moderate) Data derived from a single randomized trial or non-randomised studies
    - C (weak) Only consensus opinion of experts, case studies, or standard-of-care. (i.e., only existing clinical guidelines to support, no identified studies in the literature)
- Rate the recommendation for its strength of evidence. This rating is a blend of 'evidence' and 'clinical experience; based on the overall level of evidence, as well as the practicalities of the recommendation in practice, such as the balance between benefits and harm, and the balance between benefits and costs.
  The ratings were as follows:
    - Strong. There is evidence for and/or I agree that the recommendation is beneficial, not harmful, useful, and effective.
    - Moderate. There is conflicting evidence and/or I agree that there is a balance between benefits and harm and cost.
    - Weak. There is no evidence or weak evidence to support the recommendation and/or I agree that the recommendation is not useful or effective and in some cases may be harmful.

Overall scores for the level of evidence and strength of evidence were based on the rating that received the majority of votes from the guideline working group. A consensus rating was also given based on the number of working group members who agreed or disagreed with the recommendation (high consensus =6-9 in agreement with recommendation, moderate consensus = less than 6 in agreement with recommendation)
**Step 4:** Anonymised results of the online survey were taken back to the group in a web-based meeting to give members an opportunity to discuss and fine-tune the final wording of the recommendation and its summary statement.

*Outline of information sheets, survey questions, and survey responses used to develop recommendations*

Recommendation E1

**Information Sheet (Recommendation E1)**

Draft recommendation:

**We recommend that a complete duplex scanning examination for chronic venous disease of the lower limb should evaluate deep, superficial, and perforating veins for patency and competency using B-mode ultrasound, colour and spectral Doppler ultrasound. Measurements of reflux duration and diameter of veins should also be made.**

Draft summary statement:

This recommendation outlines the overall requirements of a DUS examination of the lower limb veins in the setting of chronic venous disease. This is consistent with existing evidence-based guidelines (guidelines 6,22,35). Further commentary on the role and techniques of B-mode, colour and spectral imaging, and to which veins they should be applied is provided in the following sections.

Supporting evidence:

This recommendation has been adapted from existing recommendations outlined in the table below.

Summary of recommendations in existing guidelines that describe characteristics of a duplex US examination for chronic venous disease of the lower limb.

| Guideline number | Quadas II score (rigour of development) | Extracted recommendation | Evidence Rating stated by authors of guideline (rating range) |
|---|---|---|---|
| 6 | 74.5 acceptable | We recommend that the four components of a complete duplex scanning examination for chronic venous disease should be visualisation, compressibility, venous flow, including measurement of duration of reflux, and augmentation | 1A<br>Grade of recommendation 1 (1; strong, 2; weak)<br>Strength of evidence A (A, B, C) |
| | | We recommend that in patients with chronic venous insufficiency, duplex scanning of the perforating veins is performed selectively. | 1B<br>Grade of recommendation 1 (1; strong, 2; weak)<br>Strength of evidence B (A, B, C) |

| | | | |
|---|---|---|---|
| 22 | 50 (low) | We recommend that a complete duplex ultrasound scanning examination for venous reflux in the lower extremities should include transverse grayscale images without and with transducer compression of the common femoral, proximal, mid, and distal femoral and popliteal veins, saphenofemoral junction, and great and small saphenous veins. | Implementation remarks |
| | | We recommend that a complete duplex ultrasound scanning examination for venous reflux in the lower extremities should include measurement of the spectral Doppler waveform using calipers. Reflux at baseline and in response to a Valsalva manoeuvre or distal augmentation in the common femoral vein and at the saphenofemoral junction and in response to distal augmentation in the mid-femoral and popliteal vein, the great saphenous vein at the proximal thigh and knee, the anterior accessory great saphenous vein and small saphenous vein, and at sapheno-popliteal junction or proximal calf should be documented. | |
| | | We recommend that a complete duplex ultrasound scanning examination for venous reflux in the lower extremities should include diameter measurements in patients with the leg in the dependent position, from the anterior to the posterior wall, at the saphenofemoral junction, in the great saphenous vein at the proximal thigh and at the knee, in the anterior accessory great saphenous vein,and in the small saphenous vein at the saphenopopliteal junction or proximal calf. Images of both normal and abnormal findings should be documented in the records of the patient. | |
| 35. | 53.1<br>low | We recommend all patients being considered for treatment must have a duplex ultrasound of the superficial venous system and, at a minimum, evaluation of the common femoral vein and popliteal vein for patency and competence. | Grade 1A<br>Grade of recommendation 1 (1; strong, 2; weak)<br>Strength of evidence A (A, B, C) |

## Anonymous web-based survey questions (Recommendation E1)

1. Do you agree with the recommendation?
2. If you do not agree with the recommendation, please state your reasons?
3. Do you have any suggestions for rewording of the recommendation, without losing the intent of the recommendation as currently written?
4. Please provide a level of evidence rating for the recommendation.
5. Please provide a strength of evidence rating for the recommendation.

## Results of web-based survey (Recommendation E1)

Number of respondents=9

1. Do you agree with the recommendation? Yes=9
2. If you do not agree with the recommendation, please state your reasons?
    - A complete examination requires all of these imaging techniques to identify any pathologies that may exist in the setting of chronic venous disease
    - I think longer durations of reflux can be eyeballed and don't necessarily need to be measured. Perhaps measurement should only be made for shorter durations if unsure? Also, I think it is only worth measuring the diameter of incompetent veins as those are the ones being targeted for treatment. I definitely agree with B mode and spectral doppler being used for patency and competency, however I do not think colour is required for most of the assessment. But I agree colour is a tool that can be used occasionally to assess for reflux.
    - In a radiology practice, sonographers will measure everything, this may lead to unnecessary longer scanning times, incorrect reporting, and a need for additional imaging if a patient arrives at a vascular lab
3. Do you have any suggestions for rewording of the recommendation, without losing the intent of the recommendation as currently written?
    - We recommend that a complete duplex scanning examination for chronic venous disease of the lower limb should evaluate deep, superficial, and perforating veins for patency and competency. The use of B mode and spectral Doppler are essential for assessment however colour Doppler can also be employed for patency or quick incompetence screening. Measurements of reflux duration should be taken when a vein is not grossly incompetent to assess whether it meets the cut off duration for incompetence. Diameters should be taken of any incompetent veins to enable the medical practitioner to offer appropriate treatment options.
    - We recommend that a duplex examination for chronic venous disease include evaluation of deep, superficial veins: that evaluation include B-Mode, colour, spectral Doppler. That spectral Doppler measurements include reflux duration and if deemed incompetent that its diameter be measured.
4. Please provide a level of evidence rating for the recommendation. Weak n=3, Moderate n=1, Strong n=5
5. Please provide a strength of evidence rating for the recommendation. Weak n=0, Moderate n=2, Strong n=7

**Information Sheet (Recommendation E2)**

Draft recommendation:

**In relation to the method of measuring vein diameter, between the anterior and posterior vein walls in CVD duplex US, we recommend that the measurement should be made:**

a. **with patient's legs in a dependent position:**
b. **from a transverse image of the vein**
c. **between the inner walls**
d. **with the vein at rest and not during any reflux provocation manoeuvres**
e. **with the vein uncompressed**

Draft summary statement:

A number of existing guidelines, when describing the procedure and technique of duplex US, state that measurements of vein diameter should be made. [30, 45, 83, 85] However, these guidelines provide little detail on the veins which should be measured, the measurement technique or on the evidence-based rationale for making these measurements. One rationale to measure vein diameter, is that existing evidence-based guidelines for the CVD treatment refer to vein size to guide treatment decisions. [8, 9, 42, 60, 78] Another rationale for performing measurements is that they may serve as surrogate markers for reflux and disease severity. Seven studies provide support for this, by demonstrating associations between diameter measurements and reflux and diameter severity. [103-108]

One existing guideline, [20] provides the most detail about where measurements should be made, and has been adopted by other guidelines. [30, 45, 110] They suggest diameter measurements should be made at the:

- great saphenous vein (GSV): of incompetent sections at 3 cm below the saphenofemoral junction (SFJ), at mid-thigh level, at the knee and also at mid-calf level.
- anterior saphenous vein (ASV): measured 3 cm below the SFJ and at mid-thigh (if the trunk exists at this level).
- posterior accessory saphenous vein (PASV)
- small saphenous vein (SSV): 3 cm below the saphenopopliteal junction (SPJ) where the pre-terminal valve, if present, is located. A mid-calf measurement should also be made.
- thigh extension of SSV/Giacomini vein

They also state that aneurysmal sections of the vein should not be measured, and in cases of treated veins, the outer diameter of the obliterated vein can be measured, and the residual inner lumen of the visible vein can be assessed in case of partial or complete patency.

Measurement sites in other guidelines also include perforating veins with abnormal flow profiles, [103] perforating veins ≥ 3.5 mm. [85]

Our recommendations for diameter measurements of the GSV are based on five studies. [103, 105-108] Our recommendations for diameter measurements of the SSV are based on the study of Joh and Park [106] and our recommendations for diameter measurements for perforator veins are based on studies by Sandri et al. [102] and Labropoulos et al. [104] There is no available evidence in the literature to support measurements of the other veins for which we recommend diameter measurements. These instead were determined through a consensus decision of the guideline working group via a web-based survey.

All existing clinical practice guidelines describing measurement techniques are consistent in measuring the vein with the patient in the dependent position, applying no external pressure to the vein when making the measurements. [85] These considerations are also consistent with measurement techniques in studies looking at associations between vein diameters, clinical severity and reflux. [105, 107, 108] De Maeseneer et al., [20] states that the measurement should be performed in the transverse view, and the outer diameter should be measured (to include the vein wall), so that comparisons can be made after endovenous ablation. [20]

Supporting evidence:

<u>Summary of Initial working group discussions about technique of measuring vein diameter in setting of chronic venous disease</u>

*Do you perform diameters measurements of veins?*

Amongst those present, some sonographers were regularly performing these measurements, others were not.

Reasons cited for performing measurements included; easy to do and does not take long, to assist in treatment decisions (including to inform about vein access, dose of injecting agent, impacts of size on treatment outcome), a large vein (>5mm) is an indicator of reflux, a large vein may not necessarily exhibit reflux when there is a small distal capacitance (high velocity and high volume reversed flow may be observed), treating doctor wants it, can help answering clinical question when there is a change in calibre of a vein.

Reasons cited for not performing measurements included; never been asked to do it (by treating doctor who will eyeball rather than rely on measurements).

There was some discussion about the different circumstances in which they would measure and document a vein diameter measurement, and these included if the vein demonstrated reflux, if the vein was larger than 5mm, if it was required to help answer the clinical question, if the treating physician asked for the measurement, and which vein it is.

There was some discussion about the difference between speciality practices and general practices, is it reasonable to recommend measuring vein diameters in general practice, when it could have an impact on the length of the examination?

A comment was made that the Medicare Benefits Schedule specifies vein diameters for therapeutic procedures, however a search of the schedule (items numbers 32500, 32507, 32508, 32511, 32514, 32517), demonstrates that diameter measurements are no longer a requirement for reimbursement for therapies.

*How should measurements be performed?*

- There was agreement that vein diameter measurements should be performed, with the patient in the erect position, or with the legs in a dependent position.
- ? Measurement from inner-inner border or from outer-outer border: It was thought given the thickness of the vein wall, and variability of measurements due to other factors that if the measurement was made from the inner or outer borders, that it would not impact much on the measurement. Method may also depend on other factors such as if the vessel is thrombosed (which makes identifying inner borders difficult, and intra-luminal diameter variable).
- There was agreement that perforating veins should be measured where they pass through the fascia.
- Measurements were generally made from the transverse plane, with some exceptions i.e., SFJ and SPJ where longitudinal measurements were made instead.
- Discussion on whether diameter measurements are made with the vein at rest or under influence from a provocation manoeuvre such as Val Salva. Comment made that measurement was made at rest.

Summary of evidence-based recommendations relating to vein diameters and treatment (associations between vein diameter and reflux, and vein diameter and disease severity)

<table>
<tr><th>Guideline number</th><th>Quadas II score rated by guideline working group (rigour of development)</th><th>Extracted recommendation</th><th>Evidence rating stated by authors of guideline (rating range)</th></tr>
<tr><td>1</td><td>low</td><td>For foam sclerotherapy: The following concentrations should be observed in proportion to the diameter of the treated vein segment. The suggested concentrations and amounts are reference values and may be adapted according to the therapist’s assessment
<table>
<tr><td rowspan="4">GSV, SSV</td><td>Vein diameter</td><td>Polidocanol concentration (%)</td></tr>
<tr><td><4mm</td><td>1</td></tr>
<tr><td>≥4 to ≤8mm</td><td>1–3</td></tr>
<tr><td>>8mm</td><td>3</td></tr>
</table></td><td>No evidence rating provided</td></tr>
<tr><td>6</td><td>acceptable</td><td>We suggest treatment of “pathologic” perforating veins that includes those with an outward flow duration of 500 ms, with a diameter of 3.5 mm, located beneath a healed or open venous ulcer (CEAP class C5-C6).</td><td>2B<br>(Grade of recommendation 1,2 Level of evidence A,B,C)</td></tr>
<tr><td>17</td><td>low</td><td>The working group suggested the vein diameter for radiofrequency ablation should be from 2 mm to 20 mm. This issue is directly related to the indication for RFA in terms of diameter criteria. Therefore, the working group suggested 2 mm of saphenous vein as the minimum diameter for access.</td><td>Consensus decision</td></tr>
<tr><td rowspan="2">21</td><td rowspan="2">low</td><td>For patients with saphenous trunk incompetence undergoing treatment, ultrasound guided foam sclerotherapy may be considered for treating saphenous trunks with a diameter less than 6 mm.</td><td>11b, B<br>(Class of recommendations, 1,11a,11b,111, Level of evidence: A,B,C)</td></tr>
<tr><td>For patients with an incompetent great saphenous vein with a very large truncal diameter (more than 12 mm), endovenous thermal ablation should be considered.</td><td>11b, C<br>(Class of recommendations, 1,11a,11b,111, Level of evidence: A,B,C)</td></tr>
<tr><td>22</td><td>low</td><td>A definition of “pathologic”perforating veins in patients with varicose veins(CEAPclinicalclassC2) includes those with an outward flow duration of 500 ms and a diameter of 3.5mm on DUS</td><td>Implementation remarks</td></tr>
<tr><td>35</td><td>low</td><td>We suggest treatment of incompetent perforating veins located beneath a healed or open venous ulcer. They should have outward flow of 500ms, with a diameter of 3.5 mm.</td><td>2B<br>(Grade of recommendation: 1,2 low Quality of evidence; A,B,C)</td></tr>
</table>

Summary of evidence-based recommendations in existing clinical practice guidelines relating to vein diameters and treatment

Mendoza et al. 2013 [108]

*Summary:*

This study aims to clarify the clinical relevance of diameter measurements 3cm below the SFJ and mid-thigh (15 cm below SFJ) by investigating if they correlate with the importance of the vein disorder. Patients in the study had untreated isolated GSV reflux, with varices limited to its territory. The GSV was examined in the standing position and vein diameters were measured holding the probe transversely with no pressure. Duplicate measurements were taken at two sites: at the SFJ distal to the terminal valve and 15 cm below the junction. 182 legs were included in the study group and 60 legs with no GSV reflux were included as controls. There were two study groups, 1) reflux limited in thigh, and 2) reflux above and below the knee. Vein diameters were larger in the presence of reflux, compared with its absence, by an average of 3.4 mm at the SFJ ($p < 0.001$) and 2.6 mm at the mid-thigh ($p < 0.001$). No difference in diameters was found between the two study groups.

Clinical disease class was better predicted by diameter assessment at the mid-thigh than the SFJ level.

A GSV diameter of <7.5 mm at the SFJ was associated with reflux in 20%, $C_{2–5}$ disease in 21% and the combined elements in 15%, respectively. A proximal thigh diameter of <3.7 mm was associated with reflux in 3%, $C_{2–5}$ disease in 9% and the combined elements in 2%.

Measurement at the proximal thigh as compared to measurement at the SFJ demonstrated higher accuracy (both higher sensitivity and specificity) for venous disease class and prediction of reflux. This measurement is also easier than the measurement at the SFJ, because at the SFJ, the curvature of the inguinal GSV makes adjustment of the ultrasound transducer exactly perpendicular to the vein axis difficult, and the shape of the vein can be altered by the draining epigastric, pudendal and accessory veins and any present aneurysmatic dilatations caused by deep venous refluxes.

2. AL-KHATEEP et al. 2020 [107]

*Summary:*

This cross-sectional study undertook diameter measurements of the SFJ and GSV in consecutive outpatients who presented with the suspicion or presence of primary varicose veins. All measurements were performed in the standing position, with no transducer pressure applied to the vein. Duplicate measurements were taken at five sites: at the SFJ distal to the terminal valve and 15 cm below the junction, at the knee, at the proximal leg, and mid leg. The 100 studied limbs were designated into groups of 1) SFJ reflux, 2) prox thigh reflux,3) distal thigh reflux, 4) knee reflux, 5) proximal leg reflux and 6) mid leg reflux.

Vein diameters were larger in the presence of reflux, compared with its absence. Sensitivity to predict reflux with thresholds for GSV diameter were reported as:

1. Cutoff point at SFJ greater than 5.7 mm with sensitivity 77.7%.
2. Cutoff point at proximal thigh greater than 7 mm with sensitivity 44.4%.
3. Cutoff point at distal thigh greater than 5.5 mm with sensitivity 60%.
4. Cutoff point at knee greater than 4.2 mm with sensitivity 86.6%.
5. Cutoff point at proximal leg greater than 3.5 mm with sensitivity 73%.
6. Cutoff point at distal leg greater than 3 mm with sensitivity 56%.
7. Measurement at six sites revealed higher sensitivity and specificity to predict reflux.

Sensitivity to predict CFV reflux with a cutoff point greater than 10.5 mm was 77.8%.

Results were similar to those reported by Mendoza *et al*. at SFJ and proximal thigh. Measurement of GSV at knee joint can predict reflux if greater than 5.5 mm.

3. Joh and Park 2013 [106]

*Summary:*

This study aimed to explore the correlation between the largest diameter measurements and reflux in the saphenous veins among 777 patients in Korea. The GSV and SSV were measured in a supine position, 5 cm distal to the SFJ or SPJ. If an aneurysmal change was detected, the diameter was chosen at 1 cm distal to the aneurysm. Patients with a larger accessory saphenous vein than the main saphenous vein were excluded. In cases of cranial extension (CE) with a connection to the popliteal vein (PV), the diameter was measured in a similar manner. However, if there was CE without a connection to the PV, terminating at the thigh or the GSV, the diameter was measured from the popliteal fossa to 5 cm distal to the knee crease. The mean diameters of normal GSV and refluxed GSV were 5.0 ± 2.4 mm and 6.4 ± 2.0 mm, respectively, while normal SSV and refluxed SSV were 3.1 ± 1.3 mm and 5.2 ± 2.7 mm, respectively. Statistically significant differences were found between normal and refluxed diameters for both GSV (1.4 mm) and SSV (2.1 mm). The study identified a GSV diameter of ≥5.05 mm as the best cut-off for predicting reflux, with a sensitivity and specificity of 76% and 60%, respectively. For SSV, a diameter of 3.55 mm was identified as the optimal cut-off, with sensitivity and specificity at 87% and 71%, respectively.

4. Kim et al. 2020 [105]

*Summary:*

This study aimed to identify the correlation between the GSV diameter at the lower thigh (LT) and venous reflux, comparing it with diameters at the SFJ, mid-thigh (MT), and below the knee (BK). In a cohort of 99 consecutive patients with signs and symptoms of venous insufficiency in both legs, GSV diameter measurements were taken in the standing position without vein compression. The measurements were obtained at four distinct regions: 2 cm distal to the SFJ, MT (midpoint between SFJ and LT), LT (5 cm above the superior margin of the patella), and BK (5 cm below the inferior margin of the patella). The GSV diameter was recorded only when it was within the saphenous compartment, excluding extrafascial or hypoplastic segments.

The study found that at the SFJ, the median GSV diameter was 6.9 mm with reflux and 6.8 mm without reflux. At the MT, these diameters were 4.3 mm and 4.2 mm, respectively. However, at the LT, the diameters were 4.7 mm and 4.2 mm, showing a significant increase in the presence of reflux ($P < .001$). At BK, the diameters were 4.3 mm and 3.9 mm, respectively. Notably, the GSV diameter with reflux was significantly larger only in the LT region. Subdividing the LT diameter from 3 to 10 mm in 1-mm increments revealed a significantly higher presence of reflux when the diameter exceeded 5 mm ($P = .025$). The findings also revealed that limbs with a diameter of <5 mm showed reflux in 37.9%, while those with >5 mm had reflux in 56.3%, establishing a cut-off diameter for the LT region at 5 mm.

5. Engelhorn et al. 1997 [103]

*Summary:*

In this study, DUS ultrasound was used to assess the superficial veins in 100 extremities of 79 patients. Patients were examined in a standing position with diameters of the GSV measured at various levels, including the SFJ at the groin, upper, mid-, and distal thigh, knee, and upper, mid-, and distal calf. Thigh and calf measurements were averaged for analysis. The GSV diameters ranged from 2.7 to 14.0 mm at the junction, 1.5 to 12.0 mm in the thigh, and 1.3 to 8.0 mm in the calf.

The study observed a consistent decrease in GSV diameters by 2 mm from the junction to the thigh and then from the thigh to the calf. At the junction and the thigh, veins with reflux were 2 mm larger in diameter than those without reflux, while at the calf level, the difference reduced to 1 mm. The study identified optimal diameter thresholds for predicting reflux: a 7-mm threshold at the SFJ with 71% accuracy, a 4-mm threshold at the thigh with 75% accuracy, and a 4-mm threshold at the calf with 74% accuracy. These thresholds corresponded to positive predictive values (PPV) of 73%, 81%, and 89%, and negative predictive values (NPV) of 70%, 69%, and 70% for veins smaller than these thresholds, respectively.

6. Sandri et al. 1999 [102]

*Summary*:

In this study, 500 perforating veins were assessed in 116 limbs of 78 patients. In the standing position, perforating veins were identified at various aspects of the thigh and calf. Measurements of perforating vein diameter were obtained in transverse at the fascial perforation site. The study revealed significant differences in diameters between competent and incompetent perforating veins at different locations. At the medial thigh, diameters averaged 2.5 ± 0.9 mm for competent and 4.7 ± 1.9 mm for incompetent perforating veins. Similar trends were observed at the medial calf, posterior calf, and lateral calf: 2.2 ± 0.8 mm (n = 179) and 3.7 ± 1.0 mm (n = 210) at the medial calf (P < .0001), 2.2 ± 0.6 mm (n = 13) and 3.5 ± 0.8 mm (n = 37) at the posterior calf (P < .0001), and 2.1 ± 0.8 mm (n = 9) and 3.3 ± 0.7 mm (n = 18) at the lateral calf (P < .003), respectively. Furthermore, a calf perforating vein diameter of 3.5 mm or larger was predictive of reflux in 90% of cases, whereas a diameter smaller than 2.2 mm predicted the absence of reflux in 92% of cases.

7. Labropoulos et al. 1999 [104]

*Summary:*

This study aimed to investigate the flow velocity characteristics of perforating veins in relation to their location, diameter, and the competency of superficial and deep veins. The research involved examining 30 limbs in 15 symptom-free volunteers and 103 limbs in 75 patients with CVD. Duplex scanning was performed with above-knee veins assessed in the standing position and below-knee veins in the sitting position. In total, 581 PVs were identified in patients, while 106 were found in volunteers. Among patients, 28% of perforating veins were incompetent, compared to none in volunteers. The total number of perforating veins and incompetent perforating veins per limb increased significantly with the severity of CVD. The mid-calf area showed a higher presence of both competent and incompetent perforating veins in patients ($p < 0.01$). The mean diameter of competent perforating veins increased with worsening CVD, particularly between normal or C1 and C5 or C6 groups. Furthermore, the mean diameter of incompetent perforating veins in all CVD classes was significantly larger than the control ($p < 0.01$ for all comparisons). Subfascial perforator diameter was notably larger than that at the fascial level ($p < 0.001$), irrespective of the CVD class. The authors found a perforator diameter ≥3.9 mm (95% CI 3.4–4.4 mm) had 91% accuracy for predicting perforator incompetence.

## Anonymous web-based survey questions (Recommendation E2)

1. Generally speaking, I will make the measurement with the patient's legs in a dependent position
2. I think in the guideline we should state that the vein diameter measurements should be made with the patient's legs in the dependent position. Yes/No
3. Please provide a Level of evidence rating for a recommendation about having the patient's legs in a dependent position when making diameter measurements.
4. Please provide a Strength of evidence rating for a recommendation about having the patient's legs in a dependent position when making diameter measurements.
5. Are there any comments you would like to make about making a recommendation about patient position?
6. Generally speaking, I will make the measurement from a: Transverse image, b. Longitudinal image
7. I think in the guideline we should state that the vein diameter measurements should be made from a: Transverse image, b. Longitudinal image c. I don't think we should make any recommendation in the guideline about the view from which the diameter measurement should be made.
8. Please provide a Level of evidence rating for a recommendation on the view from which a diameter measurement is made.
9. Please provide a Strength of evidence rating for a recommendation on the view from which a diameter measurement is made.
10. Generally speaking, I measure from the diameter between: a. The inner walls of the vein, b. The outer walls of the vein.
11. I think in the guideline we should state that the vein diameter measurements should be made between: a. The inner walls of the vein, b. The outer walls of the vein c. I don't think we should specify this in a recommendation.
12. Please provide a level of evidence rating for a recommendation on including or not including vein walls in the measurement.
13. Please provide a Strength of evidence rating for a recommendation on including or not including vein walls in the measurement.
14. Generally speaking, I measure the vein diameter: a. With the vein at rest, b. With provocation manoeuvre such as Valsalva or distal augmentation.
15. I think in the guideline we should state that the vein diameter measurements should be made with: a. With the vein at rest, b. With provocation manoeuvres such Level of evidence rating for a recommendation on a recommendation on measuring the vein at rest or not.
16. Please provide a Strength of evidence rating for a recommendation on measuring the vein at rest or not.
17. Generally speaking, I measure the vein diameter: a. With the vein uncompressed, b. With the vein compressed.
18. I think in the guideline we should state that the vein diameter measurements should be made with: a. With the vein uncompressed, b. With the vein compressed, c. I don't think we should specify this in a recommendation
19. Please provide a Level of evidence rating for a recommendation on a recommendation on measuring the vein with compression or not.
20. Please provide a Strength of evidence rating for a recommendation on measuring the vein with compression or not.

## Results of web-based survey (Recommendation E2)

Number of respondents=9

1. Generally speaking, I will make the measurement with the patient's legs in a dependent position Yes 9/9
   Comments:
   - Hydrostatic pressure affects venous pressure / and indicates size vein for treatment options. Schlerotherapy will not be effective on larger veins
   - Venous diameter is affected by pressure. Increase in hydrostatic pressure with leg in a gravity-dependent position will maximise the venous diameter.
   - I position the patient in an erect position so the veins can be assessment under the venous pressure which may demonstrate incompetence.
   - I want the veins to be dilated. The patient would also be in this position while I am testing so it does not make sense to do the reflux testing in one position and then the measurement in another.
   - vein distended in position of assessment, more accurate, repeatable measurement
   - This is to replicate there upright position
   - To aid in reproducibility
2. I think in the guideline we should state that the vein diameter measurements should be made with the patient's legs in the dependent position. Yes 9/9
3. Please provide a Level of evidence rating for a recommendation about having the patient's legs in a dependent position when making diameter measurements. 6/9 moderate,2/9 strong,1/9 weak
4. Please provide a Strength of evidence rating for a recommendation about having the patient's legs in a dependent position when making diameter measurements. 7/9 strong, 2/9 moderate
5. Are there any comments you would like to make about making a recommendation about patient position?
   - Obviously some patients are not suitable for standing - should we say these patients are not suitable for reflux in the thigh? or maybe just perform reflux in the calf on these patients because they can sit with the leg dependent. Also perhaps a disclaimer that some patients get dizzy so the sonographer should monitor how they are feeling throughout the scan.
   - I think it is important to try and have some measure of consistency, even within practices, if a vein is measured between lying and standing there could be confusion, however, according to the table there is no strong evidence to support it, whilst Mendoza does give some credence to it though.
6. Generally speaking, I will make the measurement from a: Transverse image (n=8), b. Longitudinal image (n=1)
   Comments
   - Veins can be wider than talker, so the transverse measurement provides a better overview, especially if the vessel is varicose.
   - For larger vessels, I dont' think it matters. However, when measuring small veins in longitudinal section, ultrasound often suffers from slice-thickness artefact and reduced contrast resolution. This is not the case for transverse section. Therefore I prefer a method that works every time. Transverse section.
   - This can make it easier to assess we are taking the true maximum diameter and if we are compressing the vein.
   - I find measuring in transverse can be more consistent and reproducible because I am measuring straight up and down instead of across which can create an angle and more likely to make the measurement falsely increase. I also find wall visualisation optimal. However, I measure the sapheno-femoral and sapheno-popliteal junctions in longitudinal.
   - I measure the diameter of the junction in longitudinal view in most cases, but sometimes I also do the measurement in transverse at the orifice.
   - smaller section, able to control transducer pressure, more accurate
   - I take the measurement in the same plane and image that I Doppler in.
   - SFJ i would do in longitudinal as i can see the terminal and preterminal valve directly
7. I think in the guideline we should state that the vein diameter measurements should be made from a: Transverse image, (n=6) b. Longitudinal image (n=0), c. I don't think we should make any recommendation in the guideline about the view from which the diameter measurement should be made (n=3).
8. Please provide a Level of evidence rating for a recommendation on the view from which a diameter measurement is made. Medium 5/9, 3/9 weak, Strong 1/9
9. Please provide a Strength of evidence rating for a recommendation on the view from which a diameter measurement is made. Moderate 7/10, Strong 1/9, Weak 1/9

Comments

I believe it is important to mention that it is an optimised image with no external compression, but in regard to transverse or long, I don't believe it matters.

If there is conflicting evidence, maybe we should state that as long as the vessel walls are clearly defined then a measurement in either plane should be fine. When vessels are tortuous, sometimes a transverse measurement can be difficult to obtain. I think there are a lot of exceptions eg measuring GSV/SSV in transverse but SFJ/SPJ in long so I don't think we should recommend a gold standard for

10. Generally speaking, I measure from the diameter between: a. The inner walls of the vein (n=7), b. The outer walls of the vein (n=2.

Comments

I believe it is important to mention that it is an optimised image with no external compression, but in regard to transverse or long, I don't believe it matters.

If there is conflicting evidence, maybe we should state that as long as the vessel walls are clearly defined then a measurement in either plane should be fine. When vessels are tortuous, sometimes a transverse measurement can be difficult to obtain. I think there are a lot of exceptions eg measuring GSV/SSV in transverse but SFJ/SPJ in long so I don't think we should recommend a gold standard for

11. I think in the guideline we should state that the vein diameter measurements should be made between: a. The inner walls of the vein (n=4), b. The outer walls of the vein (n=2) c. I don't think we should specify this in a recommendation (n=3).

Comments

There isnt much of a difference because the walls are generally very thin.

Venous walls are thin and it is often harder to distinguish the adventitial wall interface rather than the intimal wall interface. 2) When matching a needle/cannula/introducer to the size of the vessel, it's important to know the luminal diameter.

Veins have thinner walls than arteries. I find inner to inner allows for clear assessment of the lumen which is necessary to determine treatment options.

Vein walls are thin and unlikely to affect the outcome of the result

12. Please provide a level of evidence rating for a recommendation on including or not including vein walls in the measurement. Weak 6/9, Moderate 3/9
13. Please provide a Strength of evidence rating for a recommendation on including or not including vein walls in the measurement. Moderate 5/9, Weak 2/9, Strong 2/9
14. Generally speaking, I measure the vein diameter: a. With the vein at rest (n=9), b. With provocation manoeuvre such as Valsalva or distal augmentation.

Comments

The vein will naturally dilate wth provocative move, so is not a natural measure

Ease of doing it.

I believe this is more reproducible

During treatment, the veins will be at rest. The measurement is taken to guide treatment, so it makes sense for me to measure them this way. Valsalva and augmentation is difficult to accurately reproduce

15. I think in the guideline we should state that the vein diameter measurements should be made with: a. With the vein at rest (n=8), b. With provocation manoeuvres such as Valsalva or distal augmentation, c. I don't think we should specify this in a recommendation (n=1).
16. Please provide a Level of evidence rating for a recommendation on measuring the vein at rest or not. Weak 4/9, Moderate 3/9, Strong 2/9
17. Please provide a Strength of evidence rating for a recommendation on measuring the vein at rest or not. Moderate 6/9, Strong 2/9, Weak 1/9

Comments

Measurements are taken of the veins to guide treatment. It does not make sense to me to measure them in a way that increases dilation. It also creates a lot more work for the sonographer instructing the patient (valsalva is hard to achieve with many patients) or doing extra augmentations on a leg which might already be sore. This could increase scan time and patient discomfort.

18. Generally speaking, I measure the vein diameter: a. With the vein uncompressed (n=8), b. With the vein compressed (n=1).
19. I think in the guideline we should state that the vein diameter measurements should be made with: a. With the vein uncompressed (n=7), b. With the vein compressed, c. I don't think we should specify this in a recommendation (n=2).
20. Please provide a Level of evidence rating for a recommendation on a recommendation on measuring the vein with compression or not. Weak 5/9, Strong 3/9, Moderate 1/9

    Please provide a Strength of evidence rating for a recommendation on measuring the vein with compression or not. Strong 6/9, Weak 2/9, Moderate 1/9

Comments

I don't believe this requires a recommendation

There is no point measuring a compressed vein. An image of a compressed vein is usually only taken to show patency. The vein should be measured uncompressed to show the flow lumen.

## Recommendation E3

**Information Sheet (Recommendation E3)**

Draft recommendation:

**Sonographers should not use static colour images for the representation and documentation of venous reflux within a sampled vein segment; instead a Doppler spectral trace should be used.**

Draft summary statement:

While colour Doppler is an efficient surveillance tool in detecting venous reflux, static colour Doppler images do not represent the full cycle of venous flow during a reflux provocation manoeuvre and do not allow for effective measurement of reflux times. [34] Instead, venous reflux should be recorded and documented using a representative Doppler spectral trace, which demonstrate venous flow over time, and from which a measurement of the duration of retrograde flow can be calculated. [199]

**Anonymous web-based survey questions (Recommendation E3)**

1. Do you agree with the recommendation?
2. If you do not agree with the recommendation, please state your reasons?
3. Do you have any suggestions for rewording of the recommendation, without losing the intent of the recommendation as currently written?
4. Please provide a level of evidence rating for the recommendation.
5. Please provide a strength of evidence rating for the recommendation.

**Results of web-based survey (Recommendation E3)**

Number of respondents=9

1. Do you agree with the recommendation? Yes n=9
2. If you do not agree with the recommendation, please state your reasons?
    - Static colour can assist in demonstrating incompetency at the SFJ - however it should not be relied on
    - You can't measure reflux time with just colour - you need the spectral trace. Reflux time >0.5 secs for varicose veins is required by Medicare to plan treatment and receive Medicare rebates
3. Do you have any suggestions for rewording of the recommendation, without losing the intent of the recommendation as currently written?
    - Sonographers may complement their Spectral Doppler trace with colour Doppler at the junctions only - when captured this may assist in demonstrating distance of incompetency from the actual SFJ. This is NOT to be used as a definitive sign of SFJ incompetence
4. Please provide a level of evidence rating for the recommendation. Weak n=3, Moderate n=1, Strong n=5
5. Please provide a strength of evidence rating for the recommendation. Weak n=1, Moderate n=0, Strong n=8

## *Recommendation E4*

**Information Sheet (Recommendation E4)**

Draft recommendation:

**For best accuracy in detecting venous reflux, a spectral Doppler trace should be made:**

- **from a longitudinal image of the vein**
- **with the sample gate covering the entire lumen of the vein**
- **with a 45-60 degree angle between the alignment of the vein wall and the transducer**

Draft summary statement:

Performing a Doppler trace from a longitudinal view of the vein allows the sonographer to ensure there is a favourable Doppler angle. It is feasible to measure flow from a transverse view of the vein, but it is not ideal for achieving a good Doppler angle between the direction of blood flow in the vein and the angle of insonation. Doppler angle of greater than 60 degrees is not recommended as Doppler signals decrease as they approach 90 degrees. [115] In small vessels with slow reflux, poor Doppler angle will result in small Doppler shifts making flow difficult to detect. [34] Doppler angles of less than 45 degrees are not ideal because optimal B-mode imaging of the vein is reduced at lower angles. Angle correction is not necessary, unless reflux velocities are being measured. Reflux velocities are not normally measured in DUS for CVD. Reflux times are measured, but are not dependent on the Doppler angle. The sample gate should fill the vessel lumen without touching its walls, to ensure slow flow reflux occurring near the walls is identified. [116]

**Anonymous web-based survey questions (Recommendation E4)**

1. Do you agree with the recommendation?
2. If you do not agree with the recommendation, please state your reasons?
3. Do you have any suggestions for rewording of the recommendation, without losing the intent of the recommendation as currently written?
4. Please provide a level of evidence rating for the recommendation.
5. Please provide a strength of evidence rating for the recommendation.

**Results of web-based survey (Recommendation E4)**

Number of respondents=9

1. Do you agree with the recommendation? Yes n=8/9
2. If you do not agree with the recommendation, please state your reasons?
   - Whilst this is optimum, it becomes impractical when actually applying this to the scan - so, we want a wider sample volume - this can be reworded to the example below.
3. Do you have any suggestions for rewording of the recommendation, without losing the intent of the recommendation as currently written?
   - To demonstrate venous reflux, the most accurate approach is to have the sample gate wide (at least greater than 1/2 the size of the vessel) and to incorporate appropriate Doppler angles to optimise the spectral Doppler - this includes angle correction
4. Please provide a level of evidence rating for the recommendation. Weak n=2, Moderate n=2, Strong n=5
5. Please provide a strength of evidence rating for the recommendation. Weak n=0, Moderate n=1, Strong n=8

*Recommendation E5*

**Information Sheet (Recommendation E5)**

Draft recommendation:

**We recommend that venous reflux is defined as:**

- **>0.5 seconds of reversed flow in superficial veins (e.g., the GSV, SSV, ASV, PAGSV, Giacomini vein), calf veins (e.g. posterior tibial veins) and deep femoral veins.**
- **> 1second of reversed flow in the femoro-popliteal segments (e.g., common femoral, femoral and popliteal veins).**
- **>0.5 seconds for perforating veins.**

Draft summary statement:

Venous reflux is defined as the retrograde flow of abnormal duration in any venous segment , [45]although a definitive duration cut-off for all vein segments has not been agreed upon in the published literature. [30] Venous reflux is assessed by evaluating the response to accepted provocative manoeuvres documented by spectral Doppler waveforms. [83]. Despite this lack of consensus, the method is well-accepted and highly practical. It requires an understanding of the waveforms and accurate placement of callipers on waveforms that are free of noise. It is normal for short reverse flow to be demonstrated in response to the provocative manoeuvre, and it is good practice to wait for the resumption of normal venous flow to ensure that delayed reflux is not missed. [34] Furthermore, assessment in only the standing position due to the significant number of false-positive and false-negative findings in the supine position was also recommended by the International Union of Phlebology. The duration of reflux time can be influenced by the provocation manoeuvre, patient position, anatomical variations, and variability of reflux response in different patients and therefore cannot be used to provide a quantitative assessment of reflux severity. [34] Other parameters have been investigated such as reflux waveform surface area, reflux velocity and reflux rate, but these are also influenced by these variations. [34, 44]

Following the common practice outlined in various guidelines and consensus documents, a threshold of >500ms is recommended for superficial veins, tibial veins, DFV and perforating veins, while >1 second is suggested for the CFV, FV and popliteal vein. However, sonographers and practices may opt for a lower threshold of 350ms when defining perforator incompetence. This choice is supported by the findings of Labropolous et al., who reported that 97% of competent perforating veins exhibit reverse flow durations below this 350ms threshold. [9, 42, 115]

In addition to diagnosing perforator incompetence using the cut-off value, many authors suggested differentiating re-entry perforating veins from those serving as the source of reflux. The haemodynamic role and clinical significance of the perforating veins can be determined by evaluating the net flow direction through the perforating veins. Typically, in re-entry perforating veins, reflux flow from its connecting superficial veins is directed inward during muscle relaxation. If superficial venous reflux is not abolished, these perforating veins may eventually become dilated and incompetent over time. In contrast, perforating veins as the reflux source with their valvular dysfunction resulting from deep venous reflux typically display outward flow during muscle relaxation. They can subsequently cause superficial venous hypertension and the associated skin changes. Current practice guidelines suggest that treatment of such incompetent perforating veins may not be necessary for patients without

advanced skin changes. However, it is recommended that treatment for isolated or residual incompetent perforating veins should be considered if the disease progresses to C4b, C5, or C6 stages. [42, 117, 118, 209]

Supporting evidence:

Summary of evidence-based recommendations in existing clinical practice guidelines relating to criteria of define venous reflux

| Guideline number | Agree 11 score (Rigour of development) | | Evidence Rating |
|---|---|---|---|
| 6. | 74.5 (acceptable) | We recommend a cutoff value of 1 second for abnormally reversed flow (reflux) in the femoral and popliteal veins and of 500 ms for the great saphenous vein, the small saphenous vein, the tibial, deep femoral, and the perforating veins. | 1B<br>Grade of recommendation 1 Strong (strong/weak)<br>Strength of recommendation B (A-C) |
| | | We recommend that in patients with chronic venous insufficiency, duplex scanning of the perforating veins is performed selectively. We recommend that the definition of "pathologic" perforating veins includes those with an outward flow of duration of 500 ms, with a diameter of 3.5 mm and a location beneath healed or open venous ulcers (CEAP class C5-C6). | |
| 22. | 50 (low) | Reflux is defined as a minimum value> 500ms of reversed flow in the superficial truncal veins (great saphenous vein,small saphenous vein, anterior saphenous vein, posterior accessory great saphenous vein) and in the tibial, deep femoral, and perforating veins. A minimum value >1 second of reversed flow is diagnostic of reflux in the common femoral, femoral, and popliteal veins. | Implementation remarks (no evidence ratings provided, comment determined by guideline developers) |
| | | A definition of "pathologic" perforating veins in patients with varicose veins (CEAP[ClinicalClass,Etiol-ogy,Anatomy,Pathology] clinical classC2) includes those with an outward flow duration of 500ms and a diameter of 3.5mm on duplex ultrasound. | |
| 35 | 53.1 low | We recommend that named veins (Great Saphenous Vein (GSV), Small Saphenous Vein (SSV), Anterior Saphenous Vein (ASV), Posterior Accessory of the Great Saphenous Vein (PAGSV ), Intersaphenous Vein (Vein of Giacomini)) must have a reflux time > 500 msec, regardless of the reported vein diameter. | Grade 1A<br>Strength of recommendation: 1,2<br>Level of evidence A,B,C |
| | | We suggest treatment of incompetent perforating veins located beneath a healed or open venous ulcer. They should have outward flow of 500 ms, with a diameter of 3.5 mm. | GRADE 2B<br>Strength of recommendation: 1,2<br>Level of evidence A,B,C |

Relevant studies identified in the literature

1. Labropoulos et al. 2003 [116]

   Prospective study, measuring reflux using Doppler and pneumatic cuff for reflux provocation, in 80 healthy limbs and 60 limbs in people with CVD. 16 venous sites were interrogated for each participant. Their results suggest the following minimum values to confirm a refluxing vein:
   - 500ms (0.5s) for superficial and deep veins, but not femoropoliteal veins
   - 1000ms (1s) for femoropoliteal veins
   - 350 ms (0.35s) for perforating veins

## Anonymous web-based survey questions (Recommendation E5)

1. Do you agree with the recommendation?
2. Do you have any suggestions for rewording of the recommendation, without losing the intent of the recommendation as currently written?
3. Please provide a level of evidence rating for the recommendation
4. Please provide a strength of evidence rating for the recommendation

## Results of web-based survey (Recommendation E5)

Number of respondents=9

1. Do you agree with the recommendation? 8/9 yes
2. Do you have any suggestions for rewording of the recommendation, without losing the intent of the recommendation as currently written? N=1
   - *Yes - I noticed in the text where you explain the ">5 seconds of reversed flow .....the sentence finishes with- " and deep femoral veins". I thought this was confusing as you are describing in the next statement the reflux in the common femoral vein to be >1.....(i may have misunderstood, please double check :)*
3. Please provide a level of evidence rating for a recommendation on cut-off values used for diagnosing venous reflux of the veins of the lower limb. Weak n=0, Moderate n=6, Strong n=3
4. Please provide a Strength of evidence rating for a recommendation on cut-off values used for diagnosing venous reflux of the veins of the lower limb. Weak n=0, Moderate n=1, Strong n=8

**Information Sheet (Recommendation F1)**

Draft recommendation: **We recommend that sonographers who perform DUS to assess for CVD in the lower limb should be qualified sonographers, or student sonographers working under the supervision of qualified sonographer (s) or other specialists in vascular ultrasound.**

Draft summary statement:

Two existing evidence-based guidelines [9, 60] recommend that personnel performing DUS for chronic venous insufficiency (CVI) are credentialled or qualified. Direct evidence to support this in not available, however based on a survey of American sonographers in relation to carotid ultrasound, [173] sonographers themselves are likely to believe that qualification is important to reduce unnecessary repeat examinations, and limit examinations performed in a technically inappropriate manner. Accreditation was also identified as in important factor in examination quality in a survey of staff of from Intersocietal Accreditation Commission (IAC) accredited vascular testing facilities in North America. [174] A key feature of the standards used for this accreditation is credentialling and continuing education of all staff. Other existing guidelines also recommend Sonographers performing CVI examinations should be appropriately credentialled. [83, 84, 174]

In Australia, credentialled or qualified sonographers will have met the educational requirements to be registered on the Australasian Accreditation Registry as either a general or vascular sonographer. [34] Benefits under the Medicare Benefits Scheme are only payable if the sonographer is suitably qualified, involved in a relevant and appropriate Continuing Professional Development (CPD) program and be Registered on the Register of Accredited Sonographers held by Services Australia.

In New Zealand, credentialled or qualified sonographers will have met the educational requirements to be registered as a sonographer with the New Zealand Medical Radiation Technologists Board (NZMRTB).

Although the sonographers in Australia and New Zealand undergo rigorous training and education to qualify for their roles, it is essential that they not only meet the required credentialling standards but also feel comfortable and confident in performing the examinations. The body of knowledge required by a sonographer includes a thorough understanding of the anatomy (including common variants) and nomenclature, physiology, pathophysiology, and clinical course pertaining to CVI as well as ultrasound physics and instrumentation. [21, 177] Training should include theoretical information, practical training and clinical training. [81] This guideline establishes the groundwork for DUS examinations for CVD, emphasizing the importance of standardised protocols irrespective of the service location and the varying levels of expertise. Using this guideline will enhance diagnostic accuracy, reliability and repeatability. In addition, we strongly encourage sonographers to actively engage in continuing professional development to stay abreast of the latest advancements in ultrasound technology, diagnostic techniques, and venous treatments. Upholding CPD practices ensures that sonographers maintain and improve their knowledge and skills, ultimately enhancing the overall quality of patient care.

In this guideline we do not make a recommendation of how much clinical training is required for a sonographer to gain competence in DUS for CVD, as this will vary by sonographer, and existing estimates are variable. For example, it has been suggested that a minimum of 250-400 supervised CVI examinations is appropriate, [34] the IAC recommends 100 cases, [177] a minimum of 50 venous insufficiency ultrasound scans of the lower extremity is required for the Certificate in Clinician Performed Ultrasound (CCPU) issued by ASUM, [177] and the Society for Vascular Technology of Great Britian and Ireland recommend at least 600 scans, and at least three years full-time equivalent scanning experience. [179]

Supporting evidence:

Summary of evidence-based recommendations in existing clinical practice guidelines relating to qualifications of sonographers performing DUS to assess for CVD.

| Guideline number | Agree 11 score (Rigour of development) | | Evidence Rating |
|---|---|---|---|
| 22. | 50 (low) | We recommend that evaluation of reflux with duplex ultrasound be performed in an Intersocietal Accreditation Commissioner or American College of Radiology accredited vascular laboratory by a credentialed ultrasonographer, with the patient standing whenever possible. A sitting or reverse Trendelenburg position can be used if the patient cannot stand. | Good practice statement (not backed up by literature). |
| 35. | 53.1 low | We suggest all noninvasive vascular diagnostic studies be per formed by a qualified physician or by a qualified technologist under the general supervision of a qualified physician. | GRADE 1C<br>Strength of recommendation: 1,2<br>Level of evidence A,B,C |

Relevant studies identified in the literature

- Boswell et al. 2003 [173]

  This study was a cross-sectional survey distributed to vascular sonographers and technologists in Indiana and Kentucky, USA, who routinely performed vascular examinations. The goal of the survey was to evaluate members' opinions about credentialing and accreditation and to assess their current practice patterns. The response rate was 30%. Respondents were asked about how often and why they performed repeat carotid ultrasound examinations. The survey revealed that 12% of the carotid examinations performed annually were "repeat" studies. The most frequently reported reasons for performing repeat examinations were 1) inadequate diagnostic criteria (40%), 2) incompetent technical staff (40%), 3) incomplete interpretation by the physician (39%), and failure to adhere to a diagnostic standard (30%). Additional reasons included poor instrumentation or technique and insufficient waveforms/grey-scale data to formulate an accurate diagnosis. The authors commented that all of those reasons listed for repeat examinations would be addressed by either a credentialing or accreditation requirement. In the survey alone, 4782 examinations were repeated annually, resulting in significant cost and efficiency implications, as well as potential impacts on patient management and outcomes. When respondents were asked if they believed that accreditation and credentialing improve the appropriateness of vascular sonography services, 91% agreed, 6% disagreed, and 3% abstained.

- Brinza et al. 2016 [174]

  The authors of this article sought to determine the perceived value of accreditation among staff of IAC (ICAVL) accredited vascular laboratories. A multi-item electronic survey was sent to medical and technical staff and administrative contacts within the IAC database. Respondents were asked to rate statements about the impact of accreditation on their facility. 882 responded from 7289 vascular surveys sent (12.1%). Respondents were primarily responsible for the facility's accreditation application (75%), with the majority being technologists (82%), followed by physicians (11%). Most respondents were from hospital-based facilities (51.1%) and from facilities accredited for >3 years (79.6%). 94.3% of respondents felt that maintaining accreditation of their facility was important (3.5% neutral, 2.2% not important). The greatest perceived benefits were standardisation of study acquisition and reporting, adherence to guidelines and report completeness. conclusions: The majority of respondents from Intersocietal Accreditation Commission (IAC) accredited vascular testing facilities in North America favourably viewed accreditation. By enhancing the quality of vascular laboratory studies and reports, accreditation may standardise data used for medical decision-making and improve patient care.

### Anonymous web-based survey questions (Recommendation F1)

1. Do you agree with the recommendation?
2. Please provide a level of evidence rating for the recommendation as it is currently written
3. Please provide a Strength of evidence rating for the recommendation as it is currently written.

### Results of web-based survey (Recommendation F1)

Number of respondents=9

1. Do you agree with the recommendation? Yes: n=8
   a. Comments: It should state they are accredited medical Songraphers - this will link them to the minimum graduate qualities for sonographers in Australia
   b. Suggestion: Sonographers performing DUS to assess for CVD in the lower limb must be Accredited Medical Sonographer (AMS) - OR Accredited Student sonographer (ASS) working with an AMS who has a minimum of 2 years experience OR vascular specialists.
2. Please provide a level of evidence rating for the recommendation as it is currently written. Weak n=3, Moderate n=4, Strong n=2
3. Please provide a Strength of evidence rating for the recommendation as it is currently written. Weak n=0, Moderate n=3, Strong n=6

   Comments: We need to be proud of our qualifications and what they provide our sonographers - this may not be found in any literature, BUT both post, under and vet sector qualifications provide sonographers with an avenue to inclusion on the registry - this should be a minimum

**Information Sheet (Recommendation G1)**

Draft recommendation: **For accurate detection and measurements of venous reflux, DUS to investigate CVD of the lower limb should be performed in the afternoon**

Draft summary statement:

Three studies ( Bishara 1986, )[190-192] have provided evidence that when veins are examined later in the day, as opposed to in the morning, they are more likely to exhibit venous insufficiency. This increased likelihood is attributed to the prolonged stress on valves and progressive deterioration of valvular function throughout the day, and it occurs in both asymptomatic and symptomatic lower limbs. Notably, the effect is more pronounced in individuals with symptomatic limbs, as observed by Bishara in 1986.[196]

When considering different types of veins in patients referred for DUS to investigate CVI, the change in valvular behaviours between morning and later times of day was more common in perforator veins (38%) than in small saphenous veins (9%) and great saphenous veins (2%). However, there was no significant change observed in alternate superficial pathways or at the saphenofemoral/sapheno-popliteal junction, as reported by Tarrant and Clarke.[192]

In light of these findings, there is potential for incompetent veins, especially perforating and small veins, to be overlooked if DUS performed in the morning. Future research could explore whether increased venous insufficiency is correlated with the time of day or if the activities of the patient before undergoing DUS are a confounding factor affecting the results.

Supporting evidence:

How do existing clinical guidelines address the question?

Guideline 30 [34]: It is helpful to book patients with minor varicose veins towards the end of the day as incompetence usually worsens over the course of the day (no references provided to support statement)

Guideline 31 [81]: states reflux is more likely to occur later in the day, especially for non-dilated vein segments (no references provided to support statement)

Relevant studies identified in literature

1. Katz et al. 1994 [190]

Fifty symptom-free legs were prospectively studied twice in the early morning and twice in the late afternoon on 2 days. Air plethysmography was used to evaluate venous volumes, venous valvular function, calf muscle pump function, and the non-invasive equivalent of ambulatory venous pressure. There was significant change in venous valvular function (venous filling index) indicating progressive insufficiency in the late afternoon compared with the results of the morning studies ($p = 0.039$). Seven of 50 (14%) extremities had normal venous refill times and venous function index in the morning, which became abnormal in the afternoon, indicating deterioration of venous valve function.

2. Bishara et al. 1986 [191]

The change in venous function during the course of the day was studied noninvasively in 50 normal lower extremities of 25 physically active normal subjects. Venous refilling time, measured by photoplethysmography, was significantly shorter (p less than 0.0001), and venous capacitance, measured by impedance plethysmography, was significantly reduced (p less than 0.04) after 5 hours or more of daily activities performed in the upright position. Abnormally short venous refilling time (less than 18 seconds) developed in 21% of the extremities, which had a normal venous refilling time earlier in the same day. Lower extremity symptoms of ache, pain, or swelling were reported more frequently in extremities that developed an abnormal venous refilling time. There was a trend toward a greater change in venous refilling time during the day in symptomatic lower extremities than in asymptomatic limbs ($p = 0.07$).

3. Tarrant and Clarke 2008 [192]

A total of 32.5% (13) of participants or 29.2% (14) of limbs demonstrated a degree of change in results, transitioning from incompetence in the afternoon to competent the next morning. Most significant were the perforator veins; with 38% of those tested showed a change in results, followed by a 9% change in the small saphenous veins, a 2% change in the great saphenous veins, and no change was demonstrated from the alternative superficial vein pathways or the saphenofemoral/popliteal junctions.

Discussion points (from meeting prior to survey)

Some discussion on whether it is practical to 'mandate' afternoon appointments, although the evidence suggests it is more accurate to do so. Was suggested that patients often have preferences, due to life commitments/transport etc to have morning appointments. This needs to be respected but could be helped by providing patients with more information; better accuracy, reduce risk of repeat examinations, particularly important if disease is not severe.

**Anonymous web-based survey questions (Recommendation G1)**

1. I accept the wording of the recommendation
2. I would like to suggest some amendments to the recommendation
3. Please provide a level of evidence rating for the recommendation
4. Please provide a strength of evidence rating for the recommendation
5. Are there any comments you would like to make?

**Results of web-based survey (Recommendation G1)**

Number of respondents=10

1. I accept the wording of the recommendation. Yes: n=6
2. I would like to suggest some amendments to the recommendation. Yes n=4
   - Regarding the "Discussion" section. We could add: "Whilst venous function appears to worsen during the day which may affect the diagnosis of venous reflux in some patients, it is not known whether this has a negative flow-on effect on treatment decision-making and the outcomes of venous interventions."
   - It is recommended that for the effective evaluation, detection, and measurements of venous reflux in venous insufficiency studies, is that Duplex examinations be performed in the afternoon.
   - Whether it's worth adding the word 'increased' into the recommendation, so it reads;
     'For increased accuracy in the detection and measurements of venous reflux, DUS to investigate CVD of the lower limb should be performed in the afternoon.' Otherwise it could be preserved that if the investigation was performed in the morning it was inaccurate and possibly non diagnostic
   - Petty!! but should it read small saphenous vein not veins and great saphenous vein not veins. Each patient has multiple perforator veins and generally only one SSV and one GSV.
     Maybe some mention that it is not the time of day per say but the amount of time the patient has been on their feet- I am thinking of shift workers etc...
3. Please provide a level of evidence rating for the recommendation. Weak n=2, Moderate n=6, Strong n=2
4. Please provide a strength of evidence rating for the recommendation. Weak n=0, Moderate n=6, Strong n=4
5. Are there any comments you would like to make?
   - Its a shame there isn't a full blown RCT on this. Common sense physiology prevails here which is why I think the recommendation as a whole is strong with only medium strength evidence base
   - Whilst this is a recommendation, practically this would be difficult to enforce due to economic and waiting list issues
   - The evidence isn't conflicting, but isn't strong but there is no harm in the recommendation.
   - Practically this is not an easy recommendation for some practices that may only operate in the am.

*Recommendation G2*

**Information Sheet (Recommendation G1)**

Draft recommendation: **We recommend that evaluation of reflux with DUS should be performed with the patient standing, with the lower limb under examination non-weight bearing whenever possible. A sitting or reverse Trendelenburg position can be used if the patient cannot stand.**

Draft summary statement:

It is widely accepted that a standing position is optimal to demonstrate venous reflux because this position replicates the physiological state by allowing more definitive closure of competent valves and offers more challenge to incompetent valve. This was confirmed in a prospective study of 80 limbs of 40 healthy subjects and 60 limbs of 45 patients with CVD and which were evaluated with DUS for venous reflux (Labropoulos et al 2003), demonstrating more refluxing venous segments in the standing position compared to the supine position. Similarly, Houle et al (2013) with lower percentages of false negative results demonstrated in the standing position. Similar conclusions were made by DeMuth et al. (2012). In their, study, they found the median difference in reflux time between the RT and SP positions was 0.15 seconds and the mean difference in the diameter of the GSV between the RT and SP positions was 0.7 mm, with a standard deviation of 0.96 mm ($p < 0.0001$). Their study revealed 15% of the GSVs that initially tested negative for reflux in the RT position were later found to exhibit reflux in the SP position. This observation suggests that when patients showing signs and symptoms of venous insufficiency do not demonstrate GSV reflux in the RT position, it may be prudent to evaluate the GSV again in the SP position. The standing position can be ergonomically difficult for both the sonographer and patient to maintain. The reverse Trendelenburg is an alternate position that may offer more comfort to the sonographer and patient. A pilot study (Bonfield 2012) suggested that several alternative positions (sitting, 10-25 degrees reverse Trendelenburg) could be used for assessing incompetent veins as long as the patient is not lying horizontal. This would offer much greater flexibility, which may be of benefit to both patients and sonographers. Carty et al compared superficial reflux evaluated by DUS in reverse Trendelenburg (30 degrees) and standing positions in 72 consecutive patients , and noted that reflux duration in the RT position was longer (by a factor of > 2.8) compared with the standing position, and that as a guide, reverse Trendelenburg reflux values of ≥1.5 sec anywhere along the extremity always correspond to >0.5 sec standing reflux values ($p < 0.001$). Because of this overestimation of reflux time, they suggested that when the reverse Trendelenburg was used, and the reflux time was less than 1.5 seconds, then the vein should be retested in the standing position, to test the reflux time against the standing reflux time of 500ms. Additionally, they found that the presence of isolated segmental reflux associated with an incompetent perforating vein was most accurately identified in the standing position. Further research comparing reflux times in alternate positions against standing as the reference standard for deep, superficial and perforating veins is needed.

Supporting evidence:

Evidence-based recommendations in existing clinical practice guidelines relating to position of the patient during the evaluation for reflux with duplex US.

| Guideline number | AGREE II score determined by the guideline group (domain: rigour of development) | Recommendation | Evidence Rating (as determined by authors of the existing guideline) |
|---|---|---|---|
| 22. | 50 (low) | We recommend that evaluation of reflux with duplex ultrasound be performed in an Intersocietal Accreditation Commission or American College of Radiology accredited vascular laboratory by a credentialed ultrasonographer, with the patient standing whenever possible. A sitting or reverse Trendelenburg position can be used if the patient cannot stand. | Good practice statement (not backed up by literature). |
| 35. | 53.1 (low) | The exam should ideally be done in the standing position. | **GRADE 1A**<br>Strength recommendation 1=strong, 2=weak<br>Level of evidence A,B,C |

## How do existing clinical guidelines address the question?

The patient can be in a lying position to assess for venous obstruction, and which allows easier compression of the vein and better flow variation in response to respiration. (Guideline 2)[45] A supine, lateral decubitus or prone position may be utilized to best access veins depending on their location. (Guideline 27) [85]

For assessment of venous reflux, and to reproduce physiological conditions, the patient should be standing for maximum venous distention/filling.

The use of a consistent standing position also has the benefit of standardising measurements of venous diameter and reflux. If an alternate position is required due to conditions that make standing unfeasible for either the patient or the sonographer (i.e. obesity, cardio-respiratory conditions, ergonomics), then any follow up examinations should be done in the same position (Guidelines 16,21,31) [20, 42, 81] The lower limb should be examined leg in a non-weight bearing position, with the weight of the body supported on the contralateral leg. The patient is instructed to turn the lower limb under examination outward with slight bending of the knee for scanning of the inner thigh and calf to provide the sonographer access in examining the leg.

Alternate positions:

Reverse Trendelenburg position: can be used if the standing examination is not feasible, such as in patients with difficult body habitus. (Guidelines 2, 6,7 15,39,41) [8, 45, 48, 83, 86, 113]The position should be as steep as practical, but not in less than 45 supine position. (Guidelines 2, 6,7 15) [8, 45, 48, 83] The patient in the tilted position can be supine, prone or decubitus depending on the veins under examination. (Guideline 18)[40]

Sitting position: can be used for evaluating the superficial and perforating veins of the calf.

## Relevant studies identified in literature

### 1. Labropoulos et al. 2003 [116]

Twenty-two of 37 vein segments with reflux in the supine position were normal in the standing position. Of 38 vein segments with retrograde flow (RF) greater than 500 ms in the standing position, RF was less than 500 ms in 6 segments (13%) in the supine position. These findings indicate both increased specificity and sensitivity for detecting pathologic reflux in the standing position. Standing provides increased hydrostatic pressure, and the diameter of all veins in the lower extremity is larger. This contributes to longer RF in diseased vein segments. Standing allows more definitive closure of competent valves and offers more challenge to incompetent valves. Signs and symptoms of CVI are more noticeable only in the standing position. It has been suggested that there should be a longer cutoff value (2s) for veins tested in the supine position. However, because of our findings and reasons given above, we believe, like others, that valve competency should be tested only in the standing position when possible.

### 2. Foldes et al. 1991 [210]

Notes: unable to find full text.

### 3. DeMuth et al. 2012 [193]

A total of 52 limbs were assessed for venous reflux in 28 participants in the study. Out of the 52 limbs, 26 (50%) exhibited venous reflux when tested in the reverse Trendelenburg (RT) position. However, among these 26 limbs, three did not show reflux when tested in the standing position (SP). In contrast, 27 (53%) limbs displayed venous reflux in the SP, but four of them did not exhibit reflux in the RT position. The median difference in reflux time between the RT and SP positions was 0.15 seconds. Additionally, the mean difference in the diameter of the GSV between the RT and SP positions was 0.7 mm, with a standard deviation of 0.96 mm ($p < 0.0001$). Notably, 15% of the GSVs that tested negative for reflux in the RT position were found to be positive for reflux in the SP position. This observation suggests that when patients with signs and symptoms of venous insufficiency do not exhibit GSV reflux in the RT position, it may be advisable to evaluate the GSV in the SP position.

### 4. Bonfield et al. 2012 [89]

This pilot study aimed to evaluate the effect of varying patient positioning on the duration of venous reflux in 16 symptomatic patients; SP (gold standard) and 25 degrees RT tilt, sitting on the edge of the examination couch, 10 degrees RT tilt and 0 degrees RT tilt. Only a significant difference was noted between the standing position and the 0 degree position ($P < 0.01$ [2-tailed]). Results suggest that several

alternative positions could be used for assessing incompetent veins as long as the patient is not lying supine with 0 degree tilt. This would offer much greater flexibility, which may be of benefit to both patients and sonographers.

### 5. Carty et al. 2013 [87]

Carty et al evaluated RT and SP for superficial venous reflux, noting that reflux duration in the RT position was longer (by a factor of > 2.8) compared with the SP. Six hundred forty-five venous segments in 72 consecutive patients were prospectively evaluated for the presence of venous reflux, first in the 30° reversed RT, and subsequently in the SP. All deep veins were assessed for patency and reflux with the Valsalva manoeuvre and the addition of manual compression when necessary. Next, the entire superficial venous system starting at the SFJ was assessed with the application of Valsalva manoeuvre and manual distal compression as in the case of the deep system As a practical and simple working tool, RT reflux values of ≥1.5 sec anywhere along the extremity always correspond to >0.5 sec standing reflux values ($p < 0.001$). The study length needs to be considered along with several other important factors, such as the patient's comfort, examiner's task satisfaction, test accuracy, cost effectiveness, and laboratory throughput. We aimed to provide patient comfort and safety, examiners' satisfaction, cost effectiveness, and a reliable and reproducible method to elicit maximum diagnostic accuracy in a manner that makes the most sense in our current environment. On the basis of our results, we recommend the routine performance of duplex venous insufficiency studies in the RT position with Valsalva manoeuvre and the addition of manual compression as the preferred initial method for eliciting reflux. When reflux duration at the SFJ is less than 1.13 sec, standing testing will ensure that an accurate patient evaluation is obtained. Two special situations were identified during this study. First, the presence of isolated segmental reflux associated with an incompetent perforating vein was most accurately identified in the SP. Second, great saphenous vein segments traveling outside the fascia plane were found to have significant overestimation of reflux duration in the RT position.

### 6. Houle et al. 2013 [2]

This study aimed to compare the difference in the detection of saphenous reflux using non-standing positions (supine or reverse Trendelenburg) and the standing position. Measurements were taken in 40 extremities from 20 women at the GSV thigh, GSV calf, SSV, and CFV/SFJ, with reverse flow lasting longer than 1 second defined as a positive finding for venous reflux. False-negative results were calculated as follows in the non-standing position: 49% (16/33) for GSV-calf, 38% (12/32) for GSV-thigh, 27% (12/45) for SSV, and 26% (9/35) for CFV/SFJ. In the standing position, false-negative results were 6% (1/18) for GSV-calf and 7% (2/28) for CFV/SFJ. The authors observed that coaptable veins in the non-standing position and the detection of low-velocity reflux in the standing position influenced the outcomes. They suggested that the standing position is the preferred position for evaluating saphenous reflux.

### Discussion points (from meeting)

The group decided not to specify a reverse Trendelenburg angle as practices are variable, and variable also in the literature. Important thing is for the limb to be a lower position relative to the heart.

### Anonymous web-based survey questions (Recommendation G2)

1. I accept the wording of the recommendation
2. I would like to suggest some amendments to the recommendation
3. Please provide a level of evidence rating for the recommendation
4. Please provide a strength of evidence rating for the recommendation
5. Are there any comments you would like to make?

### Results of web-based survey (Recommendation G2)

Number of respondents=10

1. I accept the wording of the recommendation. YES n=9
2. I would like to suggest some amendments to the recommendation N=2
   - The "reverse Trendelenburg" position should be qualified as "at least 45 degrees".
   - there should be a "when safe to do so, the optimum position is non weight bearing standing"
3. Please provide a level of evidence rating for the recommendation. Weak n=0, Moderate n=7, Strong n=3
4. Please provide a strength of evidence rating for the recommendation. Weak n=0, Moderate n=4, Strong n=6
5. Are there any comments you would like to make?
   - I choose Moderate, not because either of the statements work but that while there is evidence to support the recommendation and I believe it is beneficial for the recommendation to suggest this, there isn't strong evidence. I don't think the evidence is weak or the practice harmful.
   - what are the occ health and safety issues for both Sonographer and patient-

*Recommendation G3*

**Information Sheet (Recommendation G3)**

Draft recommendation:

**We recommend that reflux to confirm valvular incompetence should be elicited using the following manoeuvres:**

- **Common femoral vein: Valsalva to increase intra-abdominal pressure and/or distal augmentation.**
- **Saphenofemoral junction: Valsalva manoeuvre to increase intra-abdominal and intra-thoracic pressure and/or distal augmentation**
- **Vein segments distal to saphenofemoral junction: Distal augmentation**

**Distal augmentation is performed using manual or cuff compression distal to the point of examination.**

**Sonographers should be aware of alternate methods to elicit venous reflux that may be more applicable in different circumstances such as; where patient or sonographer comfort is compromised, when the patient cannot perform Valsalva, the patient has a large body habitus, or if venous reflux is suspected but cannot be demonstrated using Valsalva or distal augmentation.**

Draft summary statement:

Manoeuvres for provocating reflux are required to test if venous valves are normal by stressing them. Normal valves in the lower limb act as gatekeepers to block blood in the veins from flowing away from the heart, that would otherwise occur due to physiologic pressures. [34] A provocation manoeuvre needs to achieve a high-pressure gradient across the venous segment under examination in order for reflux to occur and therefore identify failing valves. [34]

Two CPGs were identified that made specific evidence-based recommendations relating to the manoeuvres which should be used. [8,9] Both recommend that the appropriate manoeuvre for the CFV and the SFJ is Valsalva, and that more distal veins should be assessed with manual or cuff compression. These manoeuvres should be performed in an upright position. [8]

Findings by Yamaki et al 2006 [197] support the interchangeability of manual and cuff compression by demonstrating no significant differences in duration of reflux initiated by both methods at all the sites they tested in patients with minor signs and symptoms; SFJ, SPJ, GSV and in patients with more severe symptoms at the SFJ and SPJ.

Findings by Berther et al 2022 [194] support the use of Valsalva to test for reflux in the CFV. The sensitivity of detecting reflux in the CFV was slightly higher using Valsalva (50%) compared to cuff compression (42.9%) in patients with DVT, and the same for patients with varicose veins (87.5%). The use of manual compression for the FV is partially supported by this study as in DVT patients, sensitivity for detecting reflux was higher for cuff compression (50%) compared to Valsalva (42.9%), however in varicose vein patients, sensitivity was higher for Valsalva (87.5%) compared to cuff compression (71.4%).

Masuda et al 1994 [195] also compared the cuff compression method against Valsalva, but across more venous segments; common femoral, superficial femoral, deep femoral, and greater saphenous in the upper thigh, popliteal, and posterior tibial (at the ankle). The results indicated that the Valsalva method is best performed in the RT-15 position as opposed to standing, whereas the cuff technique is more effective in the standing position. A case-by-case analysis identified a large amount of variability between techniques, and inconsistencies could not be used to identify one technique as better than the other. Examination of the posterior tibial veins by all methods produced inconsistencies and a low yield of reflux in symptomatic limbs.

Demirpolat et al 2004 [196] compared the efficacy of Valsalva manoeuvre and cuff compression techniques, both performed in the standing position, in detecting lower extremity deep venous and saphenofemoral insufficiency in the femoral vein, popliteal vein, the proximal segment of the great saphenous vein close to its junction with the femoral vein and in its caudal segment at the medial aspect of the knee. The cuff deflation technique was superior at the popliteal vein and caudal segment of the great saphenous vein. The Valsalva manoeuvre was superior at the FV. Further investigation is needed to determine ideal techniques, including patient position for identifying vein reflux.

<u>The Valsalva manoeuvre:</u>

This technique requires instruction to the patient and their cooperation. [48] The patient should be encouraged to Valsalva forcefully and rapidly (within 0.5 seconds) and for a sustained period of time (at least three seconds) to increase the intrathoracic pressure. [45] If performed in veins distal to competent veins it may elicit a false-negative result. [48]

<u>Simulated Valsalva:</u>

This may be used if the patient finds it difficult to perform an adequate Valsalva. [48]The patient should be instructed to take a deep breath and hold, during which the sonographer pushes on the patient's abdomen with their free hand by firmly leaning into the patient. The patient is instructed to resist or guard against the pressure, creating a simulated Valsalva manoeuvre. [48]

<u>Distal augmentation (manoeuvre manual or with pressure cuff):</u>

Perform by applying compression distal to the examined vein with gradual firm prolonged pressure to result in increased orthograde (normal direction, feet to heart) flow. The compression is then rapidly released to detect any insufficiency in the examined vein. [45] This technique ensures that a large volume of venous blood is emptied out of the calf in order to create a high-pressure gradient on release. Augmentation of the ankle or foot is not so effective because little venous volume is found in these locations. The pressure can be applied either my manual compression or by using an automated cuff applied on the lower leg or foot which the operator can inflate with a push of a button. The cuff inflates to a desired peak pressure and then then rapidly deflates. [34] Sonographers will have a personal preference in using manual compression or a cuff. The cuff method allows for standardisation and sonographers may find it easier to remain in an ergonomic position using a cuff, [86,

113] however some sonographers may find using a cuff cumbersome, especially in the presence of venous ulcers. The strength and duration of augmentation as well as the speed of release can have an influence whether reflux is or is not observed and for what duration. Augmentation at the foot or ankle can be less effective due the low venous volume at these sites.

Alternate reflux provocation methods:

Alternate reflux provocation methods can be used when reflux in varicose veins cannot be elicited by the above methods.

· Cremona manoeuvre: A modified Valsalva manoeuvre, the patient is instructed to blow through a straw with the other end closed. This action leads to increased thoraco-abdominal pressure and push the flow to go backwards. A technique akin to the Cremona manoeuvre was demonstrated during the 18th International Union of Phlebology (UIP) conference in 2018. In this method, a patient was directed to place their thumb in their mouth and exhale forcefully onto it. [198]

· Double hands distal augmentation: squeeze by two hands (with the use of an assistant). [45] Distal compression at the calf is appropriate for proximal veins, and distal compression of the foot is appropriate for foot veins. [81]

· Elevation-dependency manoeuvre: The patient is placed supine with raised legs for 20 seconds to empty the vein. The patient then is asked to stand and the vein is re-examined during venous re-filling without provocation manoeuvre. [45]

· Paraná manoeuvre: The examiner transfers the patient's weight slightly forwards, e.g. by applying pressure to the sacrum. In response, the patient involuntarily tenses the triceps surae muscle in order to keep their balance. The activated muscle pump causes a strong, physiological, orthograde flow in the deep leg veins. This manoeuvre is disadvantageous as the sonographer has to move their left hand from the keyboard to the patient, the movement of the patient increases the chances of image blurring, it may be difficult for some patients to keep their balance, or in some patients, the manoeuvre leads them to move incessantly back and forth, which constantly activates the muscle pump in an uncontrolled manner. [212]

· Wunstorf manoeuvre: also known as the toe elevation manoeuvre, is a physiological method that patients can perform independently without the need for an examiner's assistance. During the procedure, the examined leg should remain as still as possible. Venous flow can be elicited by either raising the toes (dorsiflexion of the forefoot) or clawing the toes (plantarflexion of the forefoot). The elevation of the toes or forefoot leads to highly effective orthograde blood flow, which can be measured all the way up to the common femoral vein and is often detectable in the trunks of the saphenous veins. [45, 212]

- Proximal augmentation: involves applying manual compression above the transducer level. This technique induces valvular closure by generating a pressure wave directed towards the valves, similar to Valsalva. While it has demonstrated comparable outcomes in detecting venous reflux when compared to both Valsalva and distal augmentation, the accuracy and reliability of this method are yet to be determined, especially for the assessment of the superficial venous system. [198, 199] More research is needed to determine the efficacy of these alternate provocative manoeuvres. If reflux still cannot be provoked, this may be due to other variables such as the diameter of the re-entry vein. [45]

## Supporting evidence:

Evidence-based recommendations in existing clinical practice guidelines relating to how to elicit reflux to confirm venous competence.

| Guideline number | AGREE II score determined by the guideline group (domain: rigour of development) | Recommendation | Evidence Rating (as determined by authors of the existing guideline) |
|---|---|---|---|
| 6. | 74.5 (acceptable) | We recommend that reflux to confirm valvular incompetence in the upright position of the patients be elicited in one of two ways: either with increased intra-abdominal pressure using a Valsalva manoeuvre to assess the common femoral vein and the saphenofemoral junction, or for the more distal veins, use of manual or cuff compression and release of the limb distal to the point of examination. | Strength of recommendation: Strong (strong/weak)<br>Level of evidence A (A, B,C) |
| 22 | 50 (low) | We recommend that for evaluation of reflux with duplex ultrasound, we use either a Valsalva manoeuvre or distal augmentation to assess the common femoral vein and saphenofemoral junction and distal augmentation with either manual compression or cuff deflation for evaluation of more distal segments. | Ungraded good practice statement (not backed up by literature). |

## How do existing clinical guidelines address the question?

The Valsalva manoeuvre:

-Requires a rapid (within 0.5 seconds) and sufficiently high expiration pressure (30 mmHg) to be achieved and kept constant for at least three seconds in order to increase the intrathoracic pressure (CPG 2). [45]

- cannot be used to assess reflux in veins distal to competent veins as it may elicit a false-negative result (CPG7). [48]

-requires instruction to the patient and their cooperation (CPG 7). [48] In patients who find it difficult to perform an adequate Valsalva, a simulated Valsalva may be used.

Simulated Valsalva

-may be used in patients who find it difficult to perform adequate Valsalva. This involves instructing the patient to take a deep breath and hold. During the breath hold, the sonographer pushes on the patient's abdomen with their free hand by firmly leaning into the patient. The patient is instructed to resist or guard against the pressure, creating a simulated Valsalva manoeuvre (CPG 7). [48]

Distal augmentation (manual or with pressure cuff)

-is performed by applying compression distal to the examined vein to result in increased orthograde (normal direction, feet to heart) flow. The compression is then rapidly released to detect any insufficiency in the examined vein (CPG 2). [45] This does not replicate physiological response. Pressure cuffs can be used, but can be considered cumbersome, especially in the presence of venous ulcers. Sonographers will have a personal preference in using manual compression or a cuff. The cuff method allows for standardisation and sonographers may find it easier to remain in an ergonomic position using a cuff (CPG 39,41). [86, 113] The strength and duration of augmentation as well as the speed of release can have an influence whether reflux is or is not observed and for what duration. Augmentation at the foot or ankle can be less effective due the low venous volume at these sites (CPG30). [34]

In cases where reflux in varicose veins cannot be elicited by the above then the following can performed as additional assessments to test for reflux.

Toe elevation manoeuvre (TEM): active dorsal extension of the toes followed by a relaxation performed with the patient in the standing position (CPG 2,31). [45, 81]

Distal augmentation optimised, requiring assistance (i.e., compression with two hands by an assistant) (CPG2). [45] Distal compression at the calf is appropriate for proximal veins, and distal compression of the foot is appropriate for foot veins (CPG 31). [81]

Elevation-dependency test: The patient is placed supine with raised legs for 20 seconds to empty the vein. The patient then is asked to stand, and the vein is re-examined during venous re-filling without provocation manoeuvre (CPG2). [45]

If reflux still cannot be provoked, this may be due to other variables such as the diameter of the re-entry vein (CPG2).[45]

## Relevant studies identified in literature

### 1. Yamaki et al. 2006 [197]

Venous reflux was studied in 94 venous segments of 57 limbs in 52 consecutive patients with SVI. Limbs were divided into two groups: group I (CEAP C2–C3) and group II (CEAP C4–C6). A colour duplex scanner was used to determine quantitative venous reflux at the SFJ, at the SPJ, and in the GSV thigh segment. Patients received both manual compression and cuff deflation method in eliciting venous reflux. There were 58 venous segments in group I and 36 in group II. In group I, there were no significant differences in the duration of reflux at the SFJ, SPJ, and in the GSV. In group II, there was no significant difference in the duration of reflux at the SFJ and SPJ between the two methods.

### 2. Habenicht et al. 2016 [211]

Fifty-three legs from patients with no history of previous treatment were evaluated with duplex ultrasound in the standing position. Reflux duration at proximal thigh were assessed using both the TEM and manual calf compression and release method, but in a random sequence. Reflux >0.5s was found in 40 legs (group "reflux") and no reflux in 13 legs (group "no reflux"). No significant difference was found following manual calf compression and release or TEM (2.11s vs. 2.31s in "reflux-group" and 0.11s vs. 0.13s in "no-reflux-group"), but good correlation was found between both with Pearson's test (r=0.72). The study showed both manoeuvres had a good correlation with respect to reflux detection and reflux duration. The advantage of TEM is the easy and painless performance, low fatigability and independence from examiner.

### 3. Berther and Jeanneret-Gris 2022 [194]

The study compared two standardised methods for detecting venous reflux, including the Valsalva manoeuvre (VM) and the cuff deflation method (CM). Seventy-two patients with varicose veins (VV) and 106 patients with DVT were examined with a focus on the proximal leg veins. Additionally, a survey was distributed to members of the Union of Vascular Societies to assess the prevalence of these methods in clinical practice. The results indicated that in the VV group, there was a moderate correlation between VM and CM for reflux time in the common femoral vein (CFV) and the femoral vein (FV). Both methods demonstrated a sensitivity of 87.5% for detecting venous reflux in the CFV, and for the FV, VM had a sensitivity of 87.5%, while CM had 71.4%. In the DVT group, the correlation between VM and CM for reflux time was stronger in the CFV, FV, and GSV. However, the sensitivity for detecting severe venous disease was 50.0% for VM and 42.9% for CM in the CFV, in contrast to the VV group, where both methods had a higher sensitivity. This is in agreement with the literature, where the reflux measurements unfortunately do not correlate with the clinical signs of a post-thrombotic syndrome. Furthermore, the study revealed that a significant portion of surveyed doctors (87.3%) use non-standardized methods for reflux measurements. The conclusion drawn from the study is that both VM and CM are comparable in their ability to induce venous reflux, although further research is needed to determine if non-standardized methods can provide similarly accurate results.

### 4. Mendoza and Wunstorf 2013 [212]

Paraná manoeuvre: The examiner shifts the patient's weight forward, such as by applying pressure on the sacrum. In response, the patient involuntarily contracts the triceps surae muscle to maintain their balance. This activation of the muscle pump results in a robust upward flow in the deep leg veins, meeting the need for creating a physiological flow, and it can be repeated indefinitely. Nonetheless, this manoeuvre presents several drawbacks: 1. The examiner must shift their left hand away from the keyboard to handle the patient. 2. Patient

movements can shift the transducer on the skin, potentially causing image blurring. 3. Older patients may become uneasy as they are prone to losing their balance easily. Patients taking psychotropic medications may also struggle to maintain their balance during this manoeuvre. 4. Some patients may continuously sway back and forth, involuntarily activating the muscle pump in an uncontrolled manner, making it challenging for the examiner to line up with the vessel.

Wunstorf manoeuvre: also known as the toe elevation manoeuvre, is a physiological method that patients can perform independently without the need for an examiner's assistance. During the procedure, the examined leg should remain as still as possible. Venous flow can be elicited by either raising the toes (dorsiflexion of the forefoot) or clawing the toes (plantarflexion of the forefoot). The elevation of the toes or forefoot leads to highly effective orthograde blood flow, which can be measured all the way up to the common femoral vein and is often detectable in the trunks of the saphenous veins.

### 5. Zamboni et al 2018 [213]

Notes: Book chapter

The Cremona manoeuvre, created by Claude Franceschi and Roberto Delfrate, offers an easier alternative to the traditional Valsalva manoeuvre. In this approach, the patient is instructed to exhale forcefully through a straw with its end tied. This action results in an increase in pressure within the chest and abdomen, effectively pushing venous blood back into the lower extremities and enabling controlled pressure adjustments during the examination.

### 6. Markel et al. 1994 [214]

This study aimed to assess the efficacy of Valsalva's manoeuvre, manual limb and cuff inflation-deflation method for detecting venous reflux in patients who had DVT previously. They assessed a total of 134 legs from 67 patients. Results indicated that both limb compression and Valsalva's manoeuvre were capable of inducing reflux but standardizing these manoeuvres and obtaining meaningful results proved challenging. In contrast, the cuff inflation-deflation method consistently resulted in valve closure within less than 0.5 seconds in 95% of normal subjects. This approach facilitated easier quantification and proved effective for assessing all segments of the venous system, including both superficial and deep veins. They concluded that the cuff inflation-deflation method offered a more consistent and quantifiable approach for detecting reflux in the superficial and deep veins of the leg, as compared to Valsalva's manoeuvre and manual limb compression.

### 7. Masuda et al. 1994 [195]

The objective of this study was to establish consistent methods for testing venous reflux using duplex scanning. It specifically examined and compared the Valsalva technique and the rapid cuff deflation method in two different body positions: a 15-degree reverse Trendelenburg position (RT-15) and a standing position. The study involved 22 extremities in 19 patients with moderate to severe symptoms of CVI, as well as 21 limbs in 11 healthy volunteers. They measured the duration of retrograde flow and peak velocity in 247 venous segments. All extremities were examined in four ways: RT-15 Valsalva, standing Valsalva, RT-15 cuff, and standing cuff. Reflux was defined as retrograde flow lasting more than 0.5 seconds in these segments. The findings revealed that the effectiveness of the Valsalva technique and the cuff method depended on the body position. The Valsalva technique was more effective in the RT-15 position, while the cuff technique worked better in the standing position. In symptomatic limbs, the RT-15 Valsalva method showed similar levels of reflux in the upper thigh segments when compared to the standing cuff method. For instance, in the CFV, FV, GSV, and DFV, both methods showed substantial reflux. However, there was a significant degree of variability between the techniques on a case-by-case basis, making it difficult to conclusively determine which method was better. Regarding the popliteal vein, the standing cuff test demonstrated similar levels of reflux compared to the RT-15 Valsalva test. Nonetheless, an individual analysis revealed discrepancies between the two techniques, and neither method was particularly effective in identifying tibial vein reflux in symptomatic limbs. In the CFV, the RT-15 Valsalva testing resulted in reflux times of up to 1.5 seconds in normal limbs, which were considered "physiologic reflux." There was no apparent impact of iliac vein on the testing of distal venous segments using the Valsalva manoeuvre. In conclusion, reflux in the upper thigh veins, including the CFV, FV, DFV, and GSV, was similarly detected in both normal and symptomatic conditions using cuff deflation and RT-15 Valsalva techniques. However, inconsistencies were observed in identifying popliteal vein reflux in patients with CVI, and neither method was effective in demonstrating tibial vein reflux.

### 8. Demirpolat et al. 2004 [196]

The study aimed to compare the effectiveness of the Valsalva manoeuvre and pneumatic compression techniques for diagnosing insufficiencies in the deep veins and at the saphenofemoral junction. It included 43 patients with a total of 81 extremities who had previously undergone ultrasound examinations of the lower extremity venous system. The standing position was used to induce reflux in the veins by employing both the Valsalva manoeuvre and pneumatic cuff techniques. Spectral Doppler was used to examine reflux in various venous segments, including the FV, popliteal vein, the proximal segment of the GSV near its junction with the femoral vein, and its caudal segment at the medial aspect of the knee. Reflux was considered present when retrograde flow exceeded 1000 msec. The same measurements were repeated following rapid deflation of the pneumatic cuff, initially inflated to 200 mmHg. This study identified deep venous and/or saphenofemoral insufficiency in 61 out of the 81 extremities. The cuff deflation technique was superior in detecting insufficiency in the popliteal vein and the caudal segment of the GSV, whereas the Valsalva manoeuvre was more effective in the FV. The authors concluded using the combined Valsalva manoeuvre and pneumatic cuff techniques can produce more accurate results in the detection of venous reflux.

9. Ermini et al. 2017 [215]

The squeezing test (ST) is widely practiced, owing to its simple execution. The Paraná (P) manoeuvre was proposed in 1997, consisting in a gently pushing from the rear or pulling from the front. Our aim was to compare the hemodynamic effects of ST and P during the muscle systole and diastole. They performed DUS examination on 57 patients, with each patient having one leg examined, focusing on a single venous segment. Of these, 37 patients had incompetence of the terminal valve of the SFJ, while 20 patients had only telangiectasia (C1) and were used for comparing the manoeuvres in competent popliteal veins. Fifty-seven venous segments were measured, including 20 competent popliteal veins, 13 incompetent saphenous-femoral junctions, 13 incompetent trunks of the GSV, and 11 re-entry perforating veins. Compared to ST, P moves 68% more blood volume in systole in the competent popliteal vein (p=0.00014), while the diastolic phase of P is 2.52 times longer in incompetent SFJ (p=0.00003), 1.83 times longer in the incompetent GSV trunk (p=0.0015) and 3.27 times longer in the re-entry perforating veins (p=0.07 near significance). They concluded P does not rely on the size of the operator's hand or the size of the patient's calf which makes it a better test than ST in the evaluation and quantification of reflux.

10. Araki et al. 1993 [216]

The study investigated popliteal veins in 10 normal limbs and 11 limbs with clinical evidence of chronic venous insufficiency (CVI). The duration of reflux was measured with the patient in both supine and standing positions, applying manual (proximal and distal) and pneumatic compression sequentially to the thigh and calf. The results revealed that in normal limbs, proximal compressions resulted in a significantly longer duration compared to distal compression, with no significant impact on reverse flow velocity. In contrast, in limbs with CVI, proximal compression led to a shorter duration and lower velocity reflux than distal compression. The authors argued that the observed discrepancy, where proximal compression produced longer flow reversal in normal limbs but a shorter reversal in limbs with CVI, may introduce ambiguity in the diagnosis of insufficiency.

11. van Bemmelen et al. 1989 [217]

The study examined the duration of deep venous valvular reflux in 192 venous segments of the legs from 32 healthy patients. Reflux was induced using three methods (i.e., Valsalva, proximal and distal compression) in both the 10-degree RT and standing positions. Standardised compressions were achieved using pneumatic cuffs. Regarding the popliteal vein measured in the RT position, this study found that proximal cuff compression consistently produced a consistently shorter reflux duration (0.96 ± 0.47 seconds). The authors stated that proximal compression does not expel a comparable volume of blood as the muscle pumping mechanism and does not lead to valve closure; instead, it causes reflux throughout the compression followed by a cessation of flow. This approach can be only employed to assess valvular competency during the systolic phase. In contrast, the release of distal compression is utilised to evaluate the diastolic function, emphasizing the clinical significance of valve closure during this phase.

12. Van Bemmelen et al. 1990 [217]

In this study, valvular function in the deep vein was investigated in 20 healthy volunteers using Valsalva, proximal compression, and automatic pneumatic cuff compression to the distal part of the limb. The findings revealed that when proximal compression was applied, 19 out of 20 limbs showed a peak reflux velocity of less than 20 cm/s. The research indicated that valve closure is not only triggered by the cessation of antegrade flow; rather, it requires a reversal of flow exceeding 30 cm/s. The retrograde pressure gradient from proximal manual compression is insufficient to generate the required reverse flow velocity in the RT position, and normal valves may not stop low-velocity reflux. Consequently, physiologic reverse flow through open valves could be mistaken for pathological reflux, making proximal manual compression in RT subjects unreliable for distinguishing abnormal from normal valves.

Discussion points (from meeting)

Alternate methods, when to use. …ulcers, patient unable to Valsalva

- ? mention site of augmentation, ie close to sample site.

Query raised about augmenting proximal to perforator, rather than distal. (added to summary statement, and supported literature added)

**Anonymous web-based survey questions (Recommendation G3)**

1. I accept the wording of the recommendation
2. I would like to suggest some amendments to the recommendation
3. Please provide a level of evidence rating for the recommendation
4. Please provide a strength of evidence rating for the recommendation
5. Are there any comments you would like to make?

**Results of web-based survey (Recommendation G3)**

Number of respondents=10

1. I accept the wording of the recommendation. YES n=9
2. I would like to suggest some amendments to the recommendation N=3
    - Distal augmentation optimised, requiring assistance (i.e., compression with two hands by an assistant). Distal compression at the calf is appropriate for proximal veins, and distal compression of the foot is appropriate for FOOT veins. Small error. We need to change FOOT to CALF.
    - dont forget patient comfort, an alternative method may be required for patient comfort and compliance
    - proximal augmentation- limited research, unreliable results - should we be more forceful in not recommending this. Include as an area for further research
3. Please provide a level of evidence rating for the recommendation. Weak n=0, Moderate n=6, Strong n=4
4. Please provide a strength of evidence rating for the recommendation. Weak n=0, Moderate n=1, Strong n=9
5. Are there any comments you would like to make? No comments

## Methodology used to develop Table E1 in Section E.

Table E1 in Section E was developed to guide sonographers in what assessments should be made for specific veins, i.e., to visualize, to test for venous obstruction, to test for reflux, and to measure the vein diameter. Instructions and comments for 'visualise', test for venous obstruction, test for reflux were developed via consensus discussion.

Instructions and comments for 'measure vein diameter' were developed via a consensus process using anonymous voting via an online survey (n=10 respondents). Guideline working group members were asked how often they would measure the diameters of the listed veins. Response options included; Never, Sometimes, Always. If 7 of greater respondents stated 'Always', for a specific vein, then the instruction for this vein was determined as 'Yes' (i.e., it should be measured). If less than 7 respondents stated 'Always', then the instruction determined for this vein was 'Optional', (i.e., the decision to measure is left to the discretion of the sonographer).

Guideline working group members were also asked to select clinical situations where they would measure the diameters of the veins. The options were; 1) when there is venous reflux, 2) if the vein is dilated (i.e., focally dilated without venous reflux, 3) if the treating or referring doctor, or local protocol directs it, 4) if the vein appears to relate to the clinical presentation, 5) when reflux is suspected, but not demonstratable. Respondents could select multiple options. If even one respondent selected an option it was included as a potential situation in the comments column of the table.

The results of the online survey are demonstrated in the Table APP 2.6.

APP 2.6 Working group responses to online survey on their practice in measuring the diameter of specific veins.

| Vein | How often would you measure this vein (n) | | | Situations when you would measure the vein; i.e. when you think it would be indicated. (n) | | | | | Comments |
|---|---|---|---|---|---|---|---|---|---|
| | Never | Sometimes | Always | Option 1 | Option 2 | Option 3 | Option 4 | Option 5 | |
| Common Femoral Vein | 7 | 3 | | 2 | 3 | | 1 | 2 | |
| Femoral vein | 7 | 3 | | 2 | 3 | | 2 | 2 | |
| Popliteal vein | 6 | 4 | | 2 | 3 | | 3 | 2 | I would measure the popliteal vein if I saw it was aneurysmal. However, this is extremely rare. |
| Saphenofemoral junction | | 2 | 8 | 3 | 2 | 1 | | 2 | |
| Great Saphenous vein | | 3 | 7 | 3 | 2 | 1 | 2 | 2 | |
| Anterior Saphenous vein | 1 | 4 | 5 | 2 | 2 | 1 | 2 | 1 | |
| PAGSV | 2 | 4 | 4 | 5 | 5 | 1 | 4 | 4 | |
| Superficial Circumflex Iliac vein | 3 | 7 | | 5 | 3 | | 4 | 3 | |
| Superficial Epigastric vein | 3 | 7 | | 5 | 3 | 1 | 4 | 3 | |
| Superficial External Pudendal vein | 3 | 7 | | 4 | 2 | 1 | 2 | 2 | |
| Saphenopopliteal junction | | 3 | 7 | 3 | 3 | 2 | 2 | 1 | |
| Small Saphenous vein | | 3 | 7 | 3 | 3 | 2 | 1 | 2 | |
| Thigh Extension of SSV or Giacomini vein | | 4 | 6 | 4 | 4 | 1 | 2 | 3 | |
| Perforating veins | | 5 | 5 | 6 | 5 | 1 | 3 | 4 | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Vulval Varicosities | 2 | 6 | 2 | 5 | 2 | 1 | 3 | 1 | |
| Gluteal Varicosities | 1 | 7 | 2 | 4 | 1 | | 1 | | |
| Popliteal Fossa Vein | 1 | 6 | 3 | 5 | 3 | | 3 | 2 | |
| Posterolateral Thigh Perforator | 1 | 6 | 2 | 7 | 5 | 1 | 3 | 3 | |
| Sciatic Nerve Varices | 3 | 5 | 2 | 5 | 1 | | 2 | 3 | |
| Knee Perforating vein | 2 | 5 | 3 | 6 | 2 | 1 | 1 | 3 | |
| Bone Perforating vein | 2 | 5 | 3 | 6 | 2 | 2 | 1 | 3 | |
| Lymph node venous network | 4 | 3 | 3 | 4 | 2 | | 2 | 3 | Detection of reflux in small veins sometimes can be difficult, so I measure the diameter of LNVN |
| Un-named tributaries | 3 | 5 | 2 | 4 | 1 | | 1 | | |
| Neovascularisation | 2 | 5 | 3 | 3 | 3 | | 2 | 3 | Detection of reflux in small veins sometimes can be difficult, so I measure the diameter of neo-vascular veins<br>I measure these veins when clinically it seems reasonable to do so. |

Key: Option 1; when there is venous reflux, Option 2; if the vein is dilated i.e., focally dilated without venous reflux >3mm), Option 3; if the treating/referring doctor requests it or protocol directs it, Option 4; if the vein appears to relate to the clinical presentation; Option 5; when reflux is suspected, but not demonstrable.

## Consultation *<to be completed>*

1. Stakeholder consultation (date)

| Date | Type of consultation | Responses |
|---|---|---|
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# Abbreviations

| | | | |
|---|---|---|---|
| AAV | Anterior Arch Vein (also known as anterior accessory of the great saphenous vein of the lower leg) | LNVN | Lymph Node Venous Network |
| ALARA | As Low as Reasonably Achievable | MBS | Medicare Benefits Scheme |
| AP | Antero-Posterior | MI | Mechanical Index |
| ATV | Anterior Tibial Vein | MTS | May-Thurner Syndrome |
| ASA | Australasian Sonographers Association | NZMRTB | New Zealand Medical Radiation Technologists Board |
| ASAR | Australian Sonography Accreditation Registry | PAGSV/ PASV | Posterior Accessory of the Great Saphenous Vein (used interchangeably with Posterior Accessory Saphenous Vein) |
| AMS | Accredited Medical Sonographer | PAV | Posterior Arch Vein (also known as posterior accessory of the great saphenous vein of the lower leg) |
| ASS | Accredited Student Sonographer | PFV | Popliteal Fossa Vein |
| ASUM | Australasian Society for Ultrasound in Medicine | PLTP | Posterolateral Thigh Perforating Vein |
| ASV (Formerly AGSV/ AASV) | Anterior Saphenous Vein (previously known as Anterior Accessory of the Great Saphenous Vein or Anterior Accessory Saphenous Vein) | PREVAIT | PREsence of Varices (residual or recurrent) After InTervention |
| ATCV | Anterior Thigh Circumflex Vein | PSV | Persistent Sciatic Vein |
| AVF | Arteriovenous Fistula | PTCV | Posterior Thigh Circumflex Vein |
| AVF | American Venous Forum | PTS | Post Thrombotic Syndrome |
| AVLS | American Venous and Lymphatic Society | PTV | Posterior Tibial Vein |
| AVM | Arterio-venous formation | PV | Perforating Vein |
| AVVQ | Aberdeen Varicose Vein Questionnaire | PVeD | Pelvic Venous Disorder |
| CE | Cranial Extension of the Small Saphenous Vein | RFA | Radiofrequency Ablation |
| CEAP | Clinical-Aetiology-Anatomy Pathophysiology classification | RP | Re-entry point (referring to perforating vein) |
| CCPU | Certificate in Clinician Performed Ultrasound | SCIV | Superficial Circumflex Iliac Vein |
| CFV | Common Femoral Vein | REVAS | Recurrent varices/recurrent veins after surgery |
| CIV | Common Iliac Vein | RT | Reverse Trendelenburg |
| CPD | Continuing Professional Development | SEPV | Superficial External Pudendal Vein |
| CVD | Chronic Venous Disease | SEV | Superficial Epigastric Vein |
| CVI | Chronic Venous Insufficiency | SFJ | Saphenofemoral Junction |
| DFV (was PFV) | Deep Femoral Vein (formerly known as profunda femoris vein) | SGV | Superior Gluteal Vein |
| DVS | Deep Vein Sclerosis | SNV | Sciatic Nerve Varices |
| DVT | Deep Vein Thrombosis | SPJ | Saphenopopliteal Junction |
| EGIT | Endovenous Glue-Induced Thrombosis | SSA | Small Saphenous Artery |
| EHIT | Endovenous Heat-Induced Thrombosis | SSV | Small Saphenous Vein (note: Short Saphenous Vein, Smaller Saphenous Vein and External Saphenous Vein are not recommended) |
| EIV | External Iliac Vein | STP | Superficial Thrombophlebitis |
| EP | Escape point (referring to perforating vein) | SVI | Superficial Venous Insufficiency |
| EVLA | Endovenous Laser Ablation | SVT | Superficial Vein Thrombosis |
| FV | Femoral Vein (note: Superficial Femoral Vein (SFV) should not be used for this vein) | TE | Thigh Extension of the Small Saphenous Vein (also known as cranial extension of the small saphenous vein) |
| GSV | Great Saphenous Vein | TI | Thermal Index |
| GSVa | Great Saphenous Vein above knee | UIP | International Union of Phlebology |
| GSVb | Great Saphenous Vein below knee | US | Ultrasound |
| HL | High Ligation | VCSS | Venous Clinical Severity Score |
| IAC | Intersocietal Accreditation Commission | VEGF | Vascular Endothelial Growth Factor |
| IGV | Inferior Gluteal Vein | VELTAS | The Venous and Lymphatic Triage and Acuity Scale |
| IIV | Internal Iliac Vein | VI | Venous Insufficiency |
| KTS | Klippel-Trenaunay syndrome | VLU | Venous Leg Ucer |
| IVC | Inferior Vena Cava | | |

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