



**VASCULAR TECHNOLOGY
PROFESSIONAL PERFORMANCE GUIDELINES**

Transcranial Ultrasound in Pediatric Patients with Sickle Cell Disease

This Guideline was prepared by the Professional Guidelines Subcommittee of the Society for Vascular Ultrasound (SVU) as a template to aid the vascular technologist/sonographer and other interested parties. It implies a consensus of those substantially concerned with its scope and provisions. The guidelines contain recommendations only and should not be used as a sole basis to make medical practice decisions. This SVU Guideline may be revised or withdrawn at any time. The procedures of SVU require that action be taken to reaffirm, revise, or withdraw this Guideline no later than three years from the date of publication. Suggestions for improvement of this Guideline are welcome and should be sent to the Executive Director of the Society for Vascular Ultrasound. No part of this Guideline may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

Sponsored and published by:
Society for Vascular Ultrasound
1601 Utica Ave S., Suite 213 Minneapolis, MN
55416
Tel.: 651-288-3431
Fax: 651-290-2266
E-mail: svuinfo@svunet.org
Internet: www.svunet.org

Copyright © by the Society for Vascular Ultrasound, 2026.
ALL RIGHTS RESERVED. PRINTED IN THE UNITED STATES OF AMERICA.
VASCULAR PROFESSIONAL PERFORMANCE GUIDELINE

Updated April 2026

PURPOSE

Transcranial Doppler (TCD) can identify children with sickle cell disease at risk for stroke and in need of blood transfusion. Data from the Stroke Prevention Trial in Sickle Cell Anemia (STOP) shows that persistently increased TCD velocities in the distal internal carotid and/or middle cerebral arteries indicates a high risk for first time stroke. TCD detection of abnormal time averaged maximum mean flow velocities in two consecutive exams, followed by blood transfusion resulting in 90% risk reduction for first time stroke. Transcranial Color Duplex Imaging (TCDI) can also be used to perform these exams, but variations in velocities have been reported when compared to TCD studies.

APPROPRIATE INDICATIONS

- Patients aged 2-16 years old with a diagnosis of sickle cell anemia or thalassemia
- Annual screening is recommended for compound heterozygous genotypes, if they display severe clinical phenotypes or accelerated hemolysis matching the traditional sickle cell range
- Abnormal time averaged maximum mean velocities from previous TCD exam(s)
- If an initial screening demonstrates abnormal velocity (≥ 200 cm/s), a repeat confirmatory transcranial exam must be performed within 7 to 14 days to rule out transient physiological elevation prior to establishing a chronic therapeutic pathway.

CONTRAINDICATIONS AND LIMITATIONS

- Children should be evaluated when healthy: hypoxia, hypercarbia, fever, sickle chest syndrome, pneumonia, hypoglycemia and other processes can result in increased cerebral blood flow velocities
- Hypocarbica and recent blood transfusions can decrease cerebral blood flow velocities. It is crucial to document if/when a transfusion has occurred within the preceded 90 days, as recent red blood cell transfusions artificially suppress baseline flow rates
- Children must remain awake and alert during the TCD examination: sleeping results in increased CO₂ and can cause increased velocities and misdiagnosis; crying may also result in hyperventilation, which can impact (artificially depress) velocities.
- Restless or agitated children may be unable to maintain appropriate positioning for a complete exam. Note any variations in exam performance in technical report.
- Active compliance and dosage of hydroxyurea therapy must be documented, as this intervention steadily decreases baseline velocities over time.

PATIENT COMMUNICATION (w/ parent and guardian)

Prior to beginning the exam, the technologist/sonographer should:

- Introduce self and explain why the examination is being performed and indicate how much time the examination will take.
- Verify the patient's name and date of birth or utilize facility specific patient identifiers.
- Explain the procedure, taking into consideration the age and mental status of the child or parent/guardian. The technologist/sonographer must direct all complex questions about medical history, clinical reasoning, and/or longitudinal timelines to

the parent or guardian, while utilizing age-appropriate language and terminology.

- Respond to questions and concerns about any aspect of the evaluation of both the patient and/or parent or guardian.
- Refer specific diagnostic, treatment or prognosis questions to the patient's physician.
- Remove patient's eyeglasses, contacts and/or head-coverings.
- Explain the importance of remaining awake and breathing normally throughout the exam.

PATIENT ASSESSMENT

Patient assessment should be completed before the evaluation is performed. This includes assessment of the patient's ability to tolerate the procedure and evaluation of any contraindications to the procedure. The sonographer or technologist should obtain a complete, pertinent history by interviewing the patient or parent/ guardian and review the patient's medical record, if available. A pertinent history includes:

- Previous cardiovascular surgeries
- Current medications or therapies
- Results of other relevant diagnostic procedures
- Review of prior examinations to ensure the evaluation duplicates prior Doppler parameters and matches the established laboratory technical profile for the patient.
- Assess current medical status; patients should be without fever, cough or any symptoms of illness that could impact physiology.
- If child has had recent transfusion, document date and type within the last 90 days.

PATIENT POSITIONING

Review patient positioning requirements for the examination and determine patient's ability to maintain proper positioning for all portions of the exam:

- Sitting or supine position with head supported or stabilized for transtemporal, orbital and sub-mandibular approach.
- Turned to side with neck flexed/chin toward chest to optimize access to foramen magnum for sub-occipital (transforamenal) approach.
- Alternatively, the sub-occipital exam can be performed with patient in sitting position, arms crossed and supported by stretcher or bedside table, head resting on arms so that neck is supported and relaxed.
- Patients should be kept awake throughout the exam due to changes in CO₂ during sleep which may affect velocities and result in misdiagnosis.
- The TCD technologist/sonographer should be positioned at the patient's head with arms supported.
- Exam positions may be adapted to keep patients from moving, crying or becoming restless.

INSTRUMENTATION

Velocity reference standards for predicting stroke in children with sickle cell disease were obtained with non-imaging TCD equipment. Distinct equipment is used for TCD and TCDI, but both analyze spectral Doppler waveforms to assess flow. To maintain data harmonization across the serial studies, laboratories must standardize and document their equipment protocol according to one of the following profiles.

Transcranial Doppler Ultrasound Equipment (TCD) Profile A

- Utilizes a single crystal 1.5-2.5MHz pulsed Doppler probe
- Equipment and software specifically designed for TCD applications
- Displays all data in real time including:
- Sample volume, sample depth
 - Time averaged maximum mean velocity
 - Peak systolic velocity/end diastolic velocity
 - Acceleration time
 - Pulsatility (PI) or resistive indices (RI)
 - Doppler power output and frequency
- Direction sensitive Doppler blood flow meter
- Bi-directional Doppler waveform display
- Audible output and permanent recording of the spectral waveform

• **Transcranial Color Duplex Imaging Equipment (TCDI) Profiles B and C**

- Duplex imaging scanner with B-Mode, color and spectral Doppler capabilities
- Utilizes a 1-5MHz transducer probe
 - Displays all data in real time including:
 - Sample volume, sample depth, Doppler angle
 - Time averaged maximum mean velocity
 - Peak systolic velocity /end diastolic velocity
 - Acceleration time
 - Pulsatility (PI) or resistive indices (RI)
 - Doppler power output and frequency
 - Direction sensitive Doppler blood flow meter
 - Bi-directional Doppler waveform display
 - Visual display, audible output and permanent recording of the spectral waveforms with corresponding B-Mode/Color image
- Profile B (TCDI uncorrected): the imaging equipment system's manual angle correction must remain with a 0° cursor alignment to track against standard STOP criteria.
- Profile C (TCDI angle-corrected): active geometric angle correction is applied to match the vessel, and the angle value must be recorded, preferably on screen.

EXAM PROTOCOL

Follow a standard imaging protocol for this examination. A complete evaluation includes spectral Doppler analysis of all accessible portions of the major intracranial arteries. Velocities can be measured by automatic tracing or manual cursor placement. Bilateral evaluations are essential for a complete evaluation. Serial tracking of an individual patient must utilize the identified technical profile (A, B, or C) established during their initial baseline exam. Switching profiles across studies introduces geometric variabilities that compromise data consistency.

Spectral Doppler waveforms include the following vessels and *approaches* (without angle correction). Waveforms are obtained at 2-5mm increments, or walked through each vessel of interest:

Submandibular Window:

- Distal cervical internal carotid arteries (ICA)

Transtemporal Window:

- Terminal internal carotid arteries (TICA)
- M1 segment of the middle cerebral arteries (MCA)
 - Should obtain proximal, mid and distal measurements
- A1 segment of the anterior cerebral arteries (ACA)
- Anterior communicating artery, if detectable (ACoA)
- P1 and P2 segments of the posterior cerebral arteries
- Posterior communicating arteries, if detectable (PCoA)

Transforamenal/Suboccipital Window:

- Terminal vertebral arteries (VA)
- Proximal and distal segments of the basilar artery (BA)

Orbital Window: (not typically utilized for this exam)

- Ophthalmic Artery (OA)
- Carotid siphon

Technical Considerations:

- Time averaged maximum mean (TAMMV) flow velocities are used for interpretation
- Mean flow velocities are classified as normal, conditional or abnormal
- Diagnosis applies specifically to the internal carotid and middle cerebral arteries
- TCD detection of abnormal mean flow velocities on two separate exams determines the need for blood transfusions to reduce stroke risk
- Abnormal studies should be verified with a second exam, preferably within a one-to-two-week period (7 to 14 days)
- Conditional exams should be repeated within 3-6 months to document progression
- Acoustic window characterization: the technologist/sonographer should evaluate and document the quality of each temporal bone window and classify them as good (clear visualization), poor/ inadequate (high attenuation requiring maximum gain), or absent (zero visualization). Unilateral, applicable to studies resulting from an absent window and must be documented and labeled on the image.
- Contralateral approach: if an acoustic window is absent or poor/inadequate, technologists/sonographers may attempt to evaluate contralateral vessels across the midline from the functional ipsilateral window. All vessels imaged with this technique must be documented and labeled. Also note, a normal velocity obtained with a contralateral window may not be used to clear a patient of stroke risk, due to deep field signal attenuation.
- If a major segment demonstrates an unusually flat TAMMV less than 70cm/s or a >50% velocity drop compared to the contralateral side with the presence of severe narrowing, it should be noted as a critical or near-occlusive finding.
- In young children, the temporal bone is easy to penetrate. It may be possible

to complete most of the exam from one side. While not ideal, this may be done at times for ease and convenience of the young patient. Relying on the cross-midline approach increases ease while reducing accuracy by introducing geometric variabilities. When done, this must be documented to avoid confusion and misdiagnosis of flow direction or velocity. Whenever possible the technologist/sonographer should attempt to image from bilateral temporal windows.

- The STOP Trial did not include the orbital exam; however, if a temporal window cannot be identified, the orbital exam may be useful, as it provides access to the carotid siphon (power must be decreased for this approach).
- Velocity scaling (Profile B): if a laboratory utilizes TCDI with uncorrected angles, the interpreting physician should account for an inherent 10% to 15% underestimation of the absolute velocities when compared to Profile A. The laboratory can either apply a validated lower TCDI specific threshold matrix or include the technical caveat in the final interpretation.

REVIEW OF THE DIAGNOSTIC EXAM FINDINGS

The technologist/sonographer should:

- Review data acquired during the exam to ensure a complete and comprehensive evaluation has been performed and documented.
- Explain and document any exceptions or limitations to the protocol; including the window acoustic characterization and/or a contralateral window anatomical approach.
- Document any changes compared with previous exams, including but not limited to cross referencing the equipment used as well as the selected imaging profile (A, B, or C) to ensure serial alignment.
- Record technical findings on a worksheet or other appropriate method (e.g., computer software) and classify results according to the laboratory diagnostic criteria.
- Document the exam date, clinical indications, performing sonographer and exam summary in patient's medical record.

PRESENTATION OF EXAM FINDINGS

The technologist/sonographer should:

- Provide preliminary results, when necessary, as provided by laboratory specific guidelines.
- Present record of diagnostic images, data, explanations, and technical worksheet to the interpreting physician. Interpretation must be available within two business days.
- The technologist/sonographer and interpreting physician name must appear on the final report. Finalized/signed report should be available within four business days.
- Alert vascular laboratory Medical Director or appropriate health care provider when immediate medical attention is indicated based on departmental guidelines and procedures.

EXAM TIME RECOMMENDATIONS

High quality and accurate results are fundamental elements of TCD and TCDI examinations. A combination of indirect and direct exam components is the foundation for maximizing exam quality and accuracy.

- Indirect exam components include:
 - Pre-exam activities: obtaining previous exam data, initiating exam worksheet and paperwork, equipment and exam room preparation, patient assessment and positioning, patient communication

- Post-exam activities: exam room cleanup, compiling and processing exam data for preliminary and/or formal interpretation, and exam billing activities.
- Direct exam components include:
 - Equipment optimization and the actual hands-on examination process.
- While study times may vary depending on testing protocols, patient condition, and clinical complexity of the evaluation being performed, these are the times necessary to provide a quality diagnostic evaluation. Listed are the recommended examination times for performing each CPT related to this guideline, which were derived from the direct time inputs from the Resource Based Relative Value Scale (RBRVS).
 - 93886 73 minutes
 - 93888 49 minutes

REFERENCES

- ACR–AIUM–SPR–SRU. Joint Practice Parameter for the Performance of Transcranial Doppler Ultrasound Examination. *American College of Radiology / American Institute of Ultrasound in Medicine*. 2022.
- Adams RJ, McKie VC, Nichols FT, et al. Long term risk of stroke in children with sickle cell disease screened with transcranial Doppler. *Ann Neurol*. 1997; 42: 699-704.
- Adams RJ, McKie VC, Hsu L, et.al. Prevention of a first stroke by transfusions in children with sickle cell anemia and abnormal results on transcranial Doppler ultrasonography. *N Engl J Med*. 1998; 339: 5-11. <http://www.nejm.org/doi/pdf/10.1056/NEJM199807023390102>
- DeBaun MR, Jordan LC, King AA, et al. American Society of Hematology 2020 guidelines for sickle cell disease: Prevention, diagnosis, and treatment of cerebrovascular disease in children and adults. *Blood Advances*, 4(8), 1554–1588. 2020. <https://doi.org/10.1182/bloodadvances.2019001142>
- Gunda ST, Ng TKV, Liu TY, et al. A comparative study of Transcranial Color-Coded Doppler (TCCD) and Transcranial Doppler (TCD) ultrasonography techniques in assessing the intracranial cerebral arteries hemodynamics. *Diagnostics*, 14(4), 387. 2024. <https://doi.org/10.3390/diagnostics14040387>
- IAC Standards and Guidelines for Vascular Testing. Intersocietal Accreditation Commission Web Site. Retrieved from <http://www.intersocietal.org/vascular/standards/IACVascularTestingStandards2018.pdf>
- Jones AM, Seibert JJ, Nichols FT et al. Comparison of transcranial Doppler Imaging (TCDI) and transcranial Doppler (TCD) in children with sickle-cell anemia. *Pediatric Radiol*. 2001; 31: 461-469.
- Marques TROC. Variations in transcranial doppler among pediatric patients with sickle cell disease: A cross-sectional study of implementation confounders. *PMC*, Article PMC13094631. 2026.
- MDPI Neurosonology Data Consortium. Temporal window failure and semiquantitative scoring metrics in pediatric cranial morphology. *Diagnostics*, 16(3), 279. 2026. <https://doi.org/10.3390/brainsci16030279>
- Nichols FT, Jones AM, Adams RJ. Stroke prevention in sickle cell disease (STOP) study guidelines for transcranial Doppler testing. *J Neuroimaging*. 2001; 11: 354–362.

- Neish AS, Blews DE, Simms CA, Merritt RK, Spinks AJ. Screening for stroke in sickle cell anemia: comparison of transcranial Doppler imaging and nonimaging US techniques. *Radiology*. 2002 Mar;222(3):709-14. doi:10.1148/radiol.2223010524
- Quinn CT, & Ware RE. The modern use of hydroxyurea for children with sickle cell anemia: Physiological and rheological impacts on vascular flow. *Haematologica*, 110. 2025.
- Shu'aibu Hikima M, Idris N, Suwaid MA, et al. Variation between imaging and non-imaging transcranial Doppler systems versus a phantom Doppler generated velocity. *American Journal of Hematology*, 100(4). 2025. <https://doi.org/10.1002/ajh.27616>
- St-Onge J. Stroke burden and macrovascular functional impacts in patients with sickle cell disease. *PMC*, Article PMC12995526. 2026.