Transcranial Doppler Ultrasonography

Number: 0353

Policy

*Please see amendment for Pennsylvania Medicaid at the end of this CPB.*

I. Aetna considers transcranial Doppler ultrasonography (TDU) medically necessary when used for any of the following indications:

A. Assessing collateral blood flow and embolization during carotid endarterectomy; or

B. Assessing patterns and extent of collateral circulation in persons with known regions of severe stenosis or occlusion, including persons with Moyamoya syndrome; or

C. Assessing persons suspected of having patent foramen ovale/paradoxical embolism (symptoms include visual disturbance, weakness, hemiplegia, or slurred speech); or

D. Assessing persons with suspected brain death; or

E. Assessing stroke risk of children (2 to 16 years of age) with sickle cell anemia (although the optimal time is unknown, accepted guidelines state that re-screening should be considered approximately every 6 months); or

F. Detecting arterio-venous malformations (AVMs) and studying their supply arteries and flow patterns; or

G. Detecting noncardiac right-to-left shunts; or

H. Detecting microemboli in cerebral artery embolism; or

Policy History

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Review History

Definitions

Additional Information

Clinical Policy Bulletin Notes
I. Detecting severe stenosis in the major basal intra-cranial arteries for members who have neurological signs or symptoms or carotid bruits; or

J. Diagnosing and monitoring of reversible cerebral vasoconstriction syndromes; or

K. Diagnosing dissection of vertebral artery; or

L. Evaluating and following persons with vasoconstriction of any cause, especially after subarachnoid hemorrhage; or

M. Evaluating very low birth weight preterm infants with gestational age less than 30 weeks.

II. Aetna considers TDU experimental and investigational for all other indications, including the following:

A. Assessing autoregulation, physiologic, and pharmacologic responses of cerebral arteries; or

B. Brain tumors; or

C. Diagnosing cerebral vein and sinus thrombosis and other conditions that involve venous pathology; or

D. Diagnosing or monitoring response to anti-thrombotic therapy in ischemic cerebrovascular disease; or

E. Epilepsy; or

F. Evaluating adults with sickle cell anemia; or

G. Evaluating ataxia, head trauma/skull fracture; or

H. Evaluating children with neurofibromatosis; or

I. Evaluating persons with dilated vasculopathies such as fusiform aneurysms; or

J. Familial and degenerative diseases of the cerebrum, brainstem, cerebellum, basal ganglia and motor neurons (e.g., Parkinson’s disease); or

K. Following placement of an intra-cerebral arterial stent; or

L. Infectious and inflammatory conditions of the brain; or

M. Managing traumatic brain injury; or

N. Migraine headaches; or

O. Monitoring during cardiopulmonary bypass and other cerebrovascular and cardiovascular interventions, and surgical procedures other than carotid endarterectomy; or

P. Predicting hemorrhagic transformation of ischemic infarction; or
Q. Predicting outcome in vertebrobasilar distribution stroke; or
R. Psychiatric disorders; or
S. Screening for carotid artery stenosis in asymptomatic adults; or
T. Screening for stenosis of cerebral arteries in persons with fibromuscular dysplasia.

Background
Transcranial Doppler ultrasonography (TDU) is a non-invasive technology that uses a handheld pulsed low-frequency Doppler transducer that enables recording of blood velocities from intracranial arteries through selected cranial foramina and thin regions of the skull. Analysis of the Doppler spectra allows display and calculation of peak systolic, peak diastolic, and mean velocities and pulsatility indices. Mapping of the sampled velocities as a color display of spectra in lateral, coronal and horizontal views locates the major brain arteries in three dimensions.

Cerebral angiography provides an image of the anatomical configuration of the lesions of the intra-cranial and extra-cranial arteries and their proximal, deep and superficial branches. Transcranial Doppler obtains information about the physiology of flow through the major basal intra-cranial arteries by measuring velocities and pulsitilities in segments of these arteries. PET and SPECT scanning, xenon enhanced CT scanning, and MRI spectroscopy yield images or quantitative data about metabolism and perfusion of brain regions but do not give direct data about flow in major supplying arteries (AAN, 1990; AAN, 1991).

Strokes occur in about 10 % of children with sickle cell anemia. These events can affect motor skills, school performance, as well as overall quality of life. The treatment, periodic red blood cell transfusions to maintain the level of hemoglobin S below 30 %, lowered the rate of strokes by 90 % in children found to be at increased risk as indicated by elevated transcranial Doppler velocities (greater than or equal to 200 cm/sec time averaged mean velocities).

Adam (2000) stated that non-invasive prediction of risk using TDU
made it possible to test primary stroke prevention in a clinical trial comparing chronic blood transfusion with standard care. A consortium of 14 clinical centers conducted a randomized clinical trial (Stroke Prevention in Sickle Cell Anemia -- the "STOP" study) to test a strategy to prevent first stroke in children with sickle cell disease (SCD). Over 2,000 children were screened with TDU and of these, 130 with elevated blood velocity indicating high-risk were enrolled in the trial. Regular red cell transfusions sufficient to reduce the percentage of Hb S gene product from over 90 to less than 30 of total hemoglobin was associated with a marked reduction in stroke. The untreated risk of 10% per year was reduced over 90% with treatment, an effect sufficient to cause early termination of the trial. The study led to a Clinical Alert, issued by the National Heart, Lung, and Blood Institute, recommending screening and consideration of treatment in children with SCD and 2 to 16 years of age who are at risk based on TDU, and who have not had stroke.

Miller et al (2001) reported that the STOP trial demonstrated that chronic transfusion is highly effective in reducing the risk of stroke in children with SCD and an abnormal TDU examination result; and compliance with aggressive chronic transfusion reduces the frequency of acute chest syndrome and pain episodes.

Hirsch et al (2002) reported that the value of TDU in children is not in the primary diagnosis of disease but in the follow-up of known vascular processes (e.g., stenoses) or in chronic diseases including angiitis and SCD.

Gorman and colleagues (2009) stated that TDU is used to screen individuals with the major hemoglobin S diseases, SCD and Hb S-beta(0), for significant stenoses in the circle of Willis. Flow velocities above 200 cm/s have been shown to identify patients at elevated risk for cerebral infarction. Among TDU's limitations is the inability to insonate the distal extracranial, petrous, and cavernous internal carotid artery (ICA) through the standard transtemporal approach. These researchers extended the submandibular approach to include infra-siphon portions of the ICA. Using the extended submandibular approach to evaluate these portions of the ICA, these investigators identified stenotic
lesions in 4 patients with SCD out of a population of 131 children with SCD. Three of the 4 patients had no history of overt stroke or stroke-like symptoms. Neuroimaging confirmed the stenotic lesions, and also revealed watershed infarction as well as discrete areas of silent infarction. All 4 children had neuropsychological impairment. The authors concluded that the submandibular approach, when added to a standard transcranial Doppler examination, may increase the sensitivity of this technique to identify important potential sources of cerebral infarction. Moreover, they stated that further study is indicated.

In an editorial that accompanied the afore-mentioned article, Jordan and Strouse (2009) stated that limitations of this study included the small number of children with increased ICA velocity, inability to evaluate the temporal relationship between abnormal TDU and the development of stenosis on MRA, and the lack of concurrent TDU and MRA. If the goal of TDU screening is to identify children with SCD–related vasculopathy who are at high risk for stroke, then in an ideal study, all children should have both TDU and MRA. It is unknown how many children with a normal TDU might have an abnormal MRA. Of the 4 children with an abnormal TDU in the current study, 1 child had only mild ICA narrowing confirmed by MRA. In 2 children, the elevated TDU velocity was not as expected, with increased TDU velocity on 1 side and stenosis identified by MRA on the other. In the Stroke Prevention (STOP) Trial, all 11 children with ischemic stroke had increased velocities (200 cm/s) on the same side as the cerebral infarct. This TDU technique could provide information about vasculopathy and stroke risk in children with SCD with little additional cost or effort if added to the routine TDU screening. Thus, this work should be confirmed and extended by rigorous study in a larger population. An important aspect of future studies will be to show a temporal relationship between elevated TDU velocities in the cavernous and petrous ICA segments, vessel stenosis, and neurological outcome.

Pavlakis and associates (2010) stated that TDU is used to predict stroke risk in children with SCD, but has not been adequately studied in children under age 2 years. These investigators performed TDU on infants with SCD enrolled in the BABY HUG
Subjects were 7 to 17 months of age (mean of 12.6 months). Transcranial Doppler ultrasound examinations were successfully performed in 94% of subjects (n = 192). No patient had an abnormal TDU as defined in the older child (time averaged maximum mean TAMM velocity greater than or equal to 200 cm/sec) and only 4 subjects (2%) had velocities in the conditional range (170 to 199 cm/sec). Transcranial Doppler ultrasound velocities were inversely related to hemoglobin (Hb) concentration and directly related to increasing age. The authors concluded that determination of whether the TDU values in this very young cohort of infants with SCD can be used to predict stroke risk later in childhood will require analysis of exit TDU and long-term follow-up, which is ongoing.

Transcranial Doppler bubble ultrasound has been used to evaluate patients suspected of having patent foramen ovale when a transesophageal echocardiography is contraindicated or is unavailable.

Three methods have been used to diagnose patent foramen ovale. All procedures use a contrast solution of agitated saline that contains air bubbles. This bubbly solution is injected into a vein during normal respiration and in conjunction with some repetitive action such as a cough or performing a Valsalva maneuver, which should open the patent foramen ovale flap. Blood flow following injections is compared during the flap-opening maneuver versus the resting condition.

Three-dimensional trans-esophageal echocardiography (TEE) is the most sensitive of measurement methods, but the most uncomfortably invasive since a probe is placed in the back of the throat, which must be anesthetized for optimal imaging of the inter-atrial septum. Bubble contrast transthoracic echocardiography, or TTE, uses electronic imaging measure across the chest. Transcranial Doppler, or transcranial Doppler (TCD), uses a sonographic imaging from the of the right middle cerebral artery in the head. The sensitivity of TCD varies from 68% to 89% relative to contrast TEE, and its specificity from 92% to 100% when studying stroke populations. Advantages of TCD are that it is safe, causes little patient discomfort, and can be performed
without fasting or sedation.

The 2002 practice parameter on neuroimaging of the neonate by the American Academy of Neurology (AAN) stated that cranial ultrasonography plays an established role in the management of preterm neonates of less than 30 weeks' gestation (Ment et al, 2002). Furthermore, an assessment on TDU performed by the AAN (Sloan et al, 2004) stated that it provides important information and may have value for detection of intracranial steno-occlusive disease. On the other hand, the assessment indicated that available data do not support the use of TDU for: (i) diagnosing or monitoring response to anti-thrombotic therapy in ischemic cerebrovascular disease; (ii) predicting outcome in vertebrobasilar distribution stroke; (iii) predicting hemorrhagic transformation of ischemic infarction; (iv) detecting impaired cerebral hemodynamics distal to high-grade extracranial internal carotid artery stenosis or occlusion; and (v) evaluating adults with sickle cell anemia.

The U.S. Preventive Services Task Force (2007) examined the evidence on the natural history of carotid artery stenosis (CAS); systematic reviews of the accuracy of screening tests; observational studies of the harms of screening and treatment of asymptomatic CAS; and randomized, controlled trials of the benefits of treatment for CAS with carotid endarterectomy. The U.S. Preventive Services Task Force recommended against screening for asymptomatic CAS in the general adult population. (Grade D recommendation: There is moderate or high certainty that the service has no net benefit or that the harms outweigh the benefits).

The Report of the Therapeutics and Technology Assessment Subcommittee of the AAN considered that TCD is probably useful for detection of cerebral MES in various cardiovascular and cerebrovascular disorders and procedures (Sloan et al, 2004). The report found that the clinical utility of TCD is established in the following indications: 1) Screening of children aged 2 to 16 years with sickle cell disease for assessing stroke risk, although the optimal frequency of testing is unknown; 2) Detection and monitoring of angiographic vasospasm spontaneous
subarachnoid hemorrhage; more data are needed to show if its use affects clinical outcomes.

The AAN report (Sloan et al, 2004) found that TCD is able to provide information for the following indications, but its clinical utility, compared to other diagnostic tools, remains to be determined: 1) *Intracranial steno-occlusive disease*: TCD is probably useful for the evaluation of occlusive lesions of intracranial arteries in the basal cisterns (especially the internal carotid artery [ICA] siphon and middle cerebral artery [MCA]). The report stated that the relative value of TCD compared with magnetic resonance angiography (MRA) or computed tomography angiography (CTA) remains to be determined. Data are insufficient to recommend replacement of conventional angiography with TCD; 2) *Cerebral circulatory arrest (adjunctive test in the determination of brain death)*: If needed, TCD can be used as a confirmatory test, in support of a clinical diagnosis of brain death.

The AAN report (Sloan et al, 2004) found that TCD is able to provide information for the following indications, but its clinical utility for these indications remains to be determined: (i) *Cerebral thrombolysis*: TCD is probably useful for monitoring thrombolysis of acute MCA occlusions. The report stated that more data are needed to assess the frequency of monitoring for clot dissolution and enhanced recanalization and to influence therapy; (ii) *Cerebral microembolism detection*: TCD monitoring is probably useful for the detection of cerebral microembolic signals in a variety of cardiovascular and cerebrovascular disorders and procedures. The report stated that data do not support the use of this TCD technique for diagnosis or monitoring response to antithrombotic therapy in ischemic cerebrovascular disease; (iii) *Carotid endarterectomy* (CEA): TCD monitoring is probably useful to detect hemodynamic and embolic events that may result in perioperative stroke during and after CEA in settings where monitoring is felt to be necessary; (iv) *Coronary artery bypass graft (CABG) surgery*: TCD monitoring is probably useful during CABG for detection of cerebral microemboli. TCD is possibly useful to document changes in flow velocities and carbon dioxide (CO2) reactivity during CABG surgery. Data are insufficient
regarding the clinical impact of this information; (v) *Vasomotor reactivity (VMR) testing:* TCD is probably useful for the detection of impaired cerebral hemodynamics in patients with severe (greater than 70 percent) asymptomatic extracranial ICA stenosis, symptomatic or asymptomatic extracranial ICA occlusion, and cerebral small-artery disease. Whether these techniques should be used to influence therapy and improve patient outcomes remains to be determined; (vi) *VSP after traumatic subarachnoid hemorrhage (tSAH):* TCD is probably useful for the detection of VSP following tSAH, but data are needed to show its accuracy and clinical impact in this setting; (vii) *Transcranial color-coded sonography (TCCS):* TCCS is possibly useful for the evaluation and monitoring of space-occupying ischemic middle cerebral artery (MCA) infarctions. More data are needed to show if it has value versus computed tomography (CT) and magnetic resonance imaging (MRI) scanning and if its use affects clinical outcomes.

The AAN report (Sloan et al, 2004) found that TCD is able to provide information in the following settings, but other diagnostic tests are typically preferable: (i) *Right-to-left cardiac shunts:* Whereas TCD is useful for detection of right-to-left cardiac and extracardiac shunts, transesophageal echocardiography (TEE) is superior, as it can provide direct information regarding the anatomic site and nature of the shunt; (ii) *Extracranial ICA stenosis:* TCD is possibly useful for the evaluation of severe extracranial ICA stenosis or occlusion, but, in general, carotid duplex and magnetic resonance angiography (MRA) are the diagnostic tests of choice; (iii) *Contrast-enhanced TCCS:* Contrast-enhanced TCCS may provide information in patients with ischemic cerebrovascular disease and aneurismal subarachnoid hemorrhage (aSAH). Its clinical utility versus CT scanning, conventional angiography, or nonimaging TCD is unclear.

Ritter and colleagues (2008) compiled available studies using microembolic signals (MES) detection by TDU in varying sources of arterial brain embolism. These researchers investigated prevalences of MES and whether MES detection is of proven use for risk stratification. Studies reporting prevalences of MES and the risk of cerebral ischemic events were pooled for patients with symptomatic or asymptomatic carotid stenosis, intra-cranial
artery stenosis, cervical artery dissection, and aortic embolism. Microembolic signals were reported in 43 % of 586 patients with symptomatic and in 10 % of 1,066 patients with asymptomatic carotid stenosis. Presence of 1 MES indicated an increased risk of future events [odds ratio (OR): 7.5, 95 % confidence interval (CI): 3.6 to 15.4, p < 0.0001 for symptomatic, and OR: 13.4, 95 % CI: 6.5 to 27.4, p < 0.0001 for asymptomatic disease]. Microembolic signals were reported in 25 % of 220 patients with symptomatic versus 0 % of 86 patients with asymptomatic intra-cranial stenosis (p < 0.0001). Of 82 patients with cervical artery dissection presenting with transient ischemic attack (TIA) or stroke, 50 % had MES compared with 13 % of 16 patients with local symptoms (p = 0.006). In patients with aortic embolism, patients with plaques greater than or equal to 4 mm more frequently had MES compared with patients with smaller plaques (p = 0.04). Data were insufficient to reliably predict future events in patients with intra-cranial stenosis, cervical artery dissection, and aortic embolism. The authors concluded that MES are a frequent finding in varying sources of arterial brain embolism; and MES detection is useful for risk stratification in patients with carotid stenosis.

Jovanovic et al (2008) noted that approximately 1/3 of ischemic cerebrovascular diseases have embolic properties. Because of that, transcranial Doppler (TCD) test for detection of MES, as the only one method for detection of microemboli, is a very important test for the evaluation of cerebral artery embolism. Cerebral emboli are particles of thrombus or atheromatous plaque, platelet aggregates, lipid or air particles in cerebral circulation, which can occlude arterioles and cause TIA or stroke. Most frequently, they derive from exulcerated plaques of the carotid bifurcation or the aortic arch, from the atrial thrombus, prosthetic heart valves, as well as during carotid endarterectomy, arterial stent, aortocoronary by-pass. For MES detection, bilateral monitoring of a. cerebri mediae (ACM) is performed with each probe held in place over a temporal bone. Microembolic signals are represented as brightly colored embolic tracks as they pass through the insonated arteries. A computer hard disk provides continuous recording that is replayed for counting embolic signals. Color intensity or acoustic range indicate the size and
structure of MES. Microembolic signals in the range of one ACM indicate the source of embolism on the ipsilateral carotid artery, while the bilateral detection of MES suggests a cardiogenic source. Indications for TCD detection of MES are the evaluation of pathogenesis and risk for embolic stroke or TIA and assessing the source of embolism. These researchers started applying this method 2 years ago. They had examined 78 patients and detected MES in 23 patients (28.7 %).

Woitalla and colleagues (2010) stated that Imaging of the brain structure with trans-cranial ultrasound has become an important tool for the diagnosis and differential diagnosis of Parkinson's Disease. In up to 90 % of parkinsonian patients, abnormal echogenity of the substantia nigra (SN) could be demonstrated. Particularly in the early diagnosis in subjects with only very mild extra-pyramidal features and in the differential diagnosis to other neurodegenerative disorders with parkinsonian features, such as the parkinsonian variant of multi-system atrophy (MSA-P) and progressive supranuclear paralysis (PSP) ultrasound has a high diagnostic yield. Because of a prevalence of about 10 % in the normal population, the evidence of an abnormal echogenity of the SN has to be interpreted carefully in the context of a clinical examination. Although there are a number of studies indicating that in some of these subjects a vulnerability of the nigro-striatal system can be found, the meaning of an abnormal echogenicity of the SN in the healthy population needs to be further elucidated in already ongoing research projects.

Singh et al (2004) noted that blunt carotid artery injury (BCI) is a rare but potentially devastating injury. When undiagnosed it can result in severe disability or death. A Medline-based literature search was performed using key words "blunt carotid injury" and cross-referenced with further original papers obtained from the references from this search. The incidence of BCI is very low. However, given the serious consequences of a missed injury, recent efforts have focused on targeted screening for this injury in trauma patients. Conventional angiography remains the investigation of choice but may be superseded in the future by non-invasive methods such as magnetic resonance angiography or CT angiography. Operative intervention is rarely required and
anti-coagulation remains the treatment of choice where
dissection or pseudoaneurysm is diagnosed. The role of anti-
platelet therapy is currently being investigated. Endovascular
management using stents has been described but medium- to
long-term results are not yet available.

Sloan (2006) stated that all neuromonitoring techniques,
although imperfect, provide useful information for monitoring
cardiothoracic and carotid vascular operations. They may be
viewed as providing complementary information, which may help
surgical technique and, as a result, possibly improve clinical
outcomes. As of this writing, the efficacy of TDU and near-
infrared spectroscopy monitoring during cardiothoracic and
vascular surgery can not be considered established. The author
concluded that well-designed, prospective, adequately powered,
double-blind, and randomized outcome studies are needed to
determine the optimal neurologic monitoring modality (or
modalities), in specific surgical settings.

Kincaid (2008) stated that since its introduction in 1982, TDU has
become an important diagnostic and monitoring tool in patients
with surgical disease. It has applications in the peri-operative
period, as well as in the intensive care unit. It is therefore
appropriate for the anesthesiologist to maintain an understanding
of its current utility. Transcranial Doppler has an established role
in diagnosing cerebral vasospasm in patients with aneurysmal
subarachnoid hemorrhage and for guiding transfusion therapy in
children with sickle cell disease. It has application in the pre-
operative evaluation of patients with cerebrovascular disease, as
well as that of an intra-operative monitor in carotid
endarterectomy and carotid stenting. It is useful for detecting
right-to-left shunts in settings in which trans-esophageal
echocardiography is not desirable. Its value in settings such as
traumatic brain injury, hepatic failure, and migraine headache has
yet to be fully clarified. The author concluded that although there
are several settings in which TDU has well-established
usefulness, there are many more in which it is likely valuable,
such as traumatic brain injury, ischemic stroke, and fulminant
hepatic failure. The author stated that further research is needed
in these fields to elucidate the exact role for TDU.
Edmunds et al (2011) stated that the American Society of Neurophysiologic Monitoring (ASNM) and American Society of Neuroimaging (ASN) Guidelines Committees formed a joint task force and developed guidelines to assist in the use of TCD monitoring in the surgical and intensive care settings. Specifically, these guidelines: (i) delineate the objectives of TCD monitoring; (ii) characterize the responsibilities and behaviors of the sonographer during monitoring; (iii) describe methodological and ethical issues uniquely relevant to monitoring. The ASNM and ASN strongly support the positions that (i) acquisition and interpretation of intra-operative TCD ultrasonograms be performed by qualified individuals, (ii) service providers define their diagnostic criteria and develop on-going self-validation programs of these performance criteria in their practices. The authors agreed with the guidelines of other professional societies regarding the technical and professional qualifications of individuals responsible for TCD signal acquisition and interpretation (Class III evidence, Type C recommendation). On the basis of current clinical literature and scientific evidence, TCD monitoring is an established monitoring modality for the: (i) assessment of cerebral vasomotor reactivity and autoregulation; (ii) documentation of the circle of Willis functional status; (iii) identification of cerebral hypo- and hyper-perfusion, recanalization and re-occlusion; and (iv) detection of cerebral emboli (Class II and III evidence, Type B recommendation).

An UpToDate review on "Moyamoya disease: Etiology, clinical features, and diagnosis" (Suwanwela, 2012) states that "[t]ranscranial Doppler ultrasonography (TCD) provides a noninvasive way to evaluate intracranial hemodynamics and large artery stenosis". Furthermore, the American College of Radiology-American Institute of Ultrasound in Medicine's practice guideline for the performance of TCD ultrasound for adults and children (2007) listed "detection of vasculopathy such as moyamoya" and "detection of right-to-left shunts using agitated saline injection" as one of the recommended indications for children and adults, respectively.

In an international multi-center study, Tsivgoulis and colleagues (2011) prospectively evaluated the safety of TCD with "bubble
studies" (TCD-BS) for identifying right-to-left shunt (RLS).
Consecutive patients with cerebral ischemia (ischemic stroke or transient ischemic attack (TIA)) were screened for potential ischemic cerebrovascular events following injection of microbubbles during TCD-BS for identification of RLS at 3 tertiary care stroke centers. TCD-BS was performed according to the standardized International Consensus Protocol. Trans-oesophageal echocardiography (TOE) "bubble studies" (TOE-BS) was performed in selected cases for confirmation of TCD-BS. A total of 508 patients hospitalized with acute cerebral ischemia (mean age of 46 +/- 12 years, 59 % men; 63 % ischemic stroke, 37 % TIA) were investigated with TCD-BS within 1 week of ictus. Right-to-left shunt was identified in 151 cases (30 %). TOE-BS was performed in 101 out of 151 patients with RLS identified on TCD-BS (67 %). It was positive in 99 patients (98 %). The rate of ischemic cerebrovascular complications during or after TCD-BS was 0 % (95 % CI by the adjusted Wald METHOD: 0 to 0.6 %).
Structural cardiac abnormalities were identified in 38 patients, including atrial septal aneurysm (n = 23), tetralogy of Fallot (n = 1), intra-cardiac thrombus (n = 2), ventricular septal defect (n = 3) and atrial myxoma (n = 1). The authors concluded that TCD-BS is a safe screening test for identification of RLS, independent of the presence of cardiac structural abnormalities.

Stolz (2008) stated that ultrasound examination of cerebral veins and sinuses is a new application that has been developed in the recent years. In the acute phase of cerebral vein and sinus thrombosis, occlusion of dural sinuses may be diagnosed by TCCS after echo contrast agent application demonstrating a filling defect. Collateral venous flow can be assessed by both TCD and TCCS. However, ultrasonographic techniques are not sensitive enough to exclude cerebral venous thrombosis, but they may complement other imaging techniques. In the follow-up, sonographic findings are related to the functional outcome.

An UpToDate review on “Etiology, clinical features, and diagnosis of cerebral venous thrombosis” (Ferro and Canhao, 2013) states that “Transcranial Doppler ultrasonography and transcranial power or color Doppler imaging, with or without the use of contrast, are noninvasive techniques that have potential utility for
the diagnosis of CVT and for follow-up, but more information is needed to determine the true clinical value of these methods. In pediatric patients, transfontanellar ultrasound may support the diagnosis of CVT”.

The American College of Radiology’s “Appropriateness Criteria® ataxia” (Broderick et al, 2012) rendered TDU for evaluating ataxia associated with various causes a “1” or “2” rating (Rating scale: 1, 2, and 3: Usually not appropriate; 4, 5, and 6: May be appropriate; 7, 8, and 9: Usually appropriate).

The American College of Radiology’s “Appropriateness Criteria® head trauma” (Davis et al, 2012) rendered ultrasonic transcranial with Doppler for evaluating head trauma/skull fracture a “1” rating (Rating scale: 1, 2, and 3: Usually not appropriate; 4, 5, and 6: May be appropriate; 7, 8, and 9: Usually appropriate).

In a meta-analysis, Mojadidi et al (2014) determined the accuracy of TCD for the diagnosis of intra-cardiac RLS and compared with TEE as the reference. These investigators performed a systematic review of Medline, the Cochrane Library, and Embase to look for all the prospective studies assessing intra-cardiac RLS using TCD compared with TEE as the reference; both tests were performed with a contrast agent and a maneuver to provoke RLS in all studies. A total of 27 studies (29 comparisons) with 1,968 patients (mean age of 47.8 ± 5.7 years; 51 % male) fulfilled the inclusion criteria. The weighted mean sensitivity and specificity for TCD were 97 % and 93 %, respectively. Likewise, the positive and negative likelihood ratios were 13.51 and 0.04, respectively. When 10 microbubbles was used as the embolic cut-off for a positive TCD study, TCD produced a higher specificity compared with when 1 microbubble was used as the cut-off (p = 0.04); there was, however, no significant change in sensitivity (p = 0.29). The authors concluded that TCD is a reliable, non-invasive test with excellent diagnostic accuracies, making it a proficient test for detecting RLS. They stated that TCD can be used as a part of the stroke work-up and for patients being considered for PFO closure. If knowledge of the precise anatomy is required, then TEE can be obtained before scheduling a patient for transcatheter PFO closure.
The American Institute of Ultrasound in Medicine’s practice guideline on “Transcranial Doppler ultrasound for adults and children” (2012) listed “detection of right-to-left shunts’ as one of the indications for a TCD ultrasound examination of adults.

An UpToDate review on “Evaluation of carotid artery stenosis” (Furie, 2016) does not mention transcranial Doppler ultrasonography as a diagnostic tool.

*Parkinson’s Disease:*

Li and colleagues (2016) stated that a large number of articles have reported substantia nigra hyper-echogenicity in Parkinson's disease (PD) and have assessed the diagnostic accuracy of transcranial sonography (TCS); however, the conclusions are discrepant. In a systematic review and meta-analysis, these investigators consolidated the available observational studies and provided a comprehensive evaluation of the clinical utility of TCS in PD. A total of 31 studies containing 4,386 participants from 13 countries were included. A random effects model was utilized to pool the effect sizes. Meta-regression and sensitivity analysis were performed to explore potential heterogeneity. Overall diagnostic accuracy of TCS in differentiating PD from normal controls was quite high, with a pooled sensitivity of 0.83 (95 % CI: 0.81 to 0.85) and a pooled specificity of 0.87 (95 % CI: 0.85 to 0.88). The positive likelihood ratio, the negative likelihood ratio and diagnostic OR were calculated 6.94 (95 % CI: 5.09 to 9.48), 0.19 (95 % CI: 0.16 to 0.23), and 42.89 (95 % CI: 30.03 to 61.25), respectively. The findings of this systematic review and meta-analysis suggested that TCS has high diagnostic accuracy in the diagnosis of PD when compared to healthy control. Moreover, they stated that large cohorts of high-quality prospective studies are needed to confirm the value of TCS in the diagnosis of PD.

This study had 2 major drawbacks: (i) although these researchers carefully explored the heterogeneity by meta-regression and sensitivity analyses, notable heterogeneity was still observed, which can be due to random variation between individual studies, and (ii) failure to acquire unpublished data or studies not
published in English or Chinese for language limitation may affect the validity of these results.

*Reversible Cerebral Vasocostriction Syndrome:*

An UpToDate chapter on reversible cerebral vasoconstriction syndromes (Singhal, 2016) states that "Transcranial Doppler ultrasound has been used for diagnosis; however, normal results do not exclude this diagnosis. This noninvasive bedside tool has utility in monitoring the progression of vasoconstriction "

Levin and associates (2016) stated that reversible cerebral vasoconstriction syndrome (RCVS) is a vascular headache disorder characterized by severe headaches with vasospasm of cerebral arteries. While TCD has been widely applied and validated in studying vasospasm of intracranial vessels, the role of TCD in the diagnosis and monitoring of RCVS is less well established. These researchers determined the reliability of TCD for diagnosis and monitoring of RCVS. Patients admitted to an inpatient neurology service between 2011 and 2014 with a discharge diagnosis of RCVS were retrospectively analyzed for demographics, neuroimaging, and functional outcomes. Baseline and follow-up TCD flow velocities in the middle cerebral artery (V-MCA) were compared relative to the final diagnosis. The cohort consisted of 15 patients (93% females; mean age of 46.7 +/- 12.4 years); initial TCD evaluation was performed 10.9 +/- 6.6 (range of 1 to 24) days after headache onset; 14 patients (93.3%) had increased flow velocities by initial TCD in at least 1 major cerebral blood vessel (MCA, ACA, PCA, vertebral, basilar); TCD V-MCA reached a mean peak of 163 cm/s 3 to 4 weeks after the onset of thunderclap headache. The authors concluded that TCD is a non-invasive neuroimaging modality that may have potential for the initial diagnosis and subsequent monitoring of patients with suspected RCVS. They stated that further studies of larger numbers of patients are needed to evaluate the utility of TCD in diagnosing and monitoring patients with RCVS.

This study had several drawbacks: (i) due to the small retrospective nature of our chart review, these researchers were unable to standardize the timing with which patients received
their neuroimaging relative to headache onset, (ii) although these investigators tried to blind the sonographers to clinical data, some unintentional disclosure of vascular imaging was possible, (iii) TCD may be limited by TCD technique and operator dependency, (iv) the generalizability of these findings may be limited by selection bias in that the authors only included patients with known RCVS who had also undergone assessment with TCD; they did not have data about patients with RCVS who did not undergo TCD. Thus, they could not determine the specificity of TCD for RCVS, and (v) these researchers did not have a control group to account for potential TCD abnormalities in asymptomatic individuals.

**Traumatic Brain Injury:**

LaRovere and colleagues (2016) reviewed clinical studies using TDU in children with severe traumatic brain injury (TBI) in the pediatric intensive care unit (PICU). These researchers identified 16 articles from January 2005 to July 2015 that met inclusion (TBI, 5 or more cases in case series, subjects less than 18 years old, TDU performed in PICU) and exclusion criteria (age not stated, data from subjects less than 18 years not separated from adult data, less than 85 % study population less than 18 years in mixed population with adults); TDU parameters were used to evaluate auto-regulation, intra-cranial pressure, and vasospasm, and to predict neurological outcome. Incidence of impaired auto-regulation varied in severe TBI from 25 % to 80 %. Altered TDU flows and pulsatility index variably predicted intra-cranial hypertension across studies. Sonographic vasospasm in the MCA occurred in 34 % of 69 children with severe TBI. Outcomes appeared to be related to altered TDU-derived flow velocities while in the ICU. The authors concluded that TDU may be a useful tool to evaluate auto-regulation, intra-cranial pressure, and vasospasm following TBI in the PICU. They stated that further research is needed to establish the gold standards and validate the findings in children; TDU may then impact day-to-day management in the PICU, and potentially improve outcomes in children with severe TBI.

Brain Trauma Foundation guidelines on traumatic brain injury
(Carney, et al., 2016) found one Class 3 study of TDU for TBI. The guidelines stated that the body of evidence is insufficient to support a Level III recommendation given that this was a single-center Class III study.

### CPT Codes / HCPCS Codes / ICD-10 Codes

*Information in the [brackets] below has been added for clarification purposes. Codes requiring a 7th character are represented by "*":*

**ICD-10 codes will become effective as of October 1, 2015**

**CPT codes covered if selection criteria are met:**

<table>
<thead>
<tr>
<th>CPT Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>93886</td>
<td>Transcranial Doppler study of the intracranial arteries; complete study</td>
</tr>
<tr>
<td>93888</td>
<td>limited study</td>
</tr>
<tr>
<td>93890</td>
<td>vasoreactivity study</td>
</tr>
<tr>
<td>93892</td>
<td>emboli detection without intravenous microbubble injection</td>
</tr>
<tr>
<td>93893</td>
<td>emboli detection with intravenous microbubble injection</td>
</tr>
</tbody>
</table>

**Other CPT codes related to the CPB:**

<table>
<thead>
<tr>
<th>CPT Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>61635</td>
<td>Transcatheter placement of intravascular stent(s), intracranial (eg, atherosclerotic stenosis), including balloon angioplasty, if performed</td>
</tr>
</tbody>
</table>

**ICD-10 codes covered if selection criteria are met:**

<table>
<thead>
<tr>
<th>ICD-10 Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>D57.00 - D57.819</td>
<td>Sickle-cell disorders [for evaluating children]</td>
</tr>
<tr>
<td>G93.1</td>
<td>Anoxic brain damage, not elsewhere classified</td>
</tr>
<tr>
<td>G93.5</td>
<td>Compression of brain</td>
</tr>
<tr>
<td>H34.00 - H34.9</td>
<td>Retinal vascular occlusions</td>
</tr>
<tr>
<td>H53.10</td>
<td>Unspecified subjective visual disturbances</td>
</tr>
<tr>
<td>H53.121 - H53.129</td>
<td>Transient visual loss</td>
</tr>
<tr>
<td>H53.131 - H53.139</td>
<td>Sudden visual loss</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>I28.0</td>
<td>Arteriovenous fistula of pulmonary vessels [for detecting noncardiac right-to-left shunts]</td>
</tr>
<tr>
<td>I60.00 - I65.9, I67.0 - I69.998</td>
<td>Cerebrovascular diseases</td>
</tr>
<tr>
<td>I74.9</td>
<td>Embolism and thrombosis of unspecified artery [paradoxical embolism]</td>
</tr>
<tr>
<td>I77.1</td>
<td>Stricture of artery</td>
</tr>
<tr>
<td>I77.74</td>
<td>Dissection of vertebral artery</td>
</tr>
<tr>
<td>P05.00 - P05.9</td>
<td>Disorders of newborn related to slow fetal growth and fetal malnutrition</td>
</tr>
<tr>
<td>P07.00 - P07.32</td>
<td>Disorders of newborn related to short gestation and low birth weight, not elsewhere classified</td>
</tr>
<tr>
<td>Q21.1</td>
<td>Atrial septal defect [patent foramen ovale]</td>
</tr>
<tr>
<td>Q25.6</td>
<td>Stenosis of pulmonary artery [for detecting noncardiac right-to-left shunts]</td>
</tr>
<tr>
<td>Q25.79</td>
<td>Other congenital malformations of pulmonary artery [for detecting noncardiac right-to-left shunts]</td>
</tr>
<tr>
<td>Q28.0 - Q28.9</td>
<td>Other congenital malformations of circulatory system [arteriovenous malformation (AVM)]</td>
</tr>
<tr>
<td>R40.4</td>
<td>Transient alteration of awareness</td>
</tr>
<tr>
<td>R47.01 - R47.02</td>
<td>Aphasia and dysphasia</td>
</tr>
<tr>
<td>R47.1</td>
<td>Dysarthria and anarthria</td>
</tr>
<tr>
<td>R47.81</td>
<td>Slurred speech</td>
</tr>
</tbody>
</table>

**ICD-10 codes not covered for indications listed in the CPB (not all-inclusive):**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C71.0 - C71.9</td>
<td>Malignant neoplasm of brain</td>
</tr>
<tr>
<td>C79.31 - C79.49</td>
<td>Secondary malignant neoplasm of brain and nervous system [spinal cord]</td>
</tr>
<tr>
<td>D33.0 - D33.2</td>
<td>Benign neoplasm of brain</td>
</tr>
<tr>
<td>D43.0 - D43.4</td>
<td>Neoplasm of uncertain behavior of brain and spinal cord</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>D49.6</td>
<td>Neoplasm of unspecified behavior of brain</td>
</tr>
<tr>
<td>E75.00 - E75.19</td>
<td>Disorders of sphingolipid metabolism and other lipid storage disorders</td>
</tr>
<tr>
<td>E75.23, E75.25, E75.29, E75.4</td>
<td></td>
</tr>
<tr>
<td>F01.50 - F99</td>
<td>Mental and behavioral disorders</td>
</tr>
<tr>
<td>F84.2</td>
<td>Rett's syndrome</td>
</tr>
<tr>
<td>G00.0 - G09</td>
<td>Inflammatory diseases of the central nervous system</td>
</tr>
<tr>
<td>G10 - G12.9, G13.8</td>
<td>Systemic atrophies primarily affecting the central nervous system</td>
</tr>
<tr>
<td>G20 - G26</td>
<td>Extrapyramidal and movement disorders</td>
</tr>
<tr>
<td>G30.0 - G32.8</td>
<td>Other degenerative diseases of the nervous system</td>
</tr>
<tr>
<td>G40.00 - G40.919</td>
<td>Epilepsy and recurrent seizures</td>
</tr>
<tr>
<td>G43.001 - G43.919</td>
<td>Migraine</td>
</tr>
<tr>
<td>G80.3</td>
<td>Athetoid cerebral palsy</td>
</tr>
<tr>
<td>G90.01 - G91.9</td>
<td>Other disorders of the nervous system</td>
</tr>
<tr>
<td>G93.7</td>
<td>Reye's syndrome</td>
</tr>
<tr>
<td>G93.89 - G93.9, G94</td>
<td>Other and unspecified disorders of the brain</td>
</tr>
<tr>
<td>G95.0 - G95.9</td>
<td>Other and unspecified diseases of spinal cord</td>
</tr>
<tr>
<td>G99.0 - G99.8</td>
<td>Other disorders of nervous system in diseases classified elsewhere</td>
</tr>
<tr>
<td>I63.30 - I63.39, I66.01 - I66.9</td>
<td>Cerebral thrombosis</td>
</tr>
<tr>
<td>I72.0 - I72.9</td>
<td>Other aneurysm</td>
</tr>
<tr>
<td>I77.3</td>
<td>Arterial fibromuscular dysplasia</td>
</tr>
<tr>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Q85.00 - Q85.9</td>
<td>Neurofibromatosis (nonmalignant) [in children]</td>
</tr>
<tr>
<td>R56.1</td>
<td>Post traumatic seizures</td>
</tr>
<tr>
<td>R56.9</td>
<td>Unspecified convulsions</td>
</tr>
<tr>
<td>Z13.6</td>
<td>Encounter for screening for cardiovascular disorders [screening for carotid artery stenosis in asymptomatic persons]</td>
</tr>
<tr>
<td>Z79.01</td>
<td>Long-term (current) use of anticoagulants</td>
</tr>
<tr>
<td>Z79.02</td>
<td>Long-term (current) use of antiplatelets/antithrombotics</td>
</tr>
</tbody>
</table>

The above policy is based on the following references:


19. Portman MA. Atrial septal defect, patent foramen ovale. eMedicine Pediatric Cardiology Topic 2494. Omaha, NE: eMedicine.com; updated April 15, 2002. Available at:


21. Kapral MK, Silver FL. Preventive health care, 1999 update:


48. Suwanwela N. Moyamoya disease: Etiology, clinical features, and diagnosis. Last reviewed January 2012. UpToDate Inc. Waltham, MA.


52. Ferro JL, Canhao P. Etiology, clinical features, and diagnosis of cerebral venous thrombosis. Last reviewed February 2013. UpToDate Inc. Waltham, MA.


AETNA BETTER HEALTH® OF PENNSYLVANIA

Amendment to
Aetna Clinical Policy Bulletin Number:
0353 - Transcranial Doppler Ultrasonography

There are no amendments for Medicaid.

www.aetnabetterhealth.com/pennsylvania

revised 05/24/2017