Clinical Policy Bulletin: Magnetic Resonance Angiography (MRA) and Magnetic Resonance Venography (MRV)

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Policy

Magnetic Resonance Angiography (MRA)

I. Aetna considers magnetic resonance angiography (MRA) medically necessary according to the selection criteria outlined below. MRA is considered appropriate when it can replace a more invasive test (e.g., contrast angiography) and reduce risk for members. While MRA is a rapidly evolving technology, its clinical safety and effectiveness for all anatomical regions have not been established by the peer- reviewed medical literature.

Head and Neck

MRA of the head and neck is considered medically necessary for *any* of the following conditions:

A. As a follow-up study for a known arterio-venous malformation (AVM), and for a known non-ruptured intra-cranial aneurysm (ICA) that is greater than 3 mm in size; *or*
B. To definitively establish presence of stenoses or other abnormalities of the vertebrobasilar system in members with symptoms highly suggestive of vertebrobasilar syndrome (binocular vision loss, diplopia, dysarthria, dysphagia, positional vertigo); *or*
C. To evaluate members with signs/symptoms highly suggestive of leaking/ruptured ICA or AVM (i.e., blood in the cerebral spinal fluid, stiff neck, sudden explosive headache); *or*
D. To evaluate pulsatile tinnitus in members with signs or symptoms suggestive of a vascular lesion; *or*

E. To rule out ICA, including aneurysms of the circle of Willis, in members who are thought to be at higher risk (e.g., history of ICA in a first-degree relative or presence of polycystic kidney disease); *or*
F. To evaluate conditions of the carotid arteries such as:

- Aneurysm tumor
- Cervicocranial arterial dissection in members with suggestive signs or symptoms (e.g., amaurosis fugax, oculo-sympathetic palsy, symptoms of focal brain ischemia, and unilateral headache)
- Injury to the carotid artery
- Stenotic/occlusive disease in asymptomatic members who are candidates for carotid endarterectomy surgery (CEA) when a Duplex Doppler scan is abnormal
- Stenotic/occlusive disease in symptomatic members (e.g., cerebro -vascular disease or transient ischemic attack).

Note: As MRA is considered an alternative to angiography for evaluation of the carotids, a subsequent angiography would only be considered medically necessary if there was a significant discrepancy between the findings of Duplex ultrasonography and MRA that would impact on surgical planning.

Chest

MRA of the chest is considered medically necessary for *any* of the following indications:

A. For diagnosis, treatment planning, and post-operative follow-up for conditions of the thoracic aorta such as aneurysm (true or pseudoaneurysm), dissection, or stenotic/occlusive vascular disease; *or*
B. For diagnosis, treatment planning, and post-operative surgical shunt evaluation in members with congenital heart disease (CHD) or developmental anomalies of the thoracic vasculature (e.g., atresia or hypoplasia of the pulmonary arteries, coarctation of the aorta, double aortic arch, interrupted inferior vena cava, partial anomalous venous connection, persistent left superior vena cava, right-sided aortic arch, total anomalous pulmonary venous connection, and truncus arteriosus); *or*
C. For diagnosing a suspected pulmonary embolism when the use of intravascular iodinated contrast material is contraindicated, or as a substitute for pulmonary angiography when a ventilation/perfusion (V/Q) scan does not provide sufficient information for treatment decisions; or
D. For pulmonary venous and left atrial evaluation, pre- and post-radiofrequency ablation for atrial fibrillation.

Spine

MRA of the spinal canal is considered medically necessary for individuals with known cases of spinal cord arterio-venous fistula and arterio-venous malformation. MRA of the spinal canal is considered experimental and investigational for all other indications.

Abdomen

MRA of the abdomen is considered medically necessary for *any* of the following indications:

A. To assess of the main renal arteries for the evaluation of renal artery stenosis in persons with refractory uncontrolled hypertension* not due to pheochromocytoma; *or*
B. To assess persons with sickle cell disease; *or*
C. To assess pelvic (e.g., aorto-iliac) arteries for stenoses in members with peripheral vascular disease; *or*
D. To evaluate endoleaks following endovascular repair of abdominal aortic aneurysm; *or*
E. To evaluate hepatic vasculature prior to transjugular intrahepatic portosystemic shunt (TIPS); *or*
F. To determine the extent of an abdominal aortic aneurysm and associated occlusive disease in members undergoing elective repair; *or*
G. To evaluate for chronic mesenteric ischemia.

* Refractory hypertension is defined as diastolic blood pressure consistently greater than 100 mm Hg on 3 or more blood pressure medications.

Lower Extremity

MRA of the lower extremities is considered medically necessary as an initial test for diagnosis and surgical planning in the treatment of peripheral arterial disease of the lower extremity. A subsequent angiography study is only required if the inflow vessel is not identified on the MRA. If conventional catheter angiography is performed first, doing a subsequent MRA may be indicated if a distal run-off vessel is not identified. Both tests should not be routinely performed.

Allergy, etc.

The use of MRA is considered medically necessary in members with documented allergy to iodinated contrast material, and in members who have accelerating hypertension and/or accelerating renal insufficiency.

II. Aetna considers the use of gadofosveset trisodium (Ablavar, previously marketed as Vasovist injection) an appropriate agent for medically necessary contrast-enhanced MRA of blood vessels in the abdomen and lower extremities in adults.

III. Aetna considers MRA to be experimental and investigational for all other indications because its effectiveness for indications other than the ones listed above has not been established, including any of the following:

A. Cardiac MRI for velocity flow mapping; *or*
B. Evaluating accessory renal arteries in prospective renal donors, including potential living kidney donors; *or*
C. Evaluating members with symptoms suggestive of dural, sagittal or cavernous sinus thrombosis/occlusion; *or*
D. Evaluating microvascular compression associated with trigeminal neuralgia; *or*

E. Ruling out ICA in members who have vague central nervous system symptoms (e.g., dizziness, headache, non-specific sensory loss, or vertigo); *or*
F. Evaluating premature ventricular contraction; *or*
G. Evaluating recurrent cystic hygroma of the axilla; *or*
H. Screening for renovascular hypertension; *or*
I. Screening of the general population for ICAs.

Magnetic Resonance Venography (MRV)

I. Aetna considers MRV medically necessary for *any* of the following indications:

A. For evaluation of thrombosis or compression by tumor of the cerebral venous sinus in members who are at risk (e.g., hyper-coagulable disorders, meningitis, oral contraceptive use, otitis media, sinusitis, underlying malignant process) or have signs or symptoms (e.g., drowsiness and confusion accompanying a headache, focal motor or sensory deficits, papilledema, or seizures); *or*
B. For evaluation of venous thrombosis or occlusion in the large systemic veins (e.g., superior vena cava, subclavian, or other deep veins in the chest); *or*
C. For evaluation of venous thrombosis or occlusion in the portal and/or hepatic venous system (e.g., Budd-Chiari syndrome).

II. Aetna considers MRV experimental and investigational for diagnosis of deep vein thrombosis in the arms or legs because the peer-reviewed medical literature has not established MRV to be superior to Duplex ultrasonography for this purpose. MRV is considered experimental and investigational for all other indications (e.g., diagnosis of chronic cerebrospinal venous insufficiency) because its effectiveness for indications other than the ones listed above has not been established.

Background

Magnetic resonance angiography (MRA) is an application of magnetic resonance imaging (MRI) that provides visualization of blood flow, as well as images of normal and diseased blood vessels. While MRA appears to be a rapidly developing technology, the clinical safety and effectiveness of this procedure for all anatomical regions has not been proven.

The use of MRA in evaluating flow in the carotid arteries, the circle of Willis, the anterior, middle or posterior cerebral arteries, the vertebral or basilar arteries, or the venous sinuses have been the most well researched applications. Numerous articles have demonstrated that MRA can image the vessels with a high degree of sensitivity and specificity. However, the appropriate use of MRA in this setting must be coordinated with the use of the competing technologies, Duplex ultrasonography and angiography. There is no mention in the literature that all 3 technologies should be used routinely in the work-up of carotid artery disease. In terms of screening patients with symptoms suggestive of disease, duplex ultrasonography has been shown to be equivalent to MRA, and thus this test is recommended as the initial diagnostic test. In

terms of surgical planning, MRA has been shown to be competitive with angiography, therefore this test can be the second definitive test used for surgical planning. In this scenario, an angiography would only be considered medically necessary if the ultrasonography and MRA showed major discrepancies. Finally, in a more limited role, MRA has been suggested as an alternative to angiography in those patients unable to undergo an angiogram due to allergy to contrast material.

Patients with transient ischemic attacks or strokes typically undergo MRI as part of the initial work-up to identify infarcted areas in the brain. An intra-cranial MRA can be easily appended to the MRI and for that reason has been frequently ordered. However, an intra-cranial MRA is considered not medically necessary. MRI can adequately image any infarcted areas, and in the case of transient ischemic attacks, by definition, one would not expect to see any vascular abnormalities. The use of MRA in the work-up of patients with the vertebrobasilar syndrome must be considered on a case-by-case basis. The MRA may be appropriate in patients when other sources of emboli have been ruled out, and the MRA is considered as an alternative to an angiogram in order to establish the diagnosis of vertebral artery disease.

Although MRA provides additional imaging capabilities for intra-cranial aneurysms (ICAs) and vascular lesions, it is not clear from the literature how this information will impact on patient management. In particular, patients who present subacutely with symptoms consistent with aneurysm or vascular malformations will probably undergo a conventional spin-echo MRI followed by angiography, if indicated. It is unclear from the literature how MRA would alter this imaging hierarchy. Several authors commented that the anatomic detail provided by MRA is not sufficient to replace an angiogram. Magnetic resonance angiography has also been suggested as a novel screening technique for patients at high risk for aneurysm; however, its clinical relevance is unknown because of a lack of understanding of the natural history of aneurysms and which aneurysms represent a high risk of rupture. Due to its low diagnostic yield, MRA is considered not medically necessary for the routine work-up of patients with non-specific, non-focal symptoms, such as headache or dizziness.

Magnetic resonance angiography is an effective non-invasive technique for establishing a diagnosis and evaluating the extent and severity of nearly all diseases of the thoracic aorta. Studies have shown that MRA of the chest has a high level of diagnostic accuracy for pre-operative and post-operative evaluation of aortic dissection of aneurysm. Depending on the clinical presentation, MRA may be used as an alternative to other non-invasive imaging technologies (e.g., trans-esophageal echocardiography and CT).

Saremi and Tafti (2009) noted that cardiac ablation procedures have become the standard of therapy for various arrhythmias including atrial fibrillation (AF). Understanding the morphological characteristics of the left atrium (LA) and pulmonary vein (PV) in detail and identification of its anatomic variants is crucial to perform a successful ablation procedure and minimize complications. The current techniques for radiofrequency ablation of AF include targeting the PVs or the tissue in the antrum of the LA. Localization of the anatomic structures within the LA is performed by using fluoroscopy, electro-anatomic mapping, and intra-cardiac echocardiography. Multi-dimensional CT and MRA are invaluable techniques for better visualization of the anatomic landmarks that are essential for cardiac ablation procedures as well as prompt diagnosis and, in selected cases, prevention of procedure-related

complications. Some of the complications of ablation procedures may include cardiac tamponade, PV stenosis, as well as esophageal and phrenic nerve injuries.

Holmes et al (2009) stated that ablation procedures for AF are being performed with increasing frequency. One of the most serious complications is the development of pulmonary vein stenosis, which occurs in 1 % to 3 % of current series. The presentation of pulmonary vein stenosis varies widely. The majority of patients are symptomatic although specific referral bias patterns can affect this. Symptoms may include dyspnea or hemoptysis or may be consistent with bronchitis. These symptoms are affected by the number of stenotic veins as well as the severity of the stenosis. The more severe the stenosis and the greater number of stenosed veins result in more symptoms. Because of the variability in symptoms, clinicians must have heightened sensitivity to the presence of the condition. Diagnostic tests of value include MRA and computed tomography. Although echocardiography has been used, it does not usually provide adequate assessment. Progression of stenosis is unpredictable and may be rapid. The specific anatomy of the stenosis varies widely and affects management. Because of the presence of antral fusion of the origin of the left superior and left inferior pulmonary vein, a stenosis involving 1 or the other can impinge and affect outcome. In this setting, bifurcation techniques familiar to interventional cardiology are very helpful. Controversy currently exists about the optimal treatment approach. The use of balloons and larger stents (approximately 10 mm) results in more optimal results than just balloon angioplasty alone; however, even with stent implantation, recurrent re-stenosis may occur in 30 % to 50 % of patients. Follow-up of these patients typically involves computed tomography imaging to document re-stenosis. If significant re-stenosis is identified, it should be treated promptly because of the potential for progression to total occlusion.

Furthermore, a CMS decision memo (2010) noted that it has received a position statement in the form of a combined comment from the American College of Cardiology (ACC), American College of Radiology (ACR), American Society of Neuroradiology (ASNR), North American Society for Cardiovascular Imaging (NASCI), and the Society for Cardiovascular Magnetic Resonance (SCMR). They were in favor of combining the currently separate NCDs, allowing local Medicare contractor discretion to cover use of MRA for additional indications which are currently non-covered, and they recommended national coverage for MRA of the pulmonary veins before and after radiofrequency ablation for AF. http://www.cmms.hhs.gov/medicare-coverage-database/details/nca-decision-memo.aspx?NCAId=236&ver=11&NcaName=Magnetic+Resonance+Angiography+(MRA)&NCDId=177&ncdver=3&IsPopup=y&bc=AAAAAAAAEAAA&.

Current scientific data shows that diagnostic pulmonary MRAs are improving due to recent developments such as faster imaging capabilities and gadolinium-enhancement. However, these advances in MRA are not significant enough to warrant replacement of pulmonary angiography in the diagnosis of pulmonary embolism for patients who have no contraindication to receiving intravenous iodinated contrast material. The tortuous pulsatile nature of the coronary arteries presents an imposing technical challenge to MRA. The application of MRA for this purpose is still in its infancy.

Studies have proven that MRA is considered a reliable diagnostic tool for the pre-operative evaluation of patients who will undergo elective abdominal aortic aneurysm

(AAA) repair. In addition, scientific data has revealed that MRA is considered comparable to conventional angiography in determining the extent of the AAA, as well as evaluation of aorto-illiac occlusion disease and renal artery pathology that may be necessary in the surgical planning for AAA repair. If pre-operative angiography is not necessary, then patients are not exposed to the risks associated with invasive contrast procedures, namely allergic reactions, end-organ damage or arterial injury. Magnetic resonance angiography has also become accepted as a method to detect suspected stenosis in the main renal arteries; its inability to image distal lesions and accessory arteries limits its diagnostic abilities.

Although MRA assessment for the evaluation of renal artery stenosis is acceptable, the accuracy of MRA as a screening method for renovascular hypertension is unproven, and MRA is inadequate in the identification of accessory renal arteries because it has not achieved the level of accuracy needed to replace conventional angiography in the evaluation of potential living renal donors.

Surgical planning for peripheral arterial occlusive disease in the lower extremities depends on identification of adequate inflow and distal run off vessels. Magnetic resonance angiography has been shown to be a superior technique in identifying distal run-off vessels and is competitive with angiography in identifying appropriate inflow vessels. Therefore, MRA can be used as an initial test for surgical planning, with a subsequent angiography only if the inflow vessel is not identified. If angiography is performed first, an MRA may be appropriate if a distal run-off vessel is not identified because MRA is capable of detecting a viable run-off vessel for bypass not seen on traditional angiography, especially when exploratory surgery is not believed to be a reasonable medical course of action for the patient.

On December 24, 2008, the United States Food and Drug Administration (FDA) approved Vasovist injection (gadofosveset trisodium, now marketed as Ablavar), the first contrast imaging agent for use in patients undergoing MRA. Gadofosveset reversibly binds to albumin providing extended intravascular enhancement compared with existing extracellular magnetic resonance contrast agents. Administration of gadofosveset provides a clearer image in patients who are suspected of having blockages or other problems with the blood vessels in their abdomen or extremities. The safety and effectiveness of Vasovist was established in 2 clinical trials of patients with known or suspected aorto-iliac disease. In the studies, patients underwent MRA with and without Vasovist and their scans were compared to standard X-ray pictures using contrast. Magnetic resonance angiography with Vasovist detected more arterial disease than MRA performed without Vasovist and the pictures were of improved technical quality.

Bosch et al (2008) evaluated the safety and effectiveness of gadofosveset in patients with pedal arterial disease. A total of 185 adult patients with known or suspected pedal arterial disease were randomized in a group receiving 0.03 mmol/kg and a group receiving 0.05 mmol/kg of gadofosveset for MRA of the pedal arteries. Gadofosveset-enhanced and unenhanced time-of-flight MR angiograms were compared with conventional angiograms for the presence of vascular stenosis. All patients underwent drug safety analysis. For each of 3 blinded readers, the specificity (21 to 35 %) of gadofosveset-enhanced MRA was a statistically significant ($p < 0.010$) improvement over that of unenhanced MRA in the detection of clinically significant (greater than 50 %) stenosis. The sensitivities of the 2 techniques were similar. For all blinded readers

of MR angiograms, sensitivity, specificity, and accuracy were higher with use of the 0.03-mmol/kg dose of gadofosveset than with the 0.05-mmol/kg dose. In the 0.03-mmol/kg group, 28 % of patients reported a total of 50 adverse events, 96 % of which were reported as mild or moderate. In the 0.05-mmol/kg group, 28 % of patients reported a total of 55 adverse events, 98 % of which were reported as mild or moderate. No patients died; 1 patient left the study because of myocardial infarction considered unrelated to the study drug. The authors concluded that because of markedly better efficacy than no contrast agent and a minimal and transient side-effect profile, 0.03 mmol/kg of gadofosveset was found safe and effective for MRA of patients with pedal arterial disease.

In a multi-center, comparative, phase III single-dose clinical study, McGregor et al (2008) examined the effectiveness of gadofosveset-enhanced MRA for evaluation of renal artery disease. Gadofosveset (0.03 mmol/kg) was administered to adult patients with known or suspected renal arterial disease; the drug allows collection of images in the first-pass and steady-state phases. The combination of these images was compared to non-contrast MRA, using catheter X-ray angiography (XRA) as the standard of reference. All MRA images were collected at 1.5 T in 1 imaging session for direct comparison, and XRA within 30 days. Sensitivity, specificity, and accuracy for diagnosing significant disease (stenosis greater than or equal to 50 %) were calculated for MRA using 3 independent blinded readers. Patient safety was monitored for 72 to 96 hours. A total of 145 patients were enrolled and received gadofosveset; the 127 with complete efficacy data entered the primary efficacy analysis. Gadofosveset-enhanced MRA led to significant improvement ($p < 0.01$) in sensitivity (+25 %, +26 %, +42 %), specificity (+23 %, +25 %, +29 %), and accuracy (+23 %, +28 %, +29 %) over non-enhanced MRA for the 3 readers. The rate of uninterpretable examinations decreased from 30 % to less than 2 %. There were no serious adverse events, and the most common adverse events were nausea, pruritis, and headache (8 % each). No significant trends in clinical chemistry parameters, nor significant changes in serum creatinine, were found following administration of gadofosveset. The authors concluded that in patients with known or suspected renal arterial disease, gadofosveset -enhanced MRA significantly improves sensitivity, specificity, and accuracy versus non-enhanced MRA. Gadofosveset was safe and well-tolerated in this patient population.

There is evidence that MRA, as an adjunct to conventional MRI, is useful in the evaluation of the of spinal cord. Farb et al (2002) described the cases of 9 patients with initial MRI and clinical findings suggestive of spinal dural arterio-venous fistula (AVF) who underwent spinal MRA with an auto-triggered elliptic centric ordered three-dimensional (3-D) gadolinium-enhanced technique (hereafter, this MRA technique) before conventional intra-arterial angiography. In all 9 patients, findings with this MRA technique correctly and precisely localized the spinal dural AVF. Observer error resulted in 1 case in which the site of the fistula was not prospectively reported, but was easily identified retrospectively on the spinal MR angiogram.

Saraf-Lavi E et al (2002) studied the sensitivity, specificity, and accuracy of MRI alone compared with MRI plus MRA in determining whether dural AVF are present and established the accuracy of MRA in predicting fistula level. A total of 20 patients with surgically proven dural AVF (diagnosed with radiographic digital subtraction angiography) and 11 control patients who had normal digital subtraction angiography findings underwent routine MRI plus 3-D contrast-enhanced MRA of the spine. Images were reviewed in 2 stages (stage I, MRI only; stage II, MRI plus MRA) by 3

neuroradiologists who were blinded to the final diagnoses. The sensitivity, specificity, and accuracy of the 3 reviewers in detecting the presence of fistulae ranged from 85 % to 90 %, from 82 % to 100 %, and from 87 % to 90 %, respectively, for stage I, compared with values of 80 % to 100 %, 82 %, and 81 % to 94 %, respectively, for stage II. For each reviewer, there were no significant differences between the values for stage I and stage II; however, among the reviewers, one of the more experienced neuroradiologists had significantly greater sensitivity than a less experienced neuroradiologist for stage II. On average, the percentage of true positive results for which the correct fistula level was predicted increased from 15 % for stage I to 50 % for stage II, and the correct level +/- one level was predicted in 73 % for stage II. MR evidence of increased intra-dural vascularity was significantly greater in patients with dural AVF. The authors concluded that the addition of MRA to standard MRI of the spine may improve sensitivity in the detection of spinal dural fistulae. The principal benefit of MRA is in the improved localization of the vertebral level of the fistula, which potentially expedites the subsequent digital subtraction angiography study.

Luetmer et al (2005) tested the hypothesis that elliptic centric contrast-enhanced MRA can be used to detect spinal dural AVFs, predict the level of fistulas, and reduce the radiation dose and volume of iodinated contrast material associated with conventional angiography. These researchers examined 31 patients who presented with suspected spinal dural AVF. All patients underwent MRA and conventional angiography. The effect of MRA on subsequent conventional angiography was assessed by analyzing total fluoroscopy time and volume of iodinated contrast material used. At angiography, spinal dural AVFs were diagnosed in 22 of 31 patients, and MRA depicted an AVF in 20 of the 22 patients. Magnectic resonance angiographic findings correctly predicted a negative angiogram in 7 of 9 cases. Of the 20 true-positive MRA results, the level of the fistula was included in the imaging volume in 14. In 13 of these 14 cases, MRA results correctly predicted the side and the level of the fistula to within 1 vertebral level. Fluoroscopy time and the volume of contrast agent was reduced by more than 50 % in the 13 patients with a spinal dural AVF in whom MRA prospectively indicated the correct level. The authors concluded that contrast-enhanced MRA can be used to detect spinal dural AVFs, predict the level of fistulas, and substantially reduce the radiation dose and volume of contrast agent associated with catheter spinal angiography.

Meckel et al (2007) stated that digital subtraction angiography (DSA) is the method of reference for imaging of dural AVF (DAVF). The goal of this study was to analyze the value of different MR images including 3-D contrast-enhanced MRA with a high temporal resolution in diagnostic and follow-up imaging of DAVFs. A total of 18 MR/MRA examinations from 14 patients with untreated (n = 9) and/or treated (n = 9) DAVFs were evaluated. Two observers assessed all MR and MRA investigations for signs indicating the presence of a DAVF, for fistula characteristics such as fistula grading, location of fistulous point, and fistula obliteration after treatment. All results were compared with DSA findings. On time-resolved 3-D contrast-enhanced (TR 3-D) MRA, the side and presence of all patent fistulas (n = 13) were correctly indicated, and no false-positive findings were observed in occluded DAVFs (n = 5). Grading of fistulas with this imaging technique was correct in 77 % and 85 % of patent fistulas for both readers, respectively. On T2-weighted images, signs indicative of a DAVF were encountered only in fistulas with cortical venous reflux (56 %), whereas on 3-D time-of-flight (TOF) MRA, most fistulas (88 %) were correctly detected. In complete fistula occlusion, false-positive findings were encountered on both T2-weighted images and

on TOF MRA images. The authors concluded that TR 3-D MRA proved reliable in detecting DAVFs and suitable for follow-up imaging. The technique allowed -- within limitations -- to grade DAVFs. Although 3-D TOF MRA can depict signs of DAVFs, its value for follow-up imaging is limited.

Mull et al (2007) examined the validity of MRA for identification of spinal arterio-venous (AV) abnormalities. A total of 34 consecutive patients with suspicion of spinal vascular abnormalities underwent digital subtraction angiography (DSA) after MRA. The level and side of the suspected spinal DAVF (SDAVF) and the feeding arteries in spinal AV malformations (SAVMs) were determined from MRA and compared with DSA. DSA revealed SDAVF in 20 abnormalities of which 19 were spinal and 1 was tentorial with spinal drainage, as well as SAVM in 11 patients. In 3 patients, MRA and DSA were both normal. For detection of spinal AV abnormalities, neither false-positive nor false-negative MRA result was obtained. The MRA-derived level of the feeding artery in SDAVF agreed with DSA in 14 of 19 cases. In 5 cases, a mis-match of 1 vertebral level (not side) was noted for the feeding artery. For the tentorial AVF, only the spinal drainage was depicted; the feeding artery was outside the MRA field of view. In intra-dural SAVM, the main feeding artery was identified by MRA in 10 of 11 patients. Magnetic resonance angiography could differentiate between glomerular and fistulous SAVM in 4 of 6 cases and between sacral SDAVF and filum terminale SAVM in 2 of 5 cases. The authors concluded that MRA reliably detects or excludes various types of spinal AV abnormalities and localizes the (predominant) arterial feeder of most spinal AV shunts. Although classification of the subtype of SAVMs remains difficult, with MRA it greatly helps to focus subsequent DSA.

Sharma and Westesson (2008) noted that contrast-enhanced MRA has been increasingly used in the evaluation of spinal vascular malformations. Furthermore, in a review on advances in spinal cord MRA, Backes and Nijenhuis (2008) noted that current fast contrast-enhanced MR techniques are able to (i) visualize vessels supplying or draining the spinal cord and (ii) differentiate spinal cord arteries from veins. The localization of the Adamkiewicz artery, the largest artery supplying the thoraco-lumbar spinal cord, has become possible in a reproducible and reliable manner. Knowledge of the anatomic location of this artery and its arterial supplier may be of benefit in the work-up for aortic aneurysm surgery to reduce incidences of ischemic injury. Spinal cord MRA is ready to become a diagnostic tool that can compete with catheter angiography for detecting and localizing arterial feeders of vascular lesions and is strongly advised for use prior to invasive catheter angiography.

The use of an MRA/MRV as part of the work-up of a patient with suspected cerebral thrombosis (i.e., dural sagittal or cavernous sinus thrombosis) must be considered on a case by case basis. Magnetic resonance imaging is considered the imaging method of choice for establishing the diagnosis, but MRA/MRV may be useful in following the course of the disease.

Magnetic resonance venography (MRV) is now very effective for the evaluation of diseases of larger veins. The specific indications for using MRV for evaluating the vena cavae are diagnosis of vena caval thrombus, differentiation of tumor thrombus and blood clot of the vena cava, diagnosis of superior vena caval syndrome, identification of superior vena caval invasion or encasement by lung or mediastinal tumors, diagnosis of the Budd-Chiari syndrome, diagnosis of caval anomalies such as persistent left superior vena cava and interrupted inferior vena cava, and identification of the

presence and cause of obstruction or occlusion of the brachiocephalic, subclavian, and jugular veins.

Duplex ultrasonography is the typical initial diagnostic test for deep vein thrombosis (DVT). Magnetic resonance venography has not been shown to be superior to ultrasonography, except in imaging the deep femoral and hypogastric vessels. However, information about these vessels is frequently not needed to make patient management decisions, except perhaps in patients with pulmonary emboli where the source of the emboli has not been identified by ultrasonography. McRae and Ginsberg (2004) MRV has the potential to be used as a stand-alone test for DVT but requires further evaluation. Moreover, in a retrospective study (n = 973), Borer et al (2005) found that discontinuation of screening by means of ultrasound and MRV for the diagnosis of DVT did not change the rate of pulmonary embolism in patients with closed fractures of the pelvis or acetabulum.

Bates et al (2012) stated that objective testing for DVT is crucial because clinical assessment alone is unreliable and the consequences of misdiagnosis are serious. This guideline focused on the identification of optimal strategies for the diagnosis of DVT in ambulatory adults. The methods of this guideline followed those described in Methodology for the Development of Antithrombotic Therapy and Prevention of Thrombosis Guidelines: Antithrombotic Therapy and Prevention of Thrombosis, 9th ed: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines. These investigators suggested that clinical assessment of pre-test probability of DVT, rather than performing the same tests in all patients, should guide the diagnostic process for a first lower extremity DVT (Grade 2B). In patients with a low pre-test probability of first lower extremity DVT, these researchers recommended initial testing with D-dimer or ultrasound (US) of the proximal veins over no diagnostic testing (Grade 1B), venography (Grade 1B), or whole-leg US (Grade 2B). In patients with moderate pre-test probability, they recommended initial testing with a highly sensitive D-dimer, proximal compression US, or whole-leg US rather than no testing (Grade 1B) or venography (Grade 1B). In patients with a high pre-test probability, they recommended proximal compression or whole-leg US over no testing (Grade 1B) or venography (Grade 1B). The authors concluded that favored strategies for diagnosis of first DVT combined use of pre-test probability assessment, D-dimer, and US. There is lower-quality evidence available to guide diagnosis of recurrent DVT, upper extremity DVT, and DVT during pregnancy.

The role of chronic cerebrospinal venous insufficiency (CCSVI) in the pathogenesis of multiple sclerosis (MS) is a matter of debate. Chronic cerebrospinal venous insufficiency was first diagnosed using specialized trans-cranial and extra-cranial Doppler ultrasonography. Some have advocated the use of MRV in place of trans-cranial Doppler because the results of MRV are less operator dependent. However, there are limited data to support the use of MRV in diagnosis of CCSVI. I n a pilot study, Hojnacki et al (2010) the value of neck MRV for the diagnosis of CCSVI compared to Doppler sonography (DS) and selective venography (SV) in patients with MS and in healthy controls (HC). A total of 10 MS patients and 7 HC underwent DS, 2D-Time-Of-Flight (TOF) venography and 3D-Time Resolved Imaging of Contrast Kinetics angiography (TRICKS). Patients with MS also underwent SV. The internal jugular veins (IJVs) and the vertebral veins (VVs) were assessed by both MRV sequences, and the findings were validated against SV and DS; SV has been considered the diagnostic gold standard for MS patients. All MS patients and none of

the HC presented CCSVI, according to the DS criteria. This was confirmed by SV. For CCSVI diagnosis, DS showed sensitivity, specificity, accuracy, positive-predictive value (PPV) and negative-predictive value (NPV) of 100 %, whereas the figures were 40 %, 85 %, 58 %, 80 % and 50 % for 3D-TRICKS, and 30 %, 85 %, 52 %, 75 % and 46 % for 2D-TOF in the IJVs. In MS patients, compared to SV, DS showed sensitivity, specificity, accuracy, PPV and NPV of 100 %, 75 %, 95 %, 94 % and 100 %, whereas the figures were 31 %, 100 %, 45 %, 100 % and 26 % for 3D-TRICKS and 25 %, 100 %, 40 %, 100 % and 25 % for 2D-TOF in the IJVs. The authors concluded that the use of MRV for diagnosis of CCSVI in MS patients has limited value, and the findings should be interpreted with caution and confirmed by other imaging techniques such as DS and SV.

An UpToDate review on "Prevalence and evaluation of ventricular premature beats" (Podrid, 2012) does not mention the use of magnetic resonance angiography.

Lookstein et al (2004) compared the findings of time resolved-MRA (TR-MRA) with conventional angiography for the characterization of endoleaks. Between June 2002 and June 2003, 12 patients with documented endoleaks following endovascular repair of aortic aneurysms (10 abdominal and 2 thoracic) underwent TR-MRA to identify and characterize the endoleak. All patients had nitinol-based aortic stent grafts. MRA was performed on a 1.5-Tesla magnet (Sonata class; Siemens Medical Systems, Iselin, NJ). The TR-MRA studies were reviewed under continuous observation as a "cine MR angiogram". These MRA data sets were used to classify the endoleaks into types 1 through 3. The patients underwent conventional angiography following the MRA to confirm the findings and to plan treatment. The MRA findings were compared with the findings made at conventional arteriography. TR-MRA identified 7 patients with type 1 leaks, including 4 proximal and 3 distal. Four patients had type 2 leaks, including 2 arising from the inferior mesenteric artery and 2 from an ilio-lumbar artery. One patient had a type 3 leak. Conventional angiography confirmed the type of endoleak in all 12 patients. The authors concluded that these initial results demonstrated TR-MRA to be an effective non-invasive method for classifying endoleaks. This technique may allow for screening of patients with endoleaks to identify those requiring urgent repair.

The American College of Radiology (ACR)/North American Society for Cardiovascular Imaging (NASCI)/Society for Pediatric Radiology (SPR)'s practice guideline on "The performance of pediatric and adult body magnetic resonance angiography (MRA)" (ACR-NASCI-SPR, 2010) stated that abdominal and pelvic MRA can be used for post-procedure assessment for detection of suspected leak following aortic aneurysm surgery or MR-compatible aortic stent graft placement". Moreover, the ACR's Appropriateness Criteria on "Abdominal Aortic Aneurysm: Interventional Planning and Follow-up" (2012) stated that "For detection and sizing of endoleak, MRA is at least as sensitive as, and probably better than CTA …. 3D contrast-enhanced MRA and time resolved MRA are highly sensitive to endoleaks". The ACR's recommendation was given a "7" rating; and 7, 8, and 9 "ratings" denote "Usually appropriate".

Furthermore, an UpToDate review on "Endovascular repair of abdominal aortic aneurysm" (Chaer, 2014) states that "CT angiography with delayed images is the most widely used modality for follow-up after endovascular aneurysm repair (EVAR). It is accurate for maximal diameter measurement, and for the detection of endoleak and other device-related complications. However, CT angiography is costly and repeated

radiation exposure is associated with an increased lifetime cancer risk. Repeated administration of intravenous contrast may also contribute to a progressive decline in renal function that has been observed following EVAR. The guidelines for the management of abdominal aortic aneurysm (AAA) from the Society for Vascular Surgery advocate CT angiography at 1 and 12 months during the first year after EVAR. Imaging at six months is no longer routinely recommended unless an endoleak or other device-related abnormality is identified at the one-month imaging study after EVAR. If an endoleak or aneurysm enlargement is not documented during the first year after EVAR, DU [duplex ultrasonography] is an alternative to CT angiography for ongoing postoperative surveillance …. MR imaging is not a standard modality for EVAR surveillance, but can be used in specific situations where CT angiography is contraindicated. The advantage of MR imaging is the lack of exposure to ionizing radiation. Disadvantages are its lack of wide availability and difficulty evaluating device integrity due to artifact. The placement of stent-grafts made of nitinol does not preclude MR imaging, though MR imaging is contraindicated for stainless-steel-based grafts (e.g., Cook, Zenith)".

Miller et al (2009) stated that neuro-vascular compression (NVC) of the trigeminal nerve is associated with trigeminal neuralgia (TN), but also occurs in many patients without facial pain. These researchers identified anatomical characteristics of NVC associated with TN. A total of 30 patients with type 1 TN (intermittent shock-like pain) and 15 patients without facial pain underwent imaging for analysis of 30 trigeminal nerves ipsilateral to TN symptoms, 30 contralateral to TN symptoms, and 30 in asymptomatic patients were include in this study. Patients underwent 3-T MRI including balanced fast -field echo and MRA. Images were fused and reconstructed into virtual cisternoscopy images that were evaluated to determine the presence and degree of NVC. Reconstructed coronal images were used to measure nerve diameter and cross-sectional area. The incidence of arterial NVC in asymptomatic nerves, nerves contralateral to TN symptoms, and nerves ipsilateral to TN symptoms was 17 %, 43 %, and 57 %, respectively. The difference between symptomatic and asymptomatic nerves was significant regarding the presence of NVC, nerve distortion, and the site of compression ($p < 0.001$, Fisher exact test). The most significant predictors of TN were compression of the proximal nerve (odds ratio 10.4) and nerve indentation or displacement (odds ratio 4.3). There was a tendency for the development of increasingly severe nerve compression with more advanced patient age across all groups. Decreased nerve size was observed in patients with TN but did not correlate with the presence or extent of NVC. The authors concluded that trigeminal NVC occurs in asymptomatic patients but is more severe and more proximal in patients with TN. Moreover, they stated that this information may help identify patients who are likely to benefit from micro-vascular decompression (MVD).

Zacest et al (2010) stated that TN is a neuropathic pain syndrome that is often associated with NVC of the TN and may be effectively treated with MVD. The authors used high-resolution MRI with 3D reconstruction in patients with constant facial pain (type 2 TN) to determine the presence/absence of NVC and thus a potential MVD benefit. They retrospectively contacted patients to evaluate outcome. All patients who reported spontaneous onset of constant facial pain (type 2 TN), which occurred at least 50 % of the time, who had undergone high-resolution 3-T MRI with 3D reconstruction were retrospectively selected for this study. Clinical history, facial pain questionnaire data, physical examination findings, and results from 3-T 3D MRI reconstruction were recorded for all patients. Intra-operative findings and clinical pain outcome were

recorded for all patients who underwent MVD. Data obtained in 27 patients were assessed. On the basis of history and 3D MRI reconstruction findings, 13 patients were selected for MVD (Group A) and 14 underwent conservative treatment (Group B). Typical or suspected artery- or vein-induced NVC was predicted pre-operatively in 100 % of Group A patients and in 0 % of Group B patients. At the time of MVD, definitive NVC was confirmed in 11 (84.6 %) of 13 Group A patients. Following MVD, facial pain was completely relieved in 3 (23 %), improved in 7 (53.8 %), and no better in 3 (23 %) of 13 Group A patients. A history of episodic (type 1 TN) pain at any time was reported in 100 % and 50 % of Group A and Group B patients, respectively. A type 1 TN pain component was reportedly improved/relieved in all Group A patients, but the type 2 TN pain component was improved in only 7 (53.8 %) of 13 patients. The mean post-operative follow-up duration was 13 months. The authors concluded that high-resolution 3D MRI reconstruction in patients with constant facial pain (type 2 TN) can help determine the presence/absence of NVC. They stated that surgical selection based on both clinical and radiological criteria has the potential to improve surgical outcome in patients with type 2 TN who may potentially benefit from MVD. However, even in such selected patients, pain relief is likely to be incomplete.

Leal et al (2014) prospectively evaluated atrophic changes in trigeminal nerves (TGNs) using measurements of volume (V) and cross-sectional area (CSA) from high-resolution 3-T MR images obtained in patients with unilateral TN, and correlated these data with patient and NVC characteristics and with clinical outcomes. Anatomical TGN parameters (V and CSA) were obtained in 50 patients (30 women and 20 men; mean age of 56.42 years, range of 22 to 79 years) with classic TN before treatment with MVD. Parameters were compared between the symptomatic (ipsilateralTN) and asymptomatic (contralateralTN) sides of the face; 20 normal control subjects were also included. Two independent observers blinded to the side of pain separately analyzed the images. Measurements of V (from the pons to the entrance of the nerve into Meckel's cave) and CSA (at 5 mm from the entry of the TGN into the pons) for each TGN were performed using imaging software and axial and coronal projections, respectively. These data were correlated with patient characteristics (age, duration of symptoms before MVD, side of pain, sex, and area of pain distribution), NVC characteristics (type of vessel involved in NVC, location of compression along the nerve, site of compression around the circumference of the root, and degree of compression), and clinical outcomes at the 2-year follow-up after surgery. Comparisons were made using Bonferroni's test. Inter-observer variability was assessed using the Pearson correlation coefficient. The mean V of the TGN on the ipsilateralTN (60.35 ± 21.74 mm(3)) was significantly smaller ($p < 0.05$) than those for the contralateralTN and controls (78.62 ± 24.62 mm(3) and 89.09 ± 14.72 mm(3), respectively). The mean CSA of the TGN on the ipsilateralTN (4.17 ± 1.74 mm(2)) was significantly smaller than those for the contralateralTN and controls (5.41 ± 1.89 mm(2) and 5.64 ± 0.85 mm(2), respectively). The ipsilateralTN with NVC Grade III (marked indentation) had a significantly smaller mean V than the ipsilateralTN with NVC Grade I (mere contact), although it was not significantly smaller than that of the ipsilateralTN with NVC Grade II (displacement or distortion of root). The ipsilateralTN with NVC Grade III had a significantly smaller mean CSA than the ipsilateralTN with NVC Grades I and II ($p < 0.05$). The TGN on the ipsilateralTN in cured patients had a smaller mean CSA than that on the ipsilateralTN of patients with partial pain relief or treatment failure ($p < 0.05$). The same finding was almost found in relation to measurements of V, but the p value was slightly higher at 0.05. The authors concluded that the findings of this

study showed that TGN atrophy in patients with TN can be demonstrated by high-resolution imaging. Moreover, they stated that these data suggested that atrophic changes in TGNs, which significantly correlated with the severity of compression and clinical outcomes, may help to predict long-term prognosis after vascular decompression.

An UpToDate review on "Trigeminal neuralgia" (Bajwa et al, 2014) states that "Neuroimaging with head CT or MRI is useful for identifying the small proportion of patients who have a structural lesion (e.g., tumor in the cerebellopontine angle, demyelinating lesions including multiple sclerosis) as the cause of painful trigeminal neuropathy. In addition, high resolution MRI and magnetic resonance angiography (MRA) may be useful for identifying vascular compression as the etiology of classic TN, but the utility of these studies has not been established …. The 2008 AAN/EFNS practice parameter identified seven studies that performed high-resolution brain MRI and/or magnetic resonance angiography (MRA) to demonstrate neurovascular compression in patients with TN. The following observations were made:

> There was wide variation among the included studies for both sensitivity (range 52 to 100 %) and specificity (29 to 93 %).
> In 3 of the 5 highest-quality MRI studies (cohort surveys with prospective data collection), the difference in rate of neurovascular trigeminal nerve compression on the symptomatic side compared with asymptomatic side was statistically non-significant.

Given these inconsistent results, the AAN/EFNS concluded that there is insufficient evidence to support or refute the utility of MRI to identify neurovascular compression in classic TN, or to indicate the most reliable MRI technique".

CPT Codes / HCPCS Codes / ICD-9 Codes

Magnetic Resonance Angiography (MRA) & Venography (MRV):

Head and neck:

CPT codes covered if selection criteria are met:

70544

70545

70546

70547

70548

70549

ICD-9 codes covered if selection criteria are met for MRA:

094.87 Syphilitic ruptured cerebral aneurysm

191.0 - 191.9	Malignant neoplasm of brain
195.0	Malignant neoplasm of head, face, and neck
225.0	Benign neoplasm of brain
237.5	Neoplasm of uncertain behavior of brain and spinal cord
325	Phlebitis and thrombophlebitis of intracranial venous sinuses
362.34	Retinal transient arterial occlusion
368.2	Diplopia
369.3	Unqualified visual loss, both eyes
378.51 - 378.52	Third or oculomotor nerve palsy, partial or total
386.11	Benign paroxysmal positional vertigo
386.2	Vertigo of central origin
388.30 - 388.32	Tinnitus
430	Subarachnoid hemorrhage
435.0 - 435.9	Transient cerebral ischemia
436	Acute, but ill-defined, cerebrovascular disease
437.0 - 437.9	Other and ill-defined cerebrovascular disease
443.21, 443.24	Dissection of carotid or vertebral artery
723.5	Torticollis, unspecified
747.81	Anomalies of cerebrovascular system
780.2	Syncope and collapse
780.4	Dizziness and giddiness
781.1	Disturbances of sensation of smell and taste
784.0	Headache
784.59	Other speech disturbance
787.20 - 787.29	Dysphagia
792.0	Nonspecific abnormal findings in cerebrospinal fluid [blood in CSF]
900.00 - 900.03	Injury to carotid artery

V17.1	Family history of stroke (cerebrovascular)

ICD-9 codes covered if selection criteria are met for MRV:

191.0 - 191.9	Malignant neoplasm of brain
195.0	Malignant neoplasm of head and neck
225.0	Benign neoplasm of brain
237.5	Neoplasm of uncertain behavior of brain and spinal cord
320.0 - 322.9	Meningitis
377.00 - 377.04	Papilledema
381.0 - 382.9	Otitis media
461.0 - 461.9	Acute sinusitis
473.0 - 473.9	Chronic sinusitis
780.31 - 780.39	Convulsions [seizures]
781.99	Other symptoms involving nervous and musculoskeletal systems [focal or sensory deficits]
784.0	Headache
V58.69	Long-term (current) use of other medications [oral contraceptives]

ICD-9 codes not covered for indications listed in the CPB for MRV:

435.0 - 435.9	Transient cerebral ischemia [diagnosis of chronic cerebro-spinal venous insufficiency]
436	Acute, but ill-defined, cerebrovascular disease [diagnosis of chronic cerebro-spinal venous insufficiency]
437.0 - 437.9	Other and ill-defined cerebrovascular disease [diagnosis of chronic cerebro-spinal venous insufficiency]

Chest:

CPT codes covered if selection criteria are met:

71555

Other CPT codes related to the CPB:

75557-75564

HCPCS codes covered if selection criteria are met:

C8909	Magnetic resonance angiography with contrast, chest (excluding myocardium)
C8910	Magnetic resonance angiography without contrast, chest (excluding myocardium)
C8911	Magnetic resonance angiography without contrast followed by with contrast, chest (excluding myocardium)

ICD-9 codes covered if selection criteria are met for MRA:

415.11, 415.19	Pulmonary embolism and infarction
427.31	Atrial fibrillation
441.01	Dissection of aorta, thoracic
441.1	Thoracic aneurysm, ruptured
441.2	Thoracic aneurysm without mention of rupture
745.0 - 747.49	Bulbus cordis anomalies and anomalies of cardiac septal closure, other congenital anomalies of heart, and other congenital anomalies of aorta, pulmonary artery, or great veins
V15.1	Personal history of surgery to heart and great vessels

ICD-9 codes not covered for indications listed in the CPB for MRA:

228.1	Lymphangioma, any site [recurrent cystic hygroma of the axilla]
427.69	Premature beats, other [premature ventricular contraction]

ICD-9 codes covered if selection criteria are met for MRV:

453.77	Chronic superior vena cava thrombosis
453.87	Acute superior vena cava thrombosis
453.75	Chronic venous embolism and thrombosis of subclavian veins
453.85	Acute venous embolism and thrombosis of subclavian veins
453.87	Acute venous embolism and thrombosis of other thoracic veins

***Spine**:*

CPT codes covered if selection criteria are met:

72159

C8931

C8932

C8933

ICD-9 codes covered if selection criteria are met for MRA:

447.0	Arteriovenous fistula, acquired [spinal cord]
747.82	Spinal vessel anomaly [spinal cord]

Abdomen:

CPT codes covered if selection criteria are met:

72198

74185

Other CPT codes related to the CPB:

37182

HCPCS codes covered if selection criteria are met:

A9583	Injection, Gadofosveset Trisodium, 1 ml [Ablavar, Vasovist]
C8900	Magnetic resonance angiography with contrast, abdomen
C8901	Magnetic resonance angiography without contrast, abdomen
C8902	Magnetic resonance angiography without contrast followed by with contrast, abdomen

ICD-9 codes covered if selection criteria are met for MRA:

282.60 - 282.69	Sickle-cell disease
401.0 - 405.9	Hypertensive disease
440.1	Atherosclerosis of renal artery
441.02	Dissection of aorta, abdominal
441.03	Dissection of aorta, thoracoabdominal
444.0	Arterial embolism and thrombosis of abdominal aorta
447.3 - 447.8	Hyperplasia of renal artery, celiac artery compression syndrome, necrosis of artery, arteritis, unspecified, or other specified disorders of arteries and arterioles
557.0 - 557.9	Vascular insufficiency of intestine [chronic mesenteric ischemia]
572.3	Portal hypertension
V15.08	Personal history of allergy to radiographic dye [contrast allergy, renal insufficiency]

ICD-9 codes not covered for indications listed in the CPB for MRA:

227.0	Benign neoplasm of adrenal gland
V59.4	Donor of kidney
V81.1	Special screening for hypertension

ICD-9 codes covered if selection criteria are met for MRV:

289.81	Primary hypercoagulable state
289.82	Secondary hypercoagulable state
452	Portal vein thrombosis
453.0	Budd-Chiari syndrome (hepatic vein thrombosis)
453.1	Thrombophlebitis migrans
453.2	Other venous embolism and thrombosis of inferior vena cava
453.3	Other venous embolism and thrombosis of renal vein

Lower extremity:

CPT codes covered if selection criteria are met:

73725

HCPCS codes covered if selection criteria are met:

A9583	Injection, Gadofosveset Trisodium, 1 ml [Ablavar, Vasovist] C8912
	Magnetic resonance angiography with contrast, lower extremity
C8913	Magnetic resonance angiography without contrast, lower extremity
C8914	Magnetic resonance angiography without contrast, followed by with contrast, lower extremity

ICD-9 codes covered if selection criteria are met for MRA:

443.81 - 443.9	Other specified peripheral vascular diseases
444.22	Arterial embolism and thrombosis of lower extremity

ICD-9 codes not covered for indications listed in the CPB for MRV:

453.40 - 453.6	Acute and chronic venous embolism and thrombosis of deep and superficial vessels of lower extremity
451.11 - 451.2	Phlebitis and thrombophlebitis of deep vessels of lower extremities
453.40 - 453.42	Acute venous embolism and thrombosis of deep vessels of lower extremity
453.50 - 453.52	Chronic venous embolism and thrombosis of deep vessels of lower extremity

Upper extremity:

ICD-9 codes not covered for indications listed in the CPB for MRV:

451.83	Phlebitis and thrombophlebitis of deep veins of upper extremities
453.71 - 453.73	Chronic venous embolism and thrombosis of superficial and deep veins upper extremity
453.81 - 453.84	Acute venous embolism and thrombosis of superficial and deep veins of upper extremity

Other CPT codes related to the CPB:

72159

73225

The above policy is based on the following references:

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