Complete Summary

GUIDELINE TITLE

Cerebrovascular disease.

BIBLIOGRAPHIC SOURCE(S)

De La Paz RL, Seidenwurm DJ, Davis PC, Brunberg JA, Dormont PD, Hackney DB, Jordan JE, Karis JP, Mukherji SK, Turski PA, Wippold FJ Jr, Zimmermann RD, Sloan MA, Expert Panel on Neurologic Imaging. Cerebrovascular disease. [online publication]. Reston (VA): American College of Radiology (ACR); 2006. 20 p. [120 references]

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Masaryk T, Drayer BP, Anderson RE, Braffman B, Davis PC, Deck MD, Hasso AN, Johnson BA, Pomeranz SJ, Seidenwurm D, Tanenbaum L, Masdeu JC. Cerebrovascular disease. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):415-35.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

COMPLETE SUMMARY CONTENT

SCOPE
METHODOLOGY - including Rating Scheme and Cost Analysis
RECOMMENDATIONS
EVIDENCE SUPPORTING THE RECOMMENDATIONS
BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS
QUALIFYING STATEMENTS
IMPLEMENTATION OF THE GUIDELINE
INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES
IDENTIFYING INFORMATION AND AVAILABILITY
DISCLAIMER

SCOPE

DISEASE/CONDITION(S)

Cerebrovascular disease

GUIDELINE CATEGORY

Diagnosis

CLINICAL SPECIALTY

Emergency Medicine
Family Practice
Internal Medicine
Neurological Surgery
Neurology
Radiology

INTENDED USERS

Health Plans
Hospitals
Managed Care Organizations
Physicians
Utilization Management

GUIDELINE OBJECTIVE(S)

To evaluate the appropriateness of initial radiologic examinations for patients with cerebrovascular disease

TARGET POPULATION

Patients with cerebrovascular disease

INTERVENTIONS AND PRACTICES CONSIDERED

1. Ultrasound (US)
    - Carotid, duplex
    - Transcranial, Doppler
2. Magnetic resonance angiography (MRA)
    - Neck, with or without contrast
    - Head, with or without contrast
3. Magnetic resonance imaging (MRI), brain, without and with contrast
4. Functional magnetic resonance imaging (fMRI), brain, blood-oxygen level dependent (BOLD)
5. MR spectroscopy (MRS), head
6. Computed tomography angiography (CTA)
    - Neck
    - Head, without and with contrast
7. Computed tomography (CT), head, without and with contrast
8. Nuclear medicine (NM), single-photon-emission computed tomography (SPECT), brain
9. Position emission tomography (PET), brain
10. Invasive (INV), arteriography, head and neck

MAJOR OUTCOMES CONSIDERED

Utility of radiologic examinations in differential diagnosis

METHODOLOGY

METHODS USED TO COLLECT/SELECT EVIDENCE

Searches of Electronic Databases

DESCRIPTION OF METHODS USED TO COLLECT/SELECT THE EVIDENCE

The guideline developer performed literature searches of peer-reviewed medical journals and the major applicable articles were identified and collected.

NUMBER OF SOURCE DOCUMENTS

The total number of source documents identified as the result of the literature search is not known.

METHODS USED TO ASSESS THE QUALITY AND STRENGTH OF THE EVIDENCE

Weighting According to a Rating Scheme (Scheme Not Given)

RATING SCHEME FOR THE STRENGTH OF THE EVIDENCE

Not stated

METHODS USED TO ANALYZE THE EVIDENCE

Review of Published Meta-Analyses
Systematic Review with Evidence Tables

DESCRIPTION OF THE METHODS USED TO ANALYZE THE EVIDENCE

One or two topic leaders within a panel assume the responsibility of developing an evidence table for each clinical condition, based on analysis of the current literature. These tables serve as a basis for developing a narrative specific to each clinical condition.

METHODS USED TO FORMULATE THE RECOMMENDATIONS

Expert Consensus (Delphi)

DESCRIPTION OF METHODS USED TO FORMULATE THE RECOMMENDATIONS

Since data available from existing scientific studies are usually insufficient for meta-analysis, broad-based consensus techniques are needed to reach agreement in the formulation of the appropriateness criteria. The American College of Radiology (ACR) Appropriateness Criteria panels use a modified Delphi technique to arrive at consensus. Serial surveys are conducted by distributing questionnaires to consolidate expert opinions within each panel. These questionnaires are distributed to the participants along with the evidence table and narrative as developed by the topic leader(s). Questionnaires are completed by the participants in their own professional setting without influence of the other members. Voting is conducted using a scoring system from 1-9, indicating the least to the most appropriate imaging examination or therapeutic procedure. The survey results are collected, tabulated in anonymous fashion, and redistributed after each round. A maximum of three rounds is conducted and opinions are unified to the highest degree possible. Eighty percent agreement is considered a consensus. This modified Delphi technique enables individual, unbiased expression, is economical, easy to understand, and relatively simple to conduct.

If consensus cannot be reached by the Delphi technique, the panel is convened and group consensus techniques are utilized. The strengths and weaknesses of each test or procedure are discussed and consensus reached whenever possible. If "No consensus" appears in the rating column, reasons for this decision are added to the comment sections.

RATING SCHEME FOR THE STRENGTH OF THE RECOMMENDATIONS

Not applicable

COST ANALYSIS

The guideline developers reviewed published cost analyses.

METHOD OF GUIDELINE VALIDATION

Internal Peer Review

DESCRIPTION OF METHOD OF GUIDELINE VALIDATION

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

RECOMMENDATIONS

MAJOR RECOMMENDATIONS

ACR Appropriateness Criteria®

Clinical Condition: Cerebrovascular Disease

Variant 1: Asymptomatic. Structural lesion on physical exam (cervical bruit) and/or risk factors.

Radiologic Procedure	Appropriateness Rating	Comments
US, carotid, duplex	8	May need to confirm with second non-invasive study.
MRA, neck, with or without contrast	8	
CTA, neck	8	
MRI, brain, without and with contrast	5	Consider perfusion if stenosis found.
CT, head, without and with contrast	5	Consider perfusion if stenosis found.
US, transcranial, Doppler	3	
MRI, brain, without contrast	3	
MRA, head, with or without contrast	3	May be useful if stenosis found.
CT, head, without contrast	3	
CTA, head, without and with contrast	3	May be useful if stenosis found.
INV, arteriography, neck	2	
INV, arteriography, head and neck	2	
fMRI, brain (BOLD)	1	
MR spectroscopy (MRS), head	1	
PET, brain	1	
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 2: Carotid territory or vertebrobasilar TIA, initial screening survey. (In these tables a TIA is the report of an historical transient ischemic event by the patient or other witness. The acute neurological deficit in progress must be treated as an acute stroke and can only be considered a TIA in retrospect if it resolves without intervention.)

Radiologic Procedure	Appropriateness Rating	Comments
MRI, brain, with or without contrast	8	Consider perfusion if stenosis found. Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
MRA, head and neck, with or without contrast	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
CT, head, with or without contrast	8	Consider perfusion if stenosis found. Primarily to rule out hemorrhage. Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
CTA, head and neck	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
US, carotid, duplex	6	
US, transcranial, Doppler	3	
INV, arteriography, neck	3	
INV, arteriography, head and neck	3	
fMRI, brain (BOLD)	1	
MR spectroscopy (MRS), head	1	
PET, brain	1	
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9**		

Radiologic Procedure	Appropriateness Rating	Comments
1 = Least appropriate 9 = Most appropriate		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 3: New focal neurologic defect, fixed or worsening. Less than 3 hours.

Radiologic Procedure	Appropriateness Rating	Comments
MRI, brain, with or without contrast	8	Consider perfusion if stenosis found. Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
MRA, head and neck, with or without contrast	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
CT, head, with or without contrast	8	Consider perfusion if stenosis found. Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
CTA, head and neck	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
INV, arteriography, neck	5	If intra-arterial therapy is considered.
INV, arteriography, head and neck	5	If intra-arterial therapy is considered.
US, carotid, duplex	2	
US, transcranial, Doppler	2	
fMRI, brain (BOLD)	1	
MR spectroscopy (MRS), head	1	
PET, brain	1	

Radiologic Procedure	Appropriateness Rating	Comments
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 4: New focal neurologic defect, fixed or worsening. Three to 24 hours.

Radiologic Procedure	Appropriateness Rating	Comments
MRI, brain, with or without contrast	8	Diffusion especially valuable. Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
MRA, head and neck, with or without contrast	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
CT, head, with or without contrast	8	For perfusion according to institutional protocols. Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
CT, head and neck	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
INV, arteriography, neck	6	If intra-arterial therapy is considered.
INV, arteriography, head and neck	6	If intra-arterial therapy is considered.
US, carotid, duplex	2	
US, transcranial, Doppler	2	
fMRI, brain (BOLD)	1	
MR spectroscopy	1	

Radiologic Procedure	Appropriateness Rating	Comments
(MRS), head		
PET, brain	1	
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 5: New focal neurologic defect, fixed or worsening. Greater than 24 hours.

Radiologic Procedure	Appropriateness Rating	Comments
MRI, brain, with or without contrast	8	Diffusion especially valuable. Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
MRA, head and neck, with or without contrast	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
CT, head, with or without contrast	8	For perfusion according to institutional protocols. Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
CT, head and neck	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
INV, arteriography, neck	6	If intra-arterial therapy is considered.
INV, arteriography, head and neck	6	If intra-arterial therapy is considered.
US, carotid, duplex	2	
US, transcranial, Doppler	2	

Radiologic Procedure	Appropriateness Rating	Comments
fMRI, brain (BOLD)	1	
MR spectroscopy (MRS), head	1	
PET, brain	1	
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 6: Risk for unruptured aneurysm. Positive family history.

Radiologic Procedure	Appropriateness Rating	Comments
MRA, head, with and without contrast	8	MR preferred if treatment is not unreasonably delayed.
CTA, head	8	Noncontrast CT obtained routinely at the same time. MR preferred if treatment not unreasonably delayed.
MRI, brain, with or without contrast	6	
MRA, neck, with or without contrast	3	
CT, head, with or without contrast	3	Obtained with CTA.
CTA, neck, with or without contrast	2	
US, carotid, duplex	1	
US, transcranial, Doppler	1	
INV, arteriography, neck	1	
INV, arteriography, head and neck	1	

Radiologic Procedure	Appropriateness Rating	Comments
fMRI, brain (BOLD)	1	
MR spectroscopy (MRS), head	1	
PET, brain	1	
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 7: Clinically suspected subarachnoid hemorrhage (SAH), not yet confirmed.

Radiologic Procedure	Appropriateness Rating	Comments
CT, head, without contrast	9	
CT, head, without and with contrast	5	
MRI, brain, with or without contrast	4	
MRA, head, with or without contrast	4	
INV, arteriography, neck	2	
INV, arteriography, head and neck	2	
MRA, neck, with or without contrast	2	
CTA, head	2	
CTA, neck	2	For treatment planning.
US, carotid, duplex	1	
US, transcranial, Doppler	1	

Radiologic Procedure	Appropriateness Rating	Comments
fMRI, brain (BOLD)	1	
MR spectroscopy (MRS), head	1	
PET, brain	1	
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 8: Proven SAH by lumbar puncture or imaging.

Radiologic Procedure	Appropriateness Rating	Comments
INV, arteriography, neck	8	For treatment planning. As part of cerebral angiography.
INV, arteriography, head and neck	8	
CT, head, without contrast	8	
CTA, head	8	
MRA, head, with or without contrast	7	
MRI, brain, with or without contrast	6	
MRA, neck, with or without contrast	6	For future treatment planning.
CTA, neck	6	For future treatment planning.
US, transcranial, Doppler	5	For vasospasm
CT, head, without and with contrast	5	
US, carotid, duplex	1	

Radiologic Procedure	Appropriateness Rating	Comments
fMRI, brain (BOLD)	1	
MR spectroscopy (MRS), head	1	
PET, brain	1	
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 9: Proven SAH, negative angiogram, follow-up.

Radiologic Procedure	Appropriateness Rating	Comments
INV, arteriography, head and neck	8	
MRI, brain, with or without contrast	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
MRA, head, with or without contrast	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment not unreasonably delayed.
CTA, head	8	MR preferred if treatment not unreasonably delayed.
US, transcranial, Doppler	5	For vasospasm
INV, arteriography, neck	5	
MRA, neck, with or without contrast	5	
CT, head, without contrast	5	
CTA, neck	5	

Radiologic Procedure	Appropriateness Rating	Comments
CT, head without and with contrast	4	
US, carotid, duplex	1	
fMRI, brain (BOLD)	1	
MR, spectroscopy, head (MRS)	1	
PET, brain	1	
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 10: Clinically suspected parenchymal hemorrhage (hematoma), not yet confirmed.

Radiologic Procedure	Appropriateness Rating	Comments
CT, head, without contrast	8	
MRI, brain, with or without contrast	7	
CT, head, without and with contrast	7	
MRA, head, with or without contrast	4	
CTA, head	4	
INV, arteriography, head and neck	3	
MRA, neck, with or without contrast	3	
CTA, neck	3	
INV, arteriography, neck	2	

Radiologic Procedure	Appropriateness Rating	Comments
US, carotid, duplex	1	
US, transcranial, Doppler	1	
fMRI, brain (BOLD)	1	
MR spectroscopy (MRS), head	1	
PET, brain	1	
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Variant 11: Proven parenchymal hemorrhage (hematoma)

Radiologic Procedure	Appropriateness Rating	Comments
MRI, brain, with or without contrast	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment is not unreasonably delayed.
MRA, head, with or without contrast	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment is not unreasonably delayed.
CT, head, without contrast	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment is not unreasonably delayed.
CTA, head	8	Combined vascular and cerebral evaluation should be considered. MR preferred if treatment is not unreasonably delayed.
INV, arteriography, neck	7	
INV, arteriography,	7	If suspect AVM

Radiologic Procedure	Appropriateness Rating	Comments
head and neck		
CT, head, without and with contrast	7	
MRA, neck, with or without contrast	5	
CTA, neck	5	
US, carotid, duplex	1	
US, transcranial, Doppler	1	
fMRI, brain (BOLD)	1	
MR spectroscopy (MRS), head	1	
PET, brain	1	
NM, SPECT, brain	1	
Appropriateness Criteria Scale **1 2 3 4 5 6 7 8 9** **1 = Least appropriate 9 = Most appropriate**		

Note: Abbreviations used in the tables are listed at the end of the "Major Recommendations" field.

Summary

Because of the gravity of stroke's sequelae, considerable effort has been expended to identify risk factors for cardiovascular disease (see Appendix B in the original guideline document) and strategies for stroke prevention in high-risk patients. These range from modification of lifestyle to surgical intervention. Surgery has been shown effective in altering morbidity of both asymptomatic and symptomatic patients in randomized, prospective clinical trials in which the intent to treat was determined partly by imaging. In asymptomatic patients, screening should be undertaken not only by a sensitive, noninvasive (i.e., low-risk) test directed at identifying the abnormal cerebrovascular substrate but also with some consideration for identifying those in risk populations with a high prevalence of disease (e.g., patients with carotid bruit).

Although the diagnostic accuracy of duplex ultrasound (US), computed tomography angiography (CTA), and magnetic resonance angiography (MRA), and time resolved contrast-enhanced MRA (CEMRA) are all high for internal carotid artery (ICA) stenosis of 70% to 99%, only US appears to offer cost-effective screening. Alternatively, variability in performance (efficacy vs. effectiveness)

precludes endorsement of its routine use as the sole examination before endarterectomy, and combined use with CEMRA is an increasingly common practice. Multislice CTA is promising but relatively few rigorous studies have been done, and the technique remains limited by large intravenous contrast injection volumes, potential contrast toxicity or reaction, radiation dose, and plaque calcification that may obscure the stenosis. It should be noted that although surgical outcome studies have been based on catheter angiography, the possible morbidity of these studies and continuing improvement in noninvasive exams have made invasive studies less common. Similarly, a variety of imaging strategies may be undertaken in symptomatic cases where the initial studies can be directed toward the brain parenchyma, and a vascular study may be included immediately at the onset. Elevated ischemic stroke risk in patients with chronic carotid stenosis or occlusion can also be identified using single-photon-emission computed tomography (SPECT) and Xenon-CT methods, which show reduced cerebral vascular reserve (CVR) after acetazolamide challenge, or by elevated oxygen extraction fraction (OEF) using ^{15}O-PET (positron emission tomography). Although there is limited experience with MR and CT perfusion methods for this purpose, elevated cerebral blood volume appears to correlate with reduced CVR and increased stroke risk, and these studies are widely available.

Although stroke is typically acute in onset, occasionally the onset is less immediate and more gradual or stuttering. Differential diagnostic considerations in these cases include atypical migraine, multiple sclerosis, venous occlusive disease, and atypical epilepsy.

Traditionally, if focal neurologic symptoms continue for more than 24 hours, stroke is diagnosed; otherwise, a focal neurologic deficit lasting less than 24-hours has been defined as a transient ischemic attack (TIA). However, this time-based definition of TIA may be inadequate and misleading, potentially leading to inappropriate delays in diagnosis and treatment. A "tissue-based" definition has been proposed that considers all acute focal neurologic deficits as possible infarcts and classifies them as acute ischemic cerebrovascular syndromes (AICS) based on the degree of certainty of tissue ischemic injury, determined primarily by imaging studies. Because most transient ischemic neurologic symptoms last for 1 hour or less and 50% or more show tissue injury on MRI diffusion-weighted imaging (DWI), the TIA Working Group recently proposed a new definition of TIA as "*a brief episode of neurologic dysfunction presumptively caused by focal brain or retinal ischemia, typically lasting less than one hour, without neuroimaging evidence of acute infarction".* This change reflects the growing emphasis on the earliest possible diagnosis and treatment of acute ischemia and the use of MRI and CT for definitive infarct diagnosis and exclusion of hemorrhage. In addition, because 15% of all strokes are heralded by a TIA and the 90 day risk of stroke after a TIA is as high as 20%, a TIA should trigger an immediate work up for stroke risks and follow-up imaging studies.

With the introduction of CT scanning by Hounsfield in the early 1970's came the ability to acutely assess the brain, subarachnoid, and ventricular spaces noninvasively. Similarly, on the basis of the x-ray attenuation of blood and edema relative to cerebrospinal fluid (CSF) and brain parenchyma, CT is effective in detecting acute hemorrhage into brain parenchyma, the subarachnoid, subdural, or intraventricular spaces, and in distinguishing acute hemorrhage from ischemia/infarction. Because of its ready availability and high sensitivity to the

presence or absence of acute blood, noncontrast CT historically has been the preferred modality for initial imaging of suspected stroke, but it has lacked a similar sensitivity to acute ischemia and infarction.

Alternatively, DWI MRI has been shown to be exquisitely sensitive to acute infarction within minutes of the precipitating ictus, although tissue with small apparent diffusion coefficient (ADC) reductions (e.g., 20% below normal) may represent reversible ischemia that does not progress to completed infarct. Additional information obtainable through the combined use of dynamic cerebral blood volume techniques (perfusion-weighted imaging, PWI) as well as vascular imaging (MRA) makes MRI an appealing tool for diagnosis and treatment monitoring of acute cerebrovascular disease. However, enthusiasm for MRI in the setting of acute stroke has often been stifled by the variable and confounding appearance of hemorrhage on MRI. The recognition and characterization of the MRI findings in intracranial hemorrhage are understandable if one considers: 1) the location, specifically subarachnoid vs. intraparenchymal; 2) the oxidative state of hemoglobin and the subsequent breakdown products; 3) the type of imaging pulse sequence used (T1 vs. T2, spin-echo vs. gradient-echo, conventional spin-echo vs. Rapid Acquisition Relaxation Enhanced [RARE] sequences); and 4) the field strength of the machine used to acquire the images.

Recent experience using T2* (gradient echo) imaging to detect low signal parenchymal hemorrhage and fluid-attenuated inversion recovery (FLAIR) scans to detect high signal subarachnoid blood have helped to renew interest in MRI as a first-line modality in patients with acute, focal neurologic deficits. Although the presence of small hemorrhages on gradient-echo MRI may better predict hemorrhagic complications of recombinant tissue plasminogen activator (rtPA) therapy, there is insufficiently widespread clinical experience to recommend MRI over CT for routine exclusion of intracranial hemorrhage. It is also important to reemphasize the issue of availability of MRI in the context of the therapeutic window and potential contraindications e: patients with pacemakers, cerebral aneurysm clips, ocular foreign bodies, or cochlear implants, and those suffering from claustrophobia, or morbid obesity (>320 pounds).

As mentioned previously, CT is highly sensitive to the presence or absence of acute blood and has been the mainstay in emergent evaluation of acute cerebrovascular disease. Documented acute subarachnoid or parenchymal hemorrhage are conditions associated with high morbidity and mortality. In the case of aneurysmal subarachnoid hemorrhage (SAH), this is partly due to the relatively high rate of early rebleeding. In patients presenting with SAH, early surgery or coiling is offered as a strategy to circumvent this problem, which in turn requires early cerebral angiography. Intra-arterial angiography's sensitivity to cerebral aneurysms is estimated to be greater than 90%; in the setting of acute SAH this figure decreases to slightly greater than 80%. Initially negative studies may require additional angiography at a future time.

Recent clinical practice has shifted toward use of noncontrast CT for SAH detection, followed immediately by CTA for aneurysm detection. Comparisons between CTA and catheter angiography in SAH patients, beginning with single-slice methods and more recently with multislice methods, have shown overall aneurysm detection sensitivities of 85% to 95%, lower for smaller aneurysms, to approximately 50% for those less than 2 mm in diameter. Treatment of

intracranial aneurysms following SAH is increasingly based on CTA alone. Late appearances of new neurological changes suggestive of post-SAH vasospasm, ischemia, or hydrocephalus are increasingly investigated with transcranial Doppler (TCD) and CT imaging with CTA and CT perfusion (CTP), while catheter angiography and SPECT are being used less frequently than in the past.

Because of the cumulative long-term risk of morbidity and mortality from subarachnoid hemorrhage, especially with larger aneurysms (>25 mm in diameter) and the relatively low risk of clipping or coiling unruptured intracranial aneurysms, there may be a clinical role for prophylactic screening. Intra-arterial angiography carries the risk of thromboembolic complication and is relatively expensive; MRI and CTA provide less expensive, noninvasive alternative, although their sensitivity to lesions less than 5 mm in diameter is suspect. To date, individuals with a history of aneurysm or SAH in a first-degree relative have been considered candidates for screening. Nevertheless, significant gaps in knowledge of the natural history (and thus risk of rupture) of intracranial aneurysms remain. Hence, while screening with MRA or CTA may be appropriate in patients with a positive family history, its impact on patient outcome is questionable.

Parenchymal brain hemorrhage may be associated with underlying vascular malformations such as arteriovenous malformation (AVM), pial arteriovenous fistulae, and cavernous malformations in younger patients as well as dural fistulae in older individuals. Diagnosis, assessment of risk for future hemorrhage, and effective treatment planning are all predicated on determination of size of the underlying lesion, location within the brain parenchyma, pattern of venous drainage, and presence of intranidal aneurysm. Acutely, this information is most frequently obtained by intra-arterial angiography, which in more complicated cases may be supplemented by MRI. Although time-resolved elliptic centric bolus contrast CEMRA techniques with multicoil sensitivity encoding currently have temporal resolution in the 1-2 second range, they do not yet rival catheter digital subtraction angiography (DSA) arteriography for separation of arterial and venous phases of high-flow AVMs, but may be useful for follow-up of partially embolized lesions. Baseline and follow-up MRI may be particularly appropriate in partially embolized cases or in patients undergoing stereotactic radiosurgery as a noninvasive, low risk means of identifying ischemic complications and assessing response to therapy.

Assumptions

All patient scenarios should be addressed as though the patients had been referred for imaging following a history and physical examination including neurological, vascular, and ophthalmoscopic exams.

Abbreviations

- AVM, arteriovenous malformation
- BOLD, blood oxygen level dependent
- CT, computed tomography
- CTA, computed tomography angiography
- fMRI, functional magnetic resonance imaging
- INV, invasive
- MR, magnetic resonance

- MRA, magnetic resonance angiography
- MRI, magnetic resonance imaging
- MRS, magnetic resonance spectroscopy
- NM, nuclear medicine
- PET, positron emission tomography
- SAH, subarachnoid hemorrhage
- SPECT, single photon-emission computed tomography
- TIA, transient ischaemic attack
- US, ultrasound

CLINICAL ALGORITHM(S)

Algorithms were not developed from criteria guidelines.

EVIDENCE SUPPORTING THE RECOMMENDATIONS

TYPE OF EVIDENCE SUPPORTING THE RECOMMENDATIONS

The recommendations are based on analysis of the current literature and expert panel consensus.

BENEFITS/HARMS OF IMPLEMENTING THE GUIDELINE RECOMMENDATIONS

POTENTIAL BENEFITS

Selection of appropriate radiologic imaging procedures for evaluation of patients with acute cerebrovascular disease

POTENTIAL HARMS

Risks associated with thrombolytic therapy

QUALIFYING STATEMENTS

QUALIFYING STATEMENTS

An American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those exams generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and

applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

IMPLEMENTATION OF THE GUIDELINE

DESCRIPTION OF IMPLEMENTATION STRATEGY

An implementation strategy was not provided.

IMPLEMENTATION TOOLS

Personal Digital Assistant (PDA) Downloads

For information about availability, see the "Availability of Companion Documents" and "Patient Resources" fields below.

INSTITUTE OF MEDICINE (IOM) NATIONAL HEALTHCARE QUALITY REPORT CATEGORIES

IOM CARE NEED

Getting Better
Living with Illness

IOM DOMAIN

Effectiveness

IDENTIFYING INFORMATION AND AVAILABILITY

BIBLIOGRAPHIC SOURCE(S)

De La Paz RL, Seidenwurm DJ, Davis PC, Brunberg JA, Dormont PD, Hackney DB, Jordan JE, Karis JP, Mukherji SK, Turski PA, Wippold FJ Jr, Zimmermann RD, Sloan MA, Expert Panel on Neurologic Imaging. Cerebrovascular disease. [online publication]. Reston (VA): American College of Radiology (ACR); 2006. 20 p. [120 references]

ADAPTATION

Not applicable: The guideline was not adapted from another source.

DATE RELEASED

1996 (revised 2006)

GUIDELINE DEVELOPER(S)

American College of Radiology - Medical Specialty Society

SOURCE(S) OF FUNDING

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

GUIDELINE COMMITTEE

Committee on Appropriateness Criteria, Expert Panel on Neurologic Imaging

COMPOSITION OF GROUP THAT AUTHORED THE GUIDELINE

Panel Members: Robert L. De La Paz, MD; David J. Seidenwurm, MD; Patricia C. Davis, MD; James A. Brunberg, MD; Pr. Didier Dormont; David B. Hackney, MD; John E. Jordan, MD; John P. Karis, MD; Suresh Kumar Mukherji, MD; Patrick A. Turski, MD; Franz J. Wippold II, MD; Robert D. Zimmerman, MD; Michael A. Sloan, MD, MS

FINANCIAL DISCLOSURES/CONFLICTS OF INTEREST

Not stated

GUIDELINE STATUS

This is the current release of the guideline.

This guideline updates a previous version: Masaryk T, Drayer BP, Anderson RE, Braffman B, Davis PC, Deck MD, Hasso AN, Johnson BA, Pomeranz SJ, Seidenwurm D, Tanenbaum L, Masdeu JC. Cerebrovascular disease. American College of Radiology. ACR Appropriateness Criteria. Radiology 2000 Jun;215(Suppl):415-35.

The appropriateness criteria are reviewed annually and updated by the panels as needed, depending on introduction of new and highly significant scientific evidence.

GUIDELINE AVAILABILITY

Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

ACR Appropriateness Criteria® *Anytime*, *Anywhere*™ (PDA application). Available from the ACR Web site.

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

AVAILABILITY OF COMPANION DOCUMENTS

The following is available:

- ACR Appropriateness Criteria®. Background and development. Reston (VA): American College of Radiology; 2 p. Electronic copies: Available in Portable Document Format (PDF) from the American College of Radiology (ACR) Web site.

PATIENT RESOURCES

None available

NGC STATUS

This summary was completed by ECRI on July 31, 2001. The information was verified by the guideline developer as of August 24, 2001. This NGC summary was updated by ECRI Institute on April 26, 2007.

COPYRIGHT STATEMENT

Instructions for downloading, use, and reproduction of the American College of Radiology (ACR) Appropriateness Criteria® may be found on the ACR Web site.

DISCLAIMER

NGC DISCLAIMER

The National Guideline Clearinghouse™ (NGC) does not develop, produce, approve, or endorse the guidelines represented on this site.

All guidelines summarized by NGC and hosted on our site are produced under the auspices of medical specialty societies, relevant professional associations, public or private organizations, other government agencies, health care organizations or plans, and similar entities.

Guidelines represented on the NGC Web site are submitted by guideline developers, and are screened solely to determine that they meet the NGC Inclusion Criteria which may be found at http://www.guideline.gov/about/inclusion.aspx .

NGC, AHRQ, and its contractor ECRI Institute make no warranties concerning the content or clinical efficacy or effectiveness of the clinical practice guidelines and related materials represented on this site. Moreover, the views and opinions of developers or authors of guidelines represented on this site do not necessarily state or reflect those of NGC, AHRQ, or its contractor ECRI Institute, and inclusion or hosting of guidelines in NGC may not be used for advertising or commercial endorsement purposes.

Readers with questions regarding guideline content are directed to contact the guideline developer.

© 1998-2008 National Guideline Clearinghouse

Date Modified: 9/15/2008