



Cohere Medical Policy – Stress Echocardiogram

Clinical Guidelines for Medical Necessity Review

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Medical Necessity Criteria

Service: Stress Echocardiogram

Recommended Clinical Approach

Stress echocardiography is a diagnostic tool that provides an overview of cardiac structure and function. It is used to evaluate a variety of clinical presentations, most commonly patients with chest pain (or ischemic equivalent) and intermediate (16%-50%) or high (>50%) pretest probability of coronary artery disease (CAD).^{1,2,7} Physicians can use either exercise or pharmacologic agents (i.e., dobutamine) as the stress mechanism. Patients who cannot exercise or who exercise submaximally should undergo a pharmacologic stress echo. Stress echo results in no radiation exposure and is typically lower cost than myocardial perfusion imaging (MPI-SPECT). Other advantages of stress echo compared to MPI-SPECT include shorter patient time commitment, and additional information on cardiac structures (valves, ascending aorta, pericardial space). Stress echocardiography has lower diagnostic accuracy in patients with limited acoustic windows.²⁻⁴

In patients with valvular heart disease, stress echocardiography is a useful modality to assess a patient's functional capacity, ventricular function, and severity of valve dysfunction during exercise. This information may be useful in determining the need for and timing of surgical or interventional treatments. Stress echo is well-tolerated in the pediatric population and is often a preferred modality, as it requires no sedation, needle sticks, or radiation exposure and has been completed in children as young as six.²⁵ The absence of radiation is of particular importance among groups which require serial screening - including transplant recipients, patients with history of radiation to the chest, and patients with a history of Kawasaki Disease.²⁵

Avoid performing stress cardiac imaging or advanced non-invasive imaging in the initial evaluation of patients without cardiac symptoms unless high-risk markers are present.⁵ In patients with known coronary artery disease (CAD) [documented myocardial infarction (MI), coronary revascularization, anatomic imaging with either obstructive (\geq 50% stenosis) or non-obstructive

(<50% stenosis)]and stable symptoms, intensification of preventative measures for those with non-obstructive CAD or optimization of guideline-directed medical therapy (GDMT: includes the use of beta blockers, calcium channel blockers, long-acting nitrates, and/or ranolazine for those with obstructive CAD should be performed with an assessment of the response and consideration to defer testing⁷.

Medical Necessity Criteria

Indications

- **Stress echocardiogram** is considered appropriate if **ANY** of the following is **TRUE**^{5,25}:
- ◆ The patient has chest pain (or an ischemic equivalent^A), and **ANY** of the following⁷:
 - No known CAD with an intermediate or high pretest probability of CAD (based on the [CAD Consortium Calculator](#))²⁷; **OR**
 - No known CAD with a low (less than equal to 15%) pre-test probability of CAD with a coronary calcium score of greater than or equal to 100 Agatston; **OR**
 - No known CAD, and the patient has **ANY** of the following:
 - ECG abnormalities that interfere with the ECG diagnosis of ischemia, including **ANY** of the following, (pharmacologic stress echo recommended)^{5,14,25}:
 - ◆ An inability to achieve the target heart rate with a standard exercise treadmill test (greater than or equal to 85% of age-predicted maximal heart rate); **OR**
 - ◆ Ventricular preexcitation (Wolff-Parkinson-White pattern); **OR**
 - ◆ Ventricular-paced rhythm; **OR**
 - ◆ Left bundle branch block (LBBB); **OR**
 - ◆ Greater than 1 mm ST depression at rest; **OR**
 - ◆ Left ventricular hypertrophy with ST-T abnormalities; **OR**
 - ◆ The patient takes digoxin; **OR**
 - ◆ No known CAD and **ALL** of the following⁸:
 - No prior testing; **AND**
 - Likely or typical anginal symptoms^B; **OR**
 - ◆ No known CAD and **ALL** of the following⁸:
 - Prior testing; **AND**

- Symptoms of chest pain (or an ischemic equivalent^A) and **ANY** of the following:
 - Prior indeterminate stress testing (e.g., heart rate did not reach 85% of age-predicted maximum heart rate) (pharmacologic stress echo recommended); **OR**
 - Inconclusive routine stress ECG; **OR**
 - Abnormal routine stress ECG; **OR**
 - CCTA with moderate stenosis 50 to 69%; **OR**
 - Inconclusive CCTA; **OR**
 - Invasive coronary angiography with intermediate severity (maximal coronary diameter stenosis is 40% to 69%) and/or invasive physiological testing not done; **OR**
- ◆ Newly diagnosed heart failure without previous evaluation for CAD; **OR**
- ◆ Evaluation of ventricular arrhythmias as indicated by **ANY** of the following^{8,9}:
 - Frequent PVCs greater than 30 per hour; **OR**
 - Nonsustained ventricular tachycardia (greater than or equal to 3 consecutive beats at greater than 100 beats per minute); **OR**
 - Exercised-induced ventricular tachycardia; **OR**
 - Sustained ventricular tachycardia; **OR**
 - Ventricular fibrillation; **OR**
- ◆ Before initiation of antiarrhythmic therapy in patients with a high ASCVD risk (greater than 20% by [ACC/AHA ASCVD Risk Estimator](#)) or an intermediate or high pretest probability (greater than 20%) as indicated by the [CAD Consortium Calculator](#)⁸; **OR**
- ◆ Syncope without an ischemic equivalent^A and the initial evaluation suggests a CV abnormality (e.g., regional wall motion abnormality on echo, abnormal EKG with left bundle branch block (LBBB), greater than 1 mm ST depression at rest, or left ventricular hypertrophy with ST-T abnormalities); **OR**
- ◆ Known CAD with a history of prior myocardial infarction (MI) or coronary revascularization or coronary stenosis of greater than 50% by angiography or CCTA and **ANY** of the following⁸:
 - Asymptomatic patient and **ANY** of the following is **TRUE**:

- The patient had a percutaneous coronary intervention (PCI) over 2 years prior and last stress test was over 2 years ago; **OR**
- The patient had a bypass over 5 years prior and last stress test was over 5 years ago; **OR**
- High risk for silent ischemia as indicated by **ANY** of the following:
 - ◆ Diabetes mellitus with accelerated progression of CAD; **OR**
 - ◆ Chronic kidney disease (CKD Stage 3 or above – eGFR 15–59 mL/min/1.73 m² with or without albuminuria that is not treated with dialysis or kidney transplantation); **OR**
 - ◆ Peripheral artery disease; **OR**
 - ◆ Prior brachytherapy; **OR**
 - ◆ In-stent restenosis; **OR**
 - ◆ Saphenous vein graft intervention; **OR**
 - ◆ The patient has a history of silent ischemia; **OR**
- Symptomatic patient with a change in clinical or functional status on adequate GDMT (or documented intolerance to GDMT); **OR**
- ◆ Preoperative testing before intermediate or high risk surgery^(Table 1),²⁸ and **ANY** of the following:
 - Planned solid organ transplant (renal, pancreas, combined renal pancreas, liver, lung or intestinal); **OR**
 - No known or suspected heart disease^{C,28} and **ALL** of the following:
 - No recent (3–8 months) testing; **AND**
 - New or worsening possible cardiac symptoms; **AND**
 - Functional status less than 4 METS and **ANY** of the following:
 - ◆ High risk vascular surgery^(Table 1) or high risk nonvascular surgery^(Table 1); **OR**
 - ◆ Intermediate risk vascular surgery^(Table 1); **OR**
 - ◆ Intermediate risk nonvascular surgery^(Table 1) with at least an intermediate (16% or greater) pre-test probability of obstructive CAD by the [CAD Consortium Calculator](#); **OR**

- Known or suspected heart disease^{D,28} and **ANY** of the following:
 - No recent (3-8 months) stress testing and **ANY** of the following:
 - ◆ High risk vascular surgery^(Table 1) or high risk nonvascular surgery^(Table 1); **OR**
 - ◆ Intermediate risk vascular surgery and **ANY** of the following:
 - Greater than 4 METS and **ALL** of the following:
 - Without new or worsening possible cardiac symptoms; **AND**
 - [Revised Cardiac Risk Index](#) of 3 or greater (intermediate or high risk); **OR**
 - Less than 4 METS with or without new or worsening possible cardiac symptoms; **OR**
 - Greater than 4 METS with new or worsening possible cardiac symptoms; **OR**
 - ◆ Intermediate nonvascular surgery^(Table 1) and **ANY** of the following:
 - Less than 4 METS with or without possible cardiac symptoms; **OR**
 - Greater than 4 METS with new or worsening possible cardiac symptoms; **OR**
 - Low risk vascular or nonvascular surgery^(Table 1) planned and **ANY** of the following:
 - ◆ New or worsening possible cardiovascular symptoms; **OR**
 - ◆ [Revised Cardiac Risk Index](#) of 3 or greater (intermediate or high risk); **OR**
- Prior cardiac stress testing within 3 to 8 months and **ANY** of the following:
 - High risk vascular surgery^(Table 1) with risk factors that the physician feels warrants repeat testing; **OR**

- New findings on TTE such as new wall motion abnormalities, new significant valvular disease, or significant drop in ejection fraction; **OR**
- New or worsening possible cardiovascular symptoms; **OR**
- ◆ The patient has left ventricular outflow tract (LVOT) obstruction and otherwise equivocal indications for intervention¹⁰; **OR**
- ◆ The patient has coarctation of the aorta, and a stress echo is needed to assess for exercise-induced hypertension in patients that exercise and left ventricular (LV) function¹⁰; **OR**
- ◆ Post-intervention surveillance of functional capacity and efficacy following medical or surgical repair of congenital cardiac defects, including **ANY** of the following:
 - Atrial or ventricular left-to-right shunts; **OR**
 - Aortic coarctation; **OR**
 - Arterial switch; **OR**
 - Congenitally-corrected transposition of the great arteries; **OR**
 - Tetralogy of Fallot; **OR**
 - Hypoplastic left heart syndrome with Fontan palliation; **OR**
- ◆ The patient has anatomically severe aortic stenosis (AS, less than 1.0 cm²) and left ventricular ejection fraction (LVEF) less than 50% with a low transvalvular velocity and pressure gradient at rest (i.e., velocity less than 4 m/s or mean gradient less than 40 mmHg). Stress echo is needed to distinguish between severe AS with LV systolic dysfunction and moderate AS¹¹; **OR**
- ◆ The patient has asymptomatic moderate or severe chronic primary mitral regurgitation¹¹; **OR**
- ◆ The patient has asymptomatic moderate or severe aortic stenosis (stages B and C) for measurement of changes in valve hemodynamics with exercise or pharmacological stress¹²; **OR**
- ◆ The patient has mitral valve disease, including rheumatic mitral stenosis, with a discrepancy between clinical symptoms and resting echo findings¹²; **OR**
- ◆ The patient has moderate or severe aortic regurgitation (AR) for assessment of symptoms and functional capacity¹²; **OR**
- ◆ Discordance between clinical assessment and TTE about the severity of AR; **OR**
- ◆ In a patient with hypertrophic cardiomyopathy where a mild dynamic left ventricular outflow obstruction requires exercise provocation²⁶; **OR**
- ◆ Preoperative diagnosis and serial long-term follow-up of high risk patients with anomalous origin of coronaries²⁶; **OR**

- ◆ Patient with known congenital or valvular heart disease prior to carrying planned pregnancy^{11,26}; **OR**
- ◆ Annual screening for **ANY** of the following:
 - Coronary aneurysms among patients with a history of Kawasaki Disease²⁵; **OR**
 - Post-cardiac transplant²⁵; **OR**
- ◆ Repeat imaging (defined as repeat request following recent imaging of the same anatomic region with the same modality), in the absence of established guidelines, will be considered reasonable and necessary if **ANY** of the following is **TRUE**:
 - New or worsening symptoms, such that repeat imaging would influence treatment; **OR**
 - One-time clarifying follow-up of a prior indeterminate finding; **OR**
 - In the absence of change in symptoms, there is an established need for monitoring which would influence management.

^A**Ischemic Equivalent:** Chest pain syndrome, anginal equivalent, or ischemic electrocardiogram (ECG) abnormalities are any constellation of clinical findings that the physician believes is consistent with CAD manifestations. Examples of such findings include, but are not limited to, pain, pressure, tightness, or discomfort in the chest, shoulders, arms, neck, back, upper abdomen, or jaw, new ECG abnormalities, or other symptoms/findings suggestive of CAD. Clinical presentations in the absence of chest pain (e.g., dyspnea with exertion, fatigue, or reduced/worsening effort tolerance) consistent with CAD may also be considered an ischemic equivalent.¹⁵

^B**Likely or typical anginal symptoms:**

Chest/epigastric/shoulder/arm/jaw pain, chest pressure/discomfort, when occurring with exertion or emotional stress and relieved by rest, nitroglycerin, or both.

^C**No Known or Suspected Heart Disease by History, Exam, or**

Electrocardiogram²⁸: Heart disease is not suspected based on history of no prior cardiac event, lack of cardiac risk factors, or prior cardiac testing indicating no ischemic heart disease, VHD, or HF. Exam does not suggest underlying heart disease by lack of murmurs, other than functional, and no signs of cardiac decompensation (i.e, rales, edema not explained by other causes, or S3 gallop). ECG does not show prior myocardial infarction, left ventricular hypertrophy, LBBB, or atrial

fibrillation. B-type natriuretic peptide (BNP) or proBNP, if measured, is normal.

^DKnown or Suspected Heart Disease by History, Exam, or

Electrocardiogram²⁸: PCI, CABG, prior infarct, cardiac risk factors (HTN, HLD, DM, tobacco use, FHx premature CAD), disease conditions associated with atherosclerosis (PAD, carotid disease, abdominal aneurysm, stroke due to atherosclerosis), prior cardiac testing showing CAD, heart failure, moderate or severe valvular disease, rales, old infarct on EKG, LVH with repolarization changes, LBBB or atrial fibrillation. There may be prior evidence of biomarker elevation (troponin, proBNP) in the absence of other explanatory findings. B-type natriuretic peptide (BNP) or proBNP, if measured, is more than 3x the upper limit of normal.

Table 1. Definitions of Low, Intermediate, and High-Risk Surgery²⁸

Table 1. Definitions of Low, Intermediate, and High-Risk Surgery ²⁸			
	Surgical Risk Level		
Specialty	Low	Intermediate	High
Vascular	<ol style="list-style-type: none"> 1. Carotid stenting (monitored anesthesia care) 2. Renal artery stenosis angioplasty or stent 3. Vein stripping 	<ol style="list-style-type: none"> 1. Infra-inguinal peripheral angioplasty/stent 2. Carotid stenting (carotid approach, general anesthesia) 3. Open carotid endarterectomy 4. Above or below knee amputation 	<ol style="list-style-type: none"> 1. Abdominal aortic aneurysm repair 2. Aorto-femoral bypass graft 3. Thoracic aortic aneurysm repair 4. Infra-inguinal open peripheral revascularization
General	<ol style="list-style-type: none"> 1. Laparoscopic appendectomy 2. Hemorrhoidectomy 	<ol style="list-style-type: none"> 1. Open appendectomy 2. Ostomy procedures 3. Inguinal/umbilical hernia repair 4. Laparoscopic lysis of adhesions/obstruction 5. Laparoscopic cholecystectomy 6. Laparoscopic colon resection, segmental, for tumor 	<ol style="list-style-type: none"> 1. Laparoscopic bariatric surgery 2. Open cholecystectomy 3. Hepatic radiofrequency ablation tumor ablation 4. Splenectomy 5. Open colonic segmental resection tumor 6. Laparoscopic colonic abdominal perineal resection 7. Open lysis of adhesions/bowel obstruction

			8. Esophageal Heller myotomy 9. Nissen fundoplication 10. Cancer resection (gastric pull-through) 11. Open bariatric surgery 12. Pancreatic/Whipple resection 13. Gastric resection (tumor/ulcer) 14. Hepatic segmental resection 15. Colonic open abdominal perineal resection
Endocrine	1. Thyroidectomy 2. Parathyroidectomy	1. Adrenalectomy 2. Pheochromocytoma resection	-
Ortho.	1. Shoulder arthroscopy 2. Knee arthroscopy 3. Ankle arthroscopy 4. Closed joint reduction	1. Shoulder arthroplasty 2. Hip fracture pinning	1. Hip/ankle/knee arthroplasty
Thoracic	-	1. Pleural procedures (decortication, pleurodesis) 2. VATS lung biopsy 3. VATS wedge/lobe resection 4. Thymectomy	1. Open wedge/lobe resection 2. Tracheal surgery 3. Lung reduction 4. Pneumonectomy
Neuro-functional	1. Deep brain stimulator placement 2. Seizure mapping procedures	-	-
Neuro-intracranial	-	1. Hydrocephalus shunt/repair 2. Subdural drainage 3. Transsphenoidal resection	1. Intracranial tumor resection 2. Open intracranial aneurysm resection 3. Acoustic neuroma/cranial nerve tumor resection
Neuro/Ortho. Spine	-	1. Laminectomy	1. Spinal fusion 2. Extreme lateral interbody fusion procedures (abdominal)

Genito-urinary	<ol style="list-style-type: none"> 1. Transurethral prostate resection 2. Transurethral bladder tumor resection 3. Ureteral stents 4. Nephrostomy 5. Extracorporeal shock wave lithotripsy 	<ol style="list-style-type: none"> 1. Bladder repair 	<ol style="list-style-type: none"> 1. Radical retropubic prostatectomy 2. Nephrectomy 3. Cystectomy
Gyn.	<ol style="list-style-type: none"> 1. Vaginal hysterectomy 2. Diagnostic gynecologic procedures (laparoscopy) 	<ol style="list-style-type: none"> 1. Total abdominal hysterectomy 2. Bilateral salpingo-oophorectomy 	-
Breast	<ol style="list-style-type: none"> 1. Diagnostic breast surgery (lumpectomy, node dissection) 2. Simple mastectomy 	<ol style="list-style-type: none"> 1. Complex breast surgery 	-
Plastic Surgery	<ol style="list-style-type: none"> 1. Hand 2. Cosmetic procedures 	<ol style="list-style-type: none"> 1. Reconstructive flaps 2. Post-bariatric repair abdominoplasty 	-
Ear, Nose, Throat	<ol style="list-style-type: none"> 1. Diagnostic laryngoscopy 2. Diagnostic esophagoscopy 	<ol style="list-style-type: none"> 1. Nasal septal procedures 2. Functional endoscopic sinus surgery 	<ol style="list-style-type: none"> 1. Head/neck cancer dissection (with/without laryngectomy)
Oral & Maxillofacial Surgery	<ol style="list-style-type: none"> 1. Jaw reduction 	<ol style="list-style-type: none"> 1. Temporomandibular procedures/osteotomy 	-
Podiatry	<ol style="list-style-type: none"> 1. Arthroplasty 2. Toe amputation 3. Bunion procedure 	-	-
Eye	<ol style="list-style-type: none"> 1. Cataract repair 2. Retinal surgery 3. Eye muscle surgery 		
Organ Transplant	-	-	<ol style="list-style-type: none"> 1. Renal Transplant 2. Pancreas Transplant 3. Kidney-Pancreas Combined Transplant 4. Liver

			5. Lung 6. Intestinal
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Non-Indications

→ **Stress echo** is not considered appropriate if **ANY** of the following is true:
[6.16-24](#).

- ◆ The patient has undergone advanced imaging of the same body part within 3 months without undergoing treatment or developing new or worsening symptoms²⁹; **OR**
- ◆ Preoperative clearance for asymptomatic patients for low risk surgery that do not meet necessity criteria^(Table 1); **OR**
- ◆ An acute myocardial infarction within the last 48 hours; **OR**
- ◆ Acute pericarditis/myocarditis; **OR**
- ◆ Critical aortic stenosis; **OR**
- ◆ Uncontrolled or unstable arrhythmias; **OR**
- ◆ Acute aortic dissection; **OR**
- ◆ Unstable angina; **OR**
- ◆ An acute pulmonary embolism or pulmonary infarction; **OR**
- ◆ Patient has an unstable cardiac or pulmonary condition, or cannot tolerate pharmacologic agents to simulate exercise; **OR**
- ◆ The results of the test will not affect the treatment of the patient (e.g., the patient has a severe comorbidity that will likely limit life expectancy or candidacy for revascularization); **OR**
- ◆ To screen for coronary artery disease in patients with no significant signs or symptoms; **OR**
- ◆ To encourage the patient to make lifestyle changes; **OR**
- ◆ To evaluate if the patient qualifies for a non-covered medical treatment (i.e., fitness or weight loss programs); **OR**
- ◆ Severe hypertension (greater than 180/100 mm Hg); **OR**
- ◆ Known allergy or sensitivity to dobutamine; **OR**
- ◆ The procedure will be performed at the same time as **ANY** of the following:
 - Radionuclide ventriculography; **OR**
 - Myocardial perfusion imaging stress test (MPI-SPECT) with or without pharmacological stress.

Level of Care Criteria

Outpatient.

Procedure Codes (HCPCS/CPT)

HCPCS Code	Code Description/Definition
93350	Real time transthoracic echocardiography with

	2-dimensional (2D) image documentation during rest and cardiovascular stress test using treadmill and pharmacologically induced stress, with interpretation and report
93351	Real time transthoracic echocardiography with 2-dimensional (2D) image documentation during rest and cardiovascular stress test using treadmill, bicycle exercise and pharmacologically induced stress, with interpretation and report, including performance of continuous electrocardiographic monitoring, with physician supervision
C8928	Tte w or w/o fol w/con, stress
C8930	Tte w or w/o contr, cont ecg

Medical Evidence

Pellikka et al. (2020) and the American Society of Echocardiography published a range of echocardiography guidelines for the detection and risk assessment of stable ischemic heart disease, made in accordance with the 2015 American College of Cardiology/American Heart Association clinical practice guidelines.²⁵ Stress echocardiography was found to be appropriate as a noninvasive diagnostic and surveillance modality for a variety of pediatric and adult cardiac conditions. In follow-up testing for new or worsening symptoms, stress echo testing was appropriate for patients with suspected stable CAD. Stress echo is also the preferred imaging tool for patients with unexplained dyspnea on exertion. Stress echo is appropriate following revascularization with new cardiac symptoms, especially if refractory to guideline-directed medical therapy (GDMT). Stress echo is uncommonly recommended for preoperative evaluation for noncardiac surgery in this guideline, as well as rarely recommended prior to exercise prescription for cardiac rehabilitation. The absence of radiation makes this imaging modality particularly attractive for pediatric patients, women with indications for noninvasive imaging, serial imaging scenarios, and patients with a history of radiation to the chest. Additionally, stress echo is preferred to studies such as CMR, which involves gadolinium administration, for certain patient subsets – such as those with kidney disease.²⁵

In 2021, Gulati and colleagues developed a multi-society guideline for the evaluation and diagnosis of chest pain. Stress echocardiography was recommended by the committee for determining a range of chest pain etiologies including pericardial effusion, stress cardiomyopathy, and hypertrophic cardiomyopathy. Stress echo may also be utilized to define ischemia severity and for risk stratification after acute coronary syndrome has been ruled out.⁷

Stout et al. (2019) collaborated on behalf of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines to develop the 2018 AHA/ACC guideline for the management of adults with congenital heart disease (ACHD). Based upon the evidence, a strong recommendation was made to limit and monitor radiation exposure during imaging of patients with ACHD due to the potential for multiple exposures in these patients. Exercise stress testing is considered reasonable

for patients with subaortic stenosis to measure exercise capacity, stress-induced arrhythmias and ischemia. Patients with transposition of the great arteries with arterial switch are recommended to have baseline serial imaging and offered if the patient is symptomatic following arterial switch.¹⁰

In the 2020 ACC/AHA guideline for the management of patients with valvular heart disease, Otto et al. state that it is reasonable to use low-dose dobutamine stress echocardiography in patients with suspected low-flow, low gradient severe aortic stenosis with normal left ventricular ejection fraction (stage D3). Stress echocardiography is also recommended in the diagnosis of chronic secondary mitral regurgitation, as well as pre- and during pregnancy evaluation in women with native valvular heart disease.¹¹

A number of recent articles provided recommendations for several common clinical scenarios. [Gulati et al. \(2021\)](#) provided insights into the evaluation and diagnosis of chest pain, [Winchester et al \(2023\)](#) provided appropriate use criteria (AUC) for the detection and risk assessment of chronic coronary disease, and [Doherty et al. \(2024\)](#) updated a previous AUC document for the cardiovascular evaluation for nonemergency, noncardiac surgery, focusing more on ischemic heart disease, valvular heart disease and heart failure (rather than cardiovascular disease in general) and their relation to the risks associated with various types of surgery (solid organ transplant, vascular, non-vascular).^{13,28,30}

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Clinical Guideline Revision History/Information

Original Date: October 7, 2022		
Review History		
Version 2	10/29/2024	Annual review and policy restructure.
Version 3	10/31/2024	Edited repeat imaging criteria language.