Cardiac imaging helps assess the degree of cardiovascular disease (CVD), which is important in stratifying current CVD risk and determining management strategies toward preventing future CVD events. The intent of the “American Society for Preventive Cardiology (ASPC) Top Ten Imaging” is to help primary care clinicians and cardiology specialists keep up with the ever-increasing pace of diagnostic and prognostic imaging studies applicable to preventive cardiology. Imaging studies focused on the heart are often performed by cardiologists and/or radiologists and help with diagnosis and prognosis.
A coronary artery calcium (CAC) score utilizes computed tomography (CT) to assess the amount of calcium found in coronary arteries. In most patients, the higher the CAC score, the higher the atherosclerotic burden and the higher the risk of a subsequent cardiovascular disease (CVD) event.

**IN A SCIENTIFIC STATEMENT FROM THE NATIONAL LIPID ASSOCIATION, CAC SCORING:**
- Aids in ASCVD risk prediction, regardless of race, gender, or ethnicity
- Aids the clinician to allocate statin therapy based on ASCVD risk
- May inform decision-making about add-on therapies to statins, especially if CAC scores are very high
- Aids decision-making about aspirin and anti-hypertensive therapy

**PATIENTS MOST LIKELY TO BENEFIT FROM CAC TESTING**
- Asymptomatic individuals not known to have CVD, but who are 40 years and older without diabetes mellitus
- Individuals in whom primary CVD prevention therapeutics are being considered (e.g., statins)
- Individuals having borderline (5-7.5%) to intermediate (7.5-20%) 10-year ASCVD risk estimate to further stratify risk

**GUIDE TO CAC SCORING**

<table>
<thead>
<tr>
<th>AU</th>
<th>Coronary Plaque Burden</th>
<th>Risk of Event</th>
<th>Statin Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None identified</td>
<td>Low over the next 8 years</td>
<td>N/A</td>
</tr>
<tr>
<td>1-100</td>
<td>Mild</td>
<td>2% in ~2 years</td>
<td>May defer, but repeat CAC in 5 years</td>
</tr>
<tr>
<td>100-400</td>
<td>Moderate</td>
<td>4% in ~2 years</td>
<td>Strong</td>
</tr>
<tr>
<td>&gt;400</td>
<td>Severe</td>
<td>5% 10-year</td>
<td>Strong</td>
</tr>
<tr>
<td>&gt;1000</td>
<td>Extreme</td>
<td>Very high</td>
<td>Strong</td>
</tr>
</tbody>
</table>

AU = Agatston Unit

**REFERENCES:**
Coronary computed tomography angiography (CCTA) is a cardiac imaging study utilizing computed tomography (CT) with an iodine intravenous contrast that can quantify coronary atherosclerotic burden. CCTA has a high negative predictive value, such that if negative, then cardiovascular disease risk is low. 

- **Sensitivity**: 96%
- **Specificity**: 82%

### Patients Most Likely to Benefit from CCTA Testing

| Patients without known coronary heart disease who have chest pain and low to intermediate risk of CVD or related symptoms | In patients with symptoms of chest pain where obstructive coronary artery disease cannot be reasonably established by history and physical exam alone |

### Tips for CCTA Testing

- **CCTA may be helpful to rule out left main coronary artery disease**
- **The contrast with CCTA is contraindicated in patients with contrast dye allergies.**
- **When combined with fractional flow reserve (FFR), CCTA can help determine the functional significance of stenotic lesions.**

- **CCTA is not recommended in patients with extensive coronary calcification (which may occur with older age and kidney failure), cardiac dysrhythmias (including tachycardia), significant obesity, and in patients unable to hold their breath — all which may adversely affect image quality.**

### Equipment

- **CCTA**
Echocardiography utilizes ultrasound waves to provide hemodynamic information about heart function. When accompanied by stress testing, echocardiography is often used to assess myocardial ischemia (i.e., coronary artery atherosclerosis), left ventricular function (i.e., heart failure, cardiomyopathy), structural heart disease (i.e., valvulopathy, congenital heart disease, aneurysm, cardiac tumor, pericarditis, endocarditis, aortic dissection, heart chamber thrombosis).

**APPROACHES TO ECHOCARDIOGRAPHY**

**TRANSTHORACIC ECHOCARDIOGRAPHY**

is the most common approach

**TRANSESOPHAGEAL ECHOCARDIOGRAPHY**

preferred in patients with conditions that compromise transthoracic imaging quality (e.g., obesity, certain lung conditions).

May provide better images of the heart, evidence of potential endocarditis, valve issues, and aorta (i.e., aortic dissection)

**TIPS FOR ECHOCARDIOGRAPHY**

- Doppler echocardiography can assess stroke volume, heart chamber pressure gradients, valvular regurgitations, and intracardiac shunts.
- Echocardiography is commonly used to assess left ventricular ejection fraction, which is “normally” ~ 50-70%. Heart failure with reduced ejection fraction (HFrEF) is defined as heart failure with ejection fraction < 50%.
- While heart failure can occur with reduced ejection fraction, symptomatic heart failure can also occur with preserved ejection fraction (HFpEF) (i.e., ejection fraction ≥ 50%).

**ECHOCARDIOGRAM**

Nuclear myocardial perfusion imaging (MPI) through single photon emission computed tomography (SPECT) utilizes small amounts of nuclear tracer (typically technetium-99 \[^{99m}\text{Tc}\]) injected into the blood to assess myocardial segments that do not take up the tracer (i.e., damaged myocardium) or areas with delayed uptake of the tracer (i.e., ischemic myocardium). Positron emission tomography (PET) perfusion imaging requires injection of radiotracer to evaluate myocardial perfusion. In both cases, imaging is performed at rest, followed by walking on a treadmill with another injection of nuclear contrast or radiotracer (“exercise technetium-99 sestamibe scan”).

SPECT

Can help assess for mild cardiac ischemia.\(^1\)

PET

PET may help identify functional abnormalities suggestive of microvascular coronary artery disease (CAD).\(^3\) Coronary flow reserve can be added to improve cardiovascular disease (CVD) risk assessment.

APPROPRIATE USE FOR MPI

- To assess myocardial perfusion
- To help identify obstructive coronary artery disease as the etiology of chest pain\(^3\)
- In patients with\(^1\):
  - Immobility
  - Cardiac rhythm disorders
  - Impaired kidney function
  - Presence of cardiac devices
- PET has a high sensitivity and specificity to detect anatomic and functional atherosclerotic lesions useful for CVD risk stratification
- PET may help identify functional abnormalities suggestive of microvascular CAD.\(^5\)

STRENGTHS OF PET MPI\(^2\)

- High diagnostic accuracy
- Safety with low radiation exposure (lower than SPECT)
- Efficient with 5-minute image acquisition times (may take only 30 minutes to perform)
- Ability to assess patients with large body habitus
- Ability to accommodate ill or higher-risk patients
- Ability to assess non-obstructive coronary microvascular dysfunction

PET MRI is limited by the low availability of cardiac PET machines and higher costs\(^2\)

REFERENCES:

Cardiac Magnetic Resonance (CMR) is an imaging study that utilizes magnetic, radio frequency waves (not ionizing radiation) to create cross-sectional/2-dimensional, 3-dimensional, and even 4-dimensional images. CMR can help assess ventricular mass, volume, and systolic function and can help evaluate:

- Valvular heart disease
- Cardiac remodeling
- Ischemic heart disease
- Cardiomyopathies, i.e. restrictive, hypertrophic, and dilated cardiomyopathies
- Congenital heart disorders
- Cardiac tumors
- Pericardial disease (i.e. pericarditis)

## Patients Most Likely to Benefit from CMR Imaging

| CMR can provide additional information for patients when an echocardiogram is inconclusive. |
| CMR may be useful for patients with suspected coronary microvascular angina, which may be especially important in some women. |
| CMR can be used to see scar burden, which cannot be obtained from an echo. |
| CMR can be performed in patients with many orthopedic protheses (e.g., titanium), with some exceptions (e.g., certain screws). |

## Contraindications

Due to its magnetic field, CMR should only be performed on patients with devices or implants that are that are certified as CMR safe.

## Sensitivity and Specificity

<table>
<thead>
<tr>
<th>Sensitivity</th>
<th>Specificity</th>
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<tbody>
<tr>
<td>90%</td>
<td>80%</td>
</tr>
</tbody>
</table>

### References