Washington State Health Care Authority

Final key questions

Use of Cardiac Magnetic Resonance Angiography in Adults and Children

Background

Technology of Interest

Cardiac magnetic resonance angiography (CMRA) is an imaging modality that provides a mechanism to assess cardiac or vascular anatomy, function, perfusion, and tissue characteristics in a highly reproducible manner, during a single examination.[1] Images can be acquired in patients with various body types, in a time-efficient fashion, without an invasive procedure or exposure to either ionizing radiation or iodinated intravenous contrast medium.[1]

Clinical Need and Target Populations

CMRA may be useful for identifying coronary artery anomalies and aneurysms, and may be used to assess cardiac structure and function, blood flow, and cardiac and extracardiac conduits, in children and adults with simple and complex congenital heart disease.[1]

CMRA can also be used to determine coronary artery patency in adults with coronary artery disease (CAD), and as a diagnostic modality for patients with suspected anomalous coronary anatomy.[1] CMRA has been used in the assessment of multivessel CAD, especially in patients presenting with a dilated cardiomyopathy in the absence of a clinical history of myocardial infarction.[1]

CMRA is generally considered safe, but there are important safety concerns related to the administration of the gadolinium contrast agents.[1] Harms range from mild and moderate reactions to severe anaphylactic reactions to the contrast agent, as well as the rare complication of nephrogenic systemic fibrosis, particularly among older people, individuals with a history of renal disease or dysfunction, or patients with a prior renal transplant.[1]

Policy Context

There have been a number of CMRA technological advances in the past decade; however, its accuracy and clinical utility for diagnosis in routine clinical practice are unclear. This topic was selected because of medium-level concerns about the safety and efficacy of CMRA and high-level concern about costs.

The objective of the health technology assessment (HTA) is to evaluate the diagnostic validity (i.e., accuracy), clinical utility (i.e., effectiveness), safety, and cost-effectiveness of CMRA in adults with suspected or confirmed CAD, and in children with congenital heart disease. This evidence review will help inform Washington's independent Health Technology Clinical Committee as the committee determines coverage regarding the use of CMRA in adults with CAD and children with congenital heart disease.

Key Questions

1. What is the evidence for the diagnostic validity (i.e., accuracy) and clinical utility (i.e., effectiveness) of CMRA (with or without contrast) in adults with suspected or confirmed CAD and children with suspected or confirmed congenital heart disease? The use of CMRA will be assessed in the following populations:
    a. Adults with suspected CAD (e.g., symptomatic patients)
    b. Adults with suspected coronary vessel anomalies
    c. Adults who have undergone coronary artery bypass graft (CABG) surgery
    d. Adults being assessed for cardiac device lead placement
    e. Children with suspected or confirmed congenital heart disease

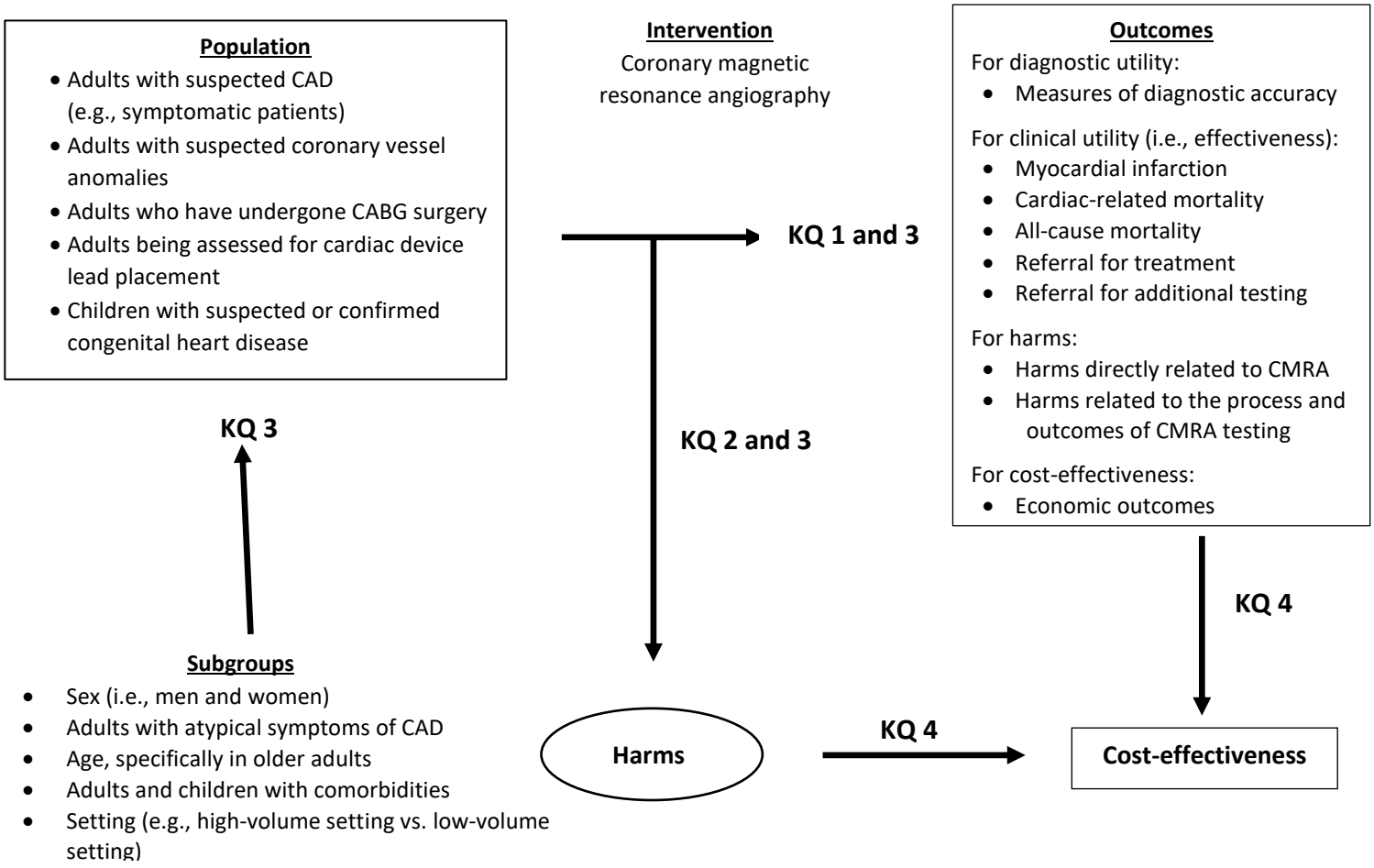
2. What direct harms are associated with CMRA in adults with suspected or confirmed CAD and children with suspected or confirmed congenital heart disease? The harms of CMRA will be assessed in the following populations:
    a. Adults with suspected CAD (e.g., symptomatic patients)
    b. Adults with suspected coronary vessel anomalies
    c. Adults who have undergone CABG surgery
    d. Adults being assessed for cardiac device lead placement
    e. Children with suspected or confirmed congenital heart disease

3. Do important diagnostic validity (i.e., accuracy) outcomes, clinical utility (i.e., effectiveness) outcomes, or direct harms of CMRA in adults with suspected or confirmed CAD and children with suspected or confirmed congenital heart disease vary by the following populations or circumstances?
    a. Sex (i.e., men, women)
    b. Adults with atypical symptoms of CAD
    c. Age, specifically in older adults
    d. Adults and children with comorbidities
    e. Setting (e.g., high-volume setting vs. low-volume setting)

4. What are the cost-effectiveness and other economic outcomes of CMRA in adults with suspected or confirmed CAD and children with suspected or confirmed congenital heart disease? The economic outcomes of CMRA will be assessed in the following populations:
    a. Adults with suspected CAD (e.g., symptomatic patients)
    b. Adults with suspected coronary vessel anomalies
    c. Adults who have undergone CABG surgery
    d. Adults being assessed for cardiac device lead placement
    e. Children with suspected or confirmed congenital heart disease

Analytic Framework

Figure 1. Analytic Framework



Abbreviations. CABG: coronary artery bypass graft; CAD: coronary artery disease; CMRA: cardiac magnetic resonance angiography.

Detailed Inclusion and Exclusion Criteria

Study Component	Inclusion	Exclusion
Populations	• Adult patients (≥ 18 years of age) with symptoms of suspected (previously undiagnosed) CAD who present with ○ Stable (nonemergent) typical or atypical symptoms suspicious for CAD (e.g., chest pain, chest tightness, chest burning, shoulder pain, palpitations, jaw pain, or non-chest pain symptoms, such as dyspnea or worsening effort tolerance) • Adults with suspected coronary vessel anomalies • Adults who have undergone CABG surgery • Adults being assessed for cardiac device lead placement • Infants and children with suspected or confirmed congenital heart disease	• Studies including adults asymptomatic for CAD or adults presenting with an acute cardiac emergency • Studies in pregnant women • Studies in people with atrial fibrillation or heart failure • Studies assessing the use of CMRA in populations other than those specified (e.g., heart transplant patients, assessment of fetal cardiac abnormalities) • Studies assessing the use of MRA for vessels other than coronary vessels
Interventions	• Cardiac magnetic resonance angiography (with or without contrast)	• Other cardiac imaging techniques • MR for cardiac imaging without angiographic evaluation • Novel uses of CMRA • Outdated CMRA equipment or methods of CMRA • Use of CMRA for screening or for monitoring purposes • Use of CMRA for preoperative assessment
Comparators	For diagnostic validity (i.e., accuracy): • Invasive coronary angiography • Coronary computed tomography angiography For clinical utility (i.e., effectiveness), safety, and cost-effectiveness : • Invasive coronary angiography • Other noninvasive testing • Usual care • No testing	• Comparisons of CMRA techniques, algorithms, analytic methods or protocols • Studies without a comparator intervention (except for harms) • Studies with indirect comparisons • Studies with an outdated comparator or a comparator intervention not available in the US • Studies evaluating CMRA for risk prediction or prognostic assessment • Studies published prior to 2000
Outcomes	For diagnostic validity (i.e., accuracy): • Sensitivity and specificity • Positive and negative predictive values • Intra- and inter-rater reliability	Other outcomes not listed • Economic outcomes from studies performed in non-US countries

Study Component	Inclusion	Exclusion

	For clinical utility (i.e., effectiveness):
	• Primary outcomes
	  ○ Myocardial infarction
	  ○ Cardiac-related mortality
	  ○ All-cause mortality
	• Secondary outcomes
	  ○ Referral for treatment
	  ○ Referral for additional testing
	For harms:
	• Harms directly related to CMRA (e.g., severe reaction to the contrast dye, radiation exposure)
	• Harms related to the process and outcomes of CMRA testing (e.g., anxiety requiring sedation during testing, psychological consequences of testing, work days lost)
	For cost-effectiveness:
	• Cost-effectiveness outcomes (e.g., cost per improved outcome) or cost-utility outcomes (e.g., cost per QALY, ICER)
		• Economic outcomes from studies performed in the US that were published more than 5 years ago

Timing	• Any point in the diagnostic workup, including in the emergency setting • After CABG surgery • Prior to cardiac lead placement	• Timing other than those stated
Setting	• Any outpatient or inpatient clinical setting in countries categorized as very high on the UN Human Development Index2	• Emergency settings • Nonclinical settings (e.g., studies in healthy volunteers, animal models of disease) • Countries categorized other than very high on the UN Human Development Index2
Study Design	For Key Questions 1–4: • Randomized controlled trials • Nonrandomized, comparative studies with 10 or more participants in each group Additional studies/data for Key Questions 2 and 3 (harms): • Governmental or other large, multisite registries with 100 or more participants • Databases of procedure-related harms or device recalls (e.g., FDA MAUDE database, FDA Medical Device Recall database) Additional studies/data for Key Question 4:	• Abstracts, conference proceedings, posters, editorials, letters • Nonrandomized, comparative studies with fewer than 10 participants in each group • Studies without a comparator (except for harms) • Proof-of-principle studies (e.g., technology development or technique modification) • Registries with fewer than 100 participants

Study Component	Inclusion	Exclusion
	• Cost-effectiveness studies and other formal comparative economic evaluations For effectiveness, we will search for RCTs and only include observational studies in the absence of RCTs. Studies published in publicly available FDA reports will also be included, if they meet the additional criteria reported above.	
Publication	• Studies in peer-reviewed journals, technology assessments, or publicly available FDA or other US government reports • Published in English • Published since January 2000	• Studies with abstracts that do not allow study characteristics to be determined • Studies that cannot be located • Duplicate publications of the same study that do not report different outcomes or follow-up times, or single site reports from published multicenter studies • Studies in languages other than English

Abbreviations. CABG: coronary artery bypass graft; CAD: coronary artery disease; CMRA: cardiac magnetic resonance angiography; FDA: US Food and Drug Administration; ICER: incremental cost-effectiveness ratio; MAUDE: Manufacturer and User Facility Device Experience; MR: magnetic resonance; MRA: magnetic resonance angiography; MR: magnetic resonance; QALY: quality-adjusted life year; RCT: randomized controlled trial; UN: United Nations.

References

1. Hundley WG, Bluemke DA, Finn JP, et al. ACCF/ACR/AHA/NASCI/SCMR 2010 expert consensus document on cardiovascular magnetic resonance: a report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents. *J Am Coll Cardiol.* 2010;55(23):2614-2662. doi: 10.1016/j.jacc.2009.11.011.
2. United Nations. Human Development Index. 2020; http://hdr.undp.org/en/content/download-data. Accessed March 3, 2021.