Washington State Health Care Authority

Use of Cardiac Magnetic Resonance Angiography in Adults and Children

Draft Key Questions: Public Comment and Response

April 9, 2021

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Use of Cardiac Magnetic Resonance Angiography in Adults and Children

Draft Key Questions: Public Comment and Response

Provided by:

Center for Evidence-based Policy
Oregon Health & Science University

April 9, 2021

Responses to Public Comment on Draft Key Questions

The Center for Evidence-based Policy is an independent vendor contracted to produce evidence assessment reports for the Washington Health Technology Assessment (HTA) program. For transparency, all comments received during the public comment periods are included in this response document. Comments related to program decisions, process, or other matters not pertaining to the evidence report are acknowledged through inclusion only.

Draft key question document comments received:

- Chiara Bucciarelli-Ducci, Chief Executive Officer, and Karen Ordovas, Board of Trustees Secretary Treasurer, Society for Cardiovascular Magnetic Resonance (SCMR)

Specific responses pertaining to submitted comments are shown in Table 1.

Table 1. Responses to Comments on Draft Key Questions for Vagal Nerve Stimulation for Epilepsy and Depression

Comments		Response
Commenter: Chiara Bucciarelli-Ducci, Chief Executive Officer, and Karen Ordovas, Board of Trustees Secretary Treasurer, Society for Cardiovascular Magnetic Resonance (SCMR)		
General Comments:		
This is a document from the Society for Cardiovascular Magnetic Resonance (SCMR) in response to the Washington State Healthcare Authority (WSHA) request for public comments for clinical utility, diagnostic validity, cost-effectiveness and potential harm associated with the use of Cardiovascular Magnetic Resonance Angiography in Adults and Children. The request has particular interest in data relative to adults with suspected CAD (e.g., symptomatic patients), adults with suspected coronary vessel anomalies, adults who have undergone CABG surgery, adults being assessed for cardiac device lead placement, and children with suspected or confirmed congenital heart disease, particularly older children with repaired congenital heart disease. The requested public comment refers only to Cardiovascular Magnetic Resonance Angiography, without and with contrast, so data related to the use of other Cardiovascular Magnetic Resonance applications (and billing codes) are not included in this document. The SCMR is the largest international scientific society for the use of cardiovascular magnetic resonance, and the Executive Board of Directors has prepared this document in collaboration with the SCMR advocacy committee. Response to specific WSHA questions are outlined below.		Thank you for your comments. Please see detailed responses to your specific comments below.
Specific Comments:		
Supporting Evidence: **Adults with suspected CAD**	There are several studies evaluating the diagnostic accuracy of CMRA compared to coronary CTA or invasive coronary angiography for the diagnosis of coronary artery disease. CMRA has very good accuracy for identification of obstructive coronary disease in a clinical research setting. A multicenter study has evaluated the diagnostic accuracy of CMRA in a "real life" environment and has shown that the test performs very well when compared to standard of care. The study included 127 patients with suspected CAD. The areas under the receiver-operator characteristic curve from coronary MRA images according to vessel- and patient-based analyses were 0.91 (95% confidence interval [CI]: 0.87 to 0.95) and 0.87 (95% CI: 0.81 to 0.93), respectively. The sensitivity, specificity, positive and negative predictive values, and accuracy of MRA according to a patient-based analysis were 88% (49 of 56, 95% CI: 75% to 94%), 72% (51 of 71, 95% CI: 60% to 82%), 71% (49 of 69, 95% CI: 59% to 81%), 88% (51 of 58, 95% CI: 76% to 95%), and 79% (100 of 127, 95% CI: 72% to 86%), respectively. The number of studies on coronary MR angiography cost-effectiveness is still limited. An increase in trained investigators and multicenter studies employing up-to-date MR angiographic techniques are essential to prove the value of coronary MR angiography for ruling out significant CAD.	Thank you for this information. We will check the references against our inclusion and exclusion criteria for this report.

Comments		Response
Commenter: Chiara Bucciarelli-Ducci, Chief Executive Officer, and Karen Ordovas, Board of Trustees Secretary Treasurer, Society for Cardiovascular Magnetic Resonance (SCMR)		
	In summary, CMRA can be used as an alternative to CTA and invasive coronary angiography for identification of coronary artery disease, especially in patients with contraindication for iodinated contrast media due to allergy. However, it is not recommended as the first line test for assessment of obstructive coronary artery disease in adults. It must be noted that CMRA is a very useful test in combination with other cardiovascular MR examinations such as stress CMR and Cardiac MRI with and without contrast for anatomy and function, as it can help delineate the culprit coronary lesion causing ischemia or myocardial infarction.	
Supporting Evidence: **Adults with suspected coronary vessel anomalies**	CMRA is the preferred technique for the diagnosis of coronary artery anomaly in adults and children, with a level I indication based on the American Heart Association and American College of Cardiology guideline for management of patients with congenital heart diseases such as coronary anomaly. CMRA has several advantages for diagnosing coronary artery anomalies. CMRA does not require ionizing radiation (likely to be an important consideration among adolescents and younger adults with suspected anomalous CAD) or iodinated contrast agents. Both contrast and non-contrast coronary MRA methods have been used with similar excellent result, including several instances in which the 3D aspects of coronary CMR were of marked utility relative to 2D projection techniques such as invasive coronary angiography. The volumetric nature of CMR makes it ideal in visualizing the proximal course that may not be apparent by two-dimensional projection X-ray angiography. CMRA easily identifies inter-arterial (traveling between the ascending aorta and pulmonary artery) vs. retroaortic coronary anomalies, with greater concern regarding sudden death risk in the former. Navigator-triggered noncontrast coronary CMRA further removes the requirement for exogenous iodinated contrast or Gadolinium agent to image the origin and proximal course of the coronary arteries.	Thank you for the information and the link to the clinical practice guideline. We will check the references against our inclusion and exclusion criteria for this report.
Supporting Evidence: **Adults who have undergone coronary artery bypass graft (CABG) surgery**	There is limited data on the accuracy of coronary MRA for assessment of CABG patency. The largest study in the topic included 86 grafts and showed sensitivity, specificity, and positive and negative predictive values for stenosis in arterial grafts of 95.2%, 96.8%, 80% and 99.4%, respectively, and in venous of 100%, 97.8%, 87.5% and 100%, respectively. CMRA is not recommended as a primary imaging modality for assessment of coronary bypass grafts, but can be used in patients with allergy to iodinated contrast or specific concerns regarding ionizing radiation.	Thank you for this information.
Supporting Evidence:	A few studies have interrogated the accuracy of CMRA for delineation of coronary venous anatomy in preparation for cardiac device lead placement. The largest study included 31 patients who have undergone contrast enhanced high resolution coronary CMR	Thank you for this information.

Comments		Response
Commenter: Chiara Bucciarelli-Ducci, Chief Executive Officer, and Karen Ordovas, Board of Trustees Secretary Treasurer, Society for Cardiovascular Magnetic Resonance (SCMR)		
Adults being assessed for cardiac device lead placement	angiography. That study showed the feasibility of using CMRA for delineation of coronary venous anatomy in all patients studied. Three-dimensional MR coronary vein angiograms can be overlaid onto real-time time acquired x-ray images, to improve guidance for catheter implantation	We will check the references against our inclusion and exclusion criteria for this report.
Supporting Evidence: **Children with suspected or confirmed congenital heart disease**	Cardiovascular MR Angiography is a unique method for assessment of pediatric patients with congenital heart disease. Cardiovascular MRA has level I indication for imaging evaluation of multiple congenital heart diseases in the AHA/ACC guidelines and ECVI guidelines. The method is particularly crucial for assessment of the thoracic aorta, pulmonary arteries, pulmonary veins and baffles/conduits, both before and after the repair of multiple CHD such as coarctation of the aorta, tetralogy of Fallot, partial anomalous pulmonary venous connection and transposition of great arteries. Cardiovascular MRA techniques with and without contrast (time-of-flight, phase contrast, SSFP, and contrast-enhanced magnetic resonance angiography) provide the ability to visualize the moving blood and to generate images of vessel lumens that allow selective display of vascular anatomy in 3D projections. With improvements in scanner speed, it is now possible to perform rapid frame rate MRA, also known as time-resolved MR angiography, allowing direct visualization of flow dynamics, which may be important for assessment of vascular shunts or dissections.	Thank you for the information and the link to the clinical practice guidelines. We will check the references against our inclusion and exclusion criteria for this report.
Supporting Evidence: **Direct harms**	Current American College of Radiology and National kidney foundation consensus statement defines that that there is minimal risk of renal dysfunction associated with the use of gadolinium agent from group II or III, currently in clinical use. The risk of nephrogenic systemic fibrosis (NSF) from group II GBCM in patients with advanced kidney disease is thought to be very low (zero events following 4931 administrations to patients with estimated glomerular filtration rate [eGFR] <30 mL/min per 1.73 m2; upper bounds of the 95% confidence intervals: 0.07% overall, 0.2% for stage 5D chronic kidney disease [CKD], 0.5% for stage 5 CKD and no dialysis). The largest meta-analysis in the field, recently published at JAMA, including group II GBCA administration in stage 4 or 5 CKD showed that the risk of NSK [sic] is less than 0.07%. The authors conclude that the potential diagnostic harms of withholding group II GBCA for indicated examinations may outweigh the risk of NSF in this population. The less than minimal risks discussed here apply equally to the specific populations addressed in this document.	Thank you for this information. We will check the references against our inclusion and exclusion criteria for this report.

Comments		Response
Commenter: Chiara Bucciarelli-Ducci, Chief Executive Officer, and Karen Ordovas, Board of Trustees Secretary Treasurer, Society for Cardiovascular Magnetic Resonance (SCMR)		
Clinical Information: **Subgroups**	A. Sex (i.e., men, women) – In female pregnant patients and those in need of serial imaging, CMRA has advantages compared with iodinating radiation techniques such as CT and conventional coronary angiogram. B. Adults with atypical symptoms of CAD – No specific variability in the utility or harm related to CMRA in this population has been reported. C. Age, specifically in older adults - No specific variability in the utility or harm related to CMRA in this population has been reported. D. Adults and children with comorbidities – In the pediatric population, especially with co-morbidities in need of multiple and serial imaging studies, CMRA has advantages compared with iodinating radiation techniques such as CT and conventional coronary angiogram. E. Setting (e.g., high volume setting vs. low volume setting) - No specific variability in the utility or harm related to CMRA in this population has been reported.	Thank you for this information.
Cost-effectiveness Information: **Subgroups**	A. Adults with suspected CAD (e.g., symptomatic patients) There is little data on cost-effectiveness of coronary MRA compared to coronary CTA or catheter angiography for assessment of patients with suspected CAD, therefore most appropriateness criteria guidelines recommend this test for patients with allergy to iodinated contrast or those with specific concerns regarding radiation exposure with other methods. B. Adults with suspected coronary vessel anomalies There is no specific publication addressing the cost-effectiveness of an imaging approach using CMRA compared to CCTA or invasive coronary angiogram for the diagnosis of patients with anomalous coronary arteries. C. Adults who have undergone CABG surgery There is no specific publication addressing the cost-effectiveness of an imaging approach using CMRA compared to CCTA or invasive coronary angiogram for the assessment of CABG patency or other CABG complications. D. Adults being assessed for cardiac device lead placement There is no specific publication addressing the cost-effectiveness of an imaging approach using CMRA compared to CCTA or invasive coronary angiogram for the assessment of coronary venous anatomy prior to device lead placement. E. Children with suspected or confirmed congenital heart disease	Thank you for this information. We will check the references against our inclusion and exclusion criteria for this report.

Comments		Response
Commenter: Chiara Bucciarelli-Ducci, Chief Executive Officer, and Karen Ordovas, Board of Trustees Secretary Treasurer, Society for Cardiovascular Magnetic Resonance (SCMR)		
	A few studies have demonstrated the ability of a CMRA imaging approach to avoid additional imaging tests or invasive procedures in pediatric patients with CHD, and therefore avoiding expenses. A study evaluating the cost savings after Cardiovascular magnetic resonance imaging in 361 consecutive patients who underwent CMR over a period of 6 months showed that CMR results avoided invasive procedures in 38 (11%) patients and prevented additional diagnostic testing in 26 (7%) patients. Comparison of health care savings using CMR as opposed to current standards of care showed a net cost savings of $833 037, i.e., per patient cost savings of $2308.	
References	• *Leiner, T., Bogaert, J., Friedrich, M.G. et al. SCMR Position Paper (2020) on clinical indications for cardiovascular magnetic resonance. J Cardiovasc Magn Reson 22, 76 (2020). https://doi.org/10.1186/s12968-020-00682-4* • *Sakuma H. Coronary CT versus MR Angiography: The Role of MR Angiography. Radiology 2011, Vol. 258, No. 2.* • *Shingo Kato, Kakuya Kitagawa, Nanaka Ishida, Masaki Ishida, Motonori Nagata, Yasutaka Ichikawa, Kazuhiro Katahira, Yuji Matsumoto, Koji Seo, Reiji Ochiai, Yasuyuki Kobayashi, Hajime Sakuma. Assessment of Coronary Artery Disease Using Magnetic Resonance Coronary Angiography: A National Multicenter Trial, Journal of the American College of Cardiology 2010, volume 56, Issue 12.* • *2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Stout K, Daniels, CJ, Aboulhosn JA et al. Circulation. 2019;139:e698–e800.* • *J Am Coll Cardiology 2010 Sep 14;56(12):983-91.* • *Stauder NI, Klumpp B, Stauder H, Blumenstock G, Fenchel M, Küttner A, Claussen CD, Miller S. Assessment of coronary artery bypass grafts by magnetic resonance imaging. Br J Radiol. 2007 Dec;80(960):975-83.* • *Younger, J.F., Plein, S., Crean, A. et al. Visualization of coronary venous anatomy by cardiovascular magnetic resonance. J Cardiovasc Magn Reson 11, 26 (2009). https://doi.org/10.1186/1532-429X-11-26* • *Magnetic Resonance Coronary Angiography: Where Are We Today? Amedeo Chiribiri, Rene M. Botnar, and Eike Nagel. Curr Cardiol Rep. 2013; 15(2): 328.* • *Use of Intravenous Gadolinium-based Contrast Media in Patients with Kidney Disease: Consensus Statements from the American College of Radiology and the National Kidney Foundation Jeffrey*	Thank you for this information. We will check the references against our inclusion and exclusion criteria for this report.

Comments		Response
Commenter: Chiara Bucciarelli-Ducci, Chief Executive Officer, and Karen Ordovas, Board of Trustees Secretary Treasurer, Society for Cardiovascular Magnetic Resonance (SCMR)		
	C. Weinreb, MD, Roger A. Rodby, MD, Jerry Yee, MD, Carolyn L. Wang, MD, Derek Fine, MD, Robert J. McDonald, MD, PhD, Mark A. Perazella, MD, Jonathan R. Dillman, MD, MS, Matthew S. Davenport, MD From the American College of Radiology, Reston, Va (J.C.W., C.L.W., R.J.M., J.R.D., M.S.D.); National Kidney Foundation, New York, NY (R.A.R., J.Y., D.F., M.A.P.); Radiology 2021; 298:28–35 • *Risk of Nephrogenic Systemic Fibrosis in Patients With Stage 4 or 5 Chronic Kidney Disease Receiving a Group II Gadolinium-Based Contrast AgentA Systematic Review and Meta-analysis. Sean A. Woolen, MD, MS1,2; Prasad R. Shankar, MD1,2; Joel J. Gagnier, ND, MSc, PhD3,4; et al.JAMA Intern Med. 2020;180(2):223-230. doi:10.1001/jamainternmed.2019.5284* • *Kilner PJ, Geva T, Kaemmerer H, Trindade PT, Schwitter J, Webb GD: Recommendations for cardiovascular magnetic resonance in adults with congenital heart disease from the respective working groups of the European Society of Cardiology. European Heart Journal. 2010, 31: 794-805. 10.1093/eurheartj/ehp586.* • *Fratz, S., Chung, T., Greil, G.F. et al. Guidelines and protocols for cardiovascular magnetic resonance in children and adults with congenital heart disease: SCMR expert consensus group on congenital heart disease. J Cardiovasc Magn Reson 15, 51 (2013).* • *E.R. Valsangiacomo Buechel, L. Grosse-Wortmann, S. Fratz, J. Eichhorn, S. Sarikouch, G.F. Greil, P. Beerbaum, C. Bucciarelli-Ducci, B. Bonello, L. Sieverding, J. Schwitter, W.A. Helbing, Document reviewers:, EACVI:, Maurizio Galderisi, Owen Miller, Rosa Sicari, John Simpson, Erik Thaulow, Thor Edvardsen, AEPC:, Konrad Brockmeier, Shakeel Qureshi, Joerg Stein, Indications for cardiovascular magnetic resonance in children with congenital and acquired heart disease: an expert consensus paper of the Imaging Working Group of the AEPC and the Cardiovascular Magnetic Resonance Section of the EACVI, European Heart Journal - Cardiovascular Imaging, Volume 16, Issue 3, March 2015, Pages 281–297* • *Cardiovascular Magnetic Resonance Imaging— Incremental Value in a Series of 361 Patients Demonstrating Cost Savings and Clinical Benefits: An Outcome-Based Study Vinayak A Hegde, Robert WW Biederman, and J Ronald Mikolich. Clinical Medicine Insights: Cardiology Volume 11: 1–10*	

Abbreviation. 2D: 2-dimensional; 3D: 3-dimensional; ACC: American College of Cardiology; AHA: American Heart Association; CABG: coronary artery bypass graft; CAD: coronary artery disease; CCTA: coronary computed tomography angiogram; CHD: congenital heart disease; CI: confidence interval; CKD: chronic kidney disease; CMR: cardiac magnetic resonance; CMRA: cardiac magnetic resonance angiography; CT: computed tomography; CTA: computed tomography angiogram; E[A]CVI: European Association of Cardiovascular Imaging; eGFR: estimated

glomerular filtration rate; GBCA: gadolinium based contrast agents; GBCM: gadolinium based contrast media; JAMA: Journal of the American Medical Association; MR; magnetic resonance; MRA: magnetic resonance angiography; MRI: magnetic resonance imaging; NSF: nephrogenic systemic fibrosis; NSK: nephrogenic systemic fibrosis [assumed]; SCMR: Society for Cardiovascular Magnetic Resonance; SSFP: steady-state free procession.

SOCIETY FOR CARDIOVASCULAR MAGNETIC RESONANCE

To: Washington State Healthcare Authority

From: Society for Cardiovascular Magnetic Resonance

Date: 3/30/21

RE: Request for Comments – CMRA in Adults and Children

This is a document from the Society for Cardiovascular Magnetic Resonance (SCMR) in response to the Washington State Healthcare Authority (WSHA) request for public comments for clinical utility, diagnostic validity, cost-effectiveness and potential harm associated with the use of Cardiovascular Magnetic Resonance Angiography in Adults and Children. The request has particular interest in data relative to adults with suspected CAD (e.g., symptomatic patients), adults with suspected coronary vessel anomalies, adults who have undergone CABG surgery, adults being assessed for cardiac device lead placement, and children with suspected or confirmed congenital heart disease, particularly older children with repaired congenital heart disease.

The requested public comment refers only to Cardiovascular Magnetic Resonance Angiography, without and with contrast, so data related to the use of other Cardiovascular Magnetic Resonance applications (and billing codes) are not included in this document.

The SCMR is the largest international scientific society for the use of cardiovascular magnetic resonance, and the Executive Board of Directors has prepared this document in collaboration with the SCMR advocacy committee. Response to specific WSHA questions are outlined below.

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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)

There are several studies evaluating the diagnostic accuracy of CMRA compared to coronary CTA or invasive coronary angiography for the diagnosis of coronary artery disease. CMRA has very good accuracy for identification of obstructive coronary disease in a clinical research setting. A multicenter study has evaluated the diagnostic accuracy of CMRA in a "real life" environment and has shown that the test performs very well when compared to standard of care. The study included 127 patients with suspected CAD. The areas under the receiver-operator characteristic curve from coronary MRA images according to vessel- and patient-based analyses were 0.91 (95% confidence interval [CI]: 0.87 to 0.95) and 0.87 (95% CI: 0.81 to 0.93), respectively. The sensitivity, specificity, positive and negative predictive values, and accuracy of MRA according to a patient-based analysis were 88% (49 of 56, 95% CI: 75% to 94%), 72% (51 of 71, 95% CI: 60% to 82%), 71% (49 of 69, 95% CI: 59% to 81%), 88% (51 of 58, 95% CI: 76% to 95%), and 79% (100 of 127, 95% CI: 72% to 86%), respectively.

The number of studies on coronary MR angiography cost-effectiveness is still limited. An increase in trained investigators and multicenter studies employing up-to-date MR angiographic techniques are essential to prove the value of coronary MR angiography for ruling out significant CAD.

In summary, CMRA can be used as an alternative to CTA and invasive coronary angiography for identification of coronary artery disease, especially in patients with contraindication for iodinated contrast media due to allergy. However, it is not recommended as the first line test for assessment of obstructive coronary artery disease in adults. It must be noted that CMRA is a very useful test in combination with other cardiovascular MR examinations such as stress CMR and Cardiac MRI with and without contrast for anatomy and function, as it can help delineate the culprit coronary lesion causing ischemia or myocardial infarction.

B. Adults with suspected coronary vessel anomalies

CMRA is the preferred technique for the diagnosis of coronary artery anomaly in adults and children, with a level I indication based on the American Heart Association and American College of Cardiology guideline for management of patients with congenital heart diseases such as coronary anomaly. CMRA has several advantages for diagnosing coronary artery anomalies. CMRA does not require ionizing radiation (likely to be an important consideration among

adolescents and younger adults with suspected anomalous CAD) or iodinated contrast agents. Both contrast and non-contrast coronary MRA methods have been used with similar excellent result, including several instances in which the 3D aspects of coronary CMR were of marked utility relative to 2D projection techniques such as invasive coronary angiography.

The volumetric nature of CMR makes it ideal in visualizing the proximal course that may not be apparent by two-dimensional projection X-ray angiography. CMRA easily identifies inter-arterial (traveling between the ascending aorta and pulmonary artery) vs. retroaortic coronary anomalies, with greater concern regarding sudden death risk in the former. Navigator-triggered noncontrast coronary CMRA further removes the requirement for exogenous iodinated contrast or Gadolinium agent to image the origin and proximal course of the coronary arteries.

C. Adults who have undergone coronary artery bypass graft (CABG) surgery

There is limited data on the accuracy of coronary MRA for assessment of CABG patency. The largest study in the topic included 86 grafts and showed sensitivity, specificity, and positive and negative predictive values for stenosis in arterial grafts of 95.2%, 96.8%, 80% and 99.4%, respectively, and in venous of 100%, 97.8%, 87.5% and 100%, respectively. CMRA is not recommended as a primary imaging modality for assessment of coronary bypass grafts, but can be used in patients with allergy to iodinated contrast or specific concerns regarding ionizing radiation.

D. Adults being assessed for cardiac device lead placement

A few studies have interrogated the accuracy of CMRA for delineation of coronary venous anatomy in preparation for cardiac device lead placement. The largest study included 31 patients who have undergone contrast enhanced high resolution coronary CMR angiography. That study showed the feasibility of using CMRA for delineation of coronary venous anatomy in all patients studied.

Three-dimensional MR coronary vein angiograms can be overlaid onto real-time time acquired x-ray images, to improve guidance for catheter implantation.

E. Children with suspected or confirmed congenital heart disease

Cardiovascular MR Angiography is a unique method for assessment of pediatric patients with congenital heart disease. Cardiovascular MRA has level I indication for imaging evaluation of multiple congenital heart diseases in the AHA/ ACC guidelines and ECVI guidelines. The method is particularly crucial for assessment of the thoracic aorta, pulmonary arteries, pulmonary veins and baffles/conduits, both before and after the repair of multiple CHD such as coarctation of the aorta, tetralogy of Fallot, partial anomalous pulmonary venous connection and transposition of great arteries.

Cardiovascular MRA techniques with and without contrast (time-of-flight, phase contrast, SSFP, and contrast-enhanced magnetic resonance angiography) provide the ability to visualize the moving blood and to generate images of vessel lumens that allow selective display of vascular anatomy in 3D projections. With improvements in scanner speed, it is now possible to perform rapid frame rate MRA, also known as time-resolved MR angiography, allowing direct visualization of flow dynamics, which may be important for assessment of vascular shunts or dissections.

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

Current American College of Radiology and National kidney foundation consensus statement defines that that there is minimal risk of renal dysfunction associated with the use of gadolinium agent from group II or III, currently in clinical use. The risk of nephrogenic systemic fibrosis (NSF) from group II GBCM in patients with advanced kidney disease is thought to be very low (zero events following 4931 administrations to patients with estimated glomerular filtration rate [eGFR] <30 mL/min per 1.73 m^2; upper bounds of the 95% confidence intervals: 0.07% overall, 0.2% for stage 5D chronic kidney disease [CKD], 0.5% for stage 5 CKD and no dialysis).

The largest meta-analysis in the field, recently published at JAMA, including group II GBCA administration in stage 4 or 5 CKD showed that the risk of NSK is less than 0.07%. The authors conclude that the potential diagnostic harms of withholding group II GBCA for indicated examinations may outweigh the risk of NSF in this population.
The less than minimal risks discussed here apply equally to the specific populations addressed in this document.

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) – *In female pregnant patients and those in need of serial imaging, CMRA has advantages compared with iodinating radiation techniques such as CT and conventional coronary angiogram.*

B. Adults with atypical symptoms of CAD – *No specific variability in the utility or harm related to CMRA in this population has been reported.*

C. Age, specifically in older adults - *No specific variability in the utility or harm related to CMRA in this population has been reported.*

D. Adults and children with comorbidities – In the pediatric population, especially with co-morbidities in need of multiple and serial imaging studies, *CMRA has advantages compared with iodinating radiation techniques such as CT and conventional coronary angiogram.*

E. Setting (e.g., high volume setting vs. low volume setting) - *No specific variability in the utility or harm related to CMRA in this population has been reported.*

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)

There is little data on cost-effectiveness of coronary MRA compared to coronary CTA or catheter angiography for assessment of patients with suspected CAD, therefore most appropriateness criteria guidelines recommend this test for patients with allergy to iodinated contrast or those with specific concerns regarding radiation exposure with other methods.

B. Adults with suspected coronary vessel anomalies

There is no specific publication addressing the cost-effectiveness of an imaging approach using CMRA compared to CCTA or invasive coronary angiogram for the diagnosis of patients with anomalous coronary arteries.

C. Adults who have undergone CABG surgery

There is no specific publication addressing the cost-effectiveness of an imaging approach using CMRA compared to CCTA or invasive coronary angiogram for the assessment of CABG patency or other CABG complications.

D. Adults being assessed for cardiac device lead placement

There is no specific publication addressing the cost-effectiveness of an imaging approach using CMRA compared to CCTA or invasive coronary angiogram for the assessment of coronary venous anatomy prior to device lead placement.

E. Children with suspected or confirmed congenital heart disease

A few studies have demonstrated the ability of a CMRA imaging approach to avoid additional imaging tests or invasive procedures in pediatric patients with CHD, and therefore avoiding expenses. A study evaluating the cost savings after Cardiovascular magnetic resonance imaging in 361 consecutive patients who underwent CMR over a period of 6 months showed that CMR results avoided invasive procedures in 38 (11%) pts and prevented additional diagnostic testing in 26 (7%) pts. Comparison of health care savings using CMR as opposed to current standards of care showed a net cost savings of $833 037, ie, per patient cost savings of $2308.

Thank you for your consideration of these comments. If you have questions or require additional information, please contact Karen Ordovas, MD, MAS, SCMR Board Member and Chief, Cardiothoracic Imaging Section, Professor of Radiology, University of Washington, at ordovask@uw.edu.

Sincerely,

Chiara Bucciarelli-Ducci, MD, PhD, FSCMR
Chief Executive Officer
SCMR

Karen Ordovas, MD, MAS, FSCMR
SCMR Board of Trustees Secretary Treasurer

References

Leiner, T., Bogaert, J., Friedrich, M.G. *et al.* SCMR Position Paper (2020) on clinical indications for cardiovascular magnetic resonance. *J Cardiovasc Magn Reson* **22,** 76 (2020). https://doi.org/10.1186/s12968-020-00682-4

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Shingo Kato, Kakuya Kitagawa, Nanaka Ishida, Masaki Ishida, Motonori Nagata, Yasutaka Ichikawa, Kazuhiro Katahira, Yuji Matsumoto, Koji Seo, Reiji Ochiai, Yasuyuki Kobayashi, Hajime Sakuma. Assessment of Coronary Artery Disease Using Magnetic Resonance Coronary Angiography: A National Multicenter Trial, Journal of the American College of Cardiology 2010, volume 56, Issue 12.

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Younger, J.F., Plein, S., Crean, A. *et al.* Visualization of coronary venous anatomy by cardiovascular magnetic resonance. *J Cardiovasc Magn Reson* **11,** 26 (2009). https://doi.org/10.1186/1532-429X-11-26

Magnetic Resonance Coronary Angiography: Where Are We Today? A**medeo Chiribiri, Rene M. Botnar, and Eike Nagel. Curr Cardiol Rep. 2013; 15(2): 328.**

Use of Intravenous Gadolinium-based Contrast Media in Patients with Kidney Disease: Consensus Statements from the American College of Radiology and the National Kidney Foundation Jeffrey C. Weinreb, MD • Roger A. Rodby, MD • Jerry Yee, MD • Carolyn L. Wang, MD • Derek Fine, MD • Robert J. McDonald, MD, PhD • Mark A. Perazella, MD • Jonathan R. Dillman, MD, MS • Matthew S. Davenport, MD From the American College of Radiology,

Reston, Va (J.C.W., C.L.W., R.J.M., J.R.D., M.S.D.); National Kidney Foundation, New York, NY (R.A.R., J.Y., D.F., M.A.P.); Radiology 2021; 298:28–35

Risk of Nephrogenic Systemic Fibrosis in Patients With Stage 4 or 5 Chronic Kidney Disease Receiving a Group II Gadolinium-Based Contrast AgentA Systematic Review and Meta-analysis

Sean A. Woolen, MD, MS[1,2]; Prasad R. Shankar, MD[1,2]; Joel J. Gagnier, ND, MSc, PhD[3,4]; et al.*JAMA Intern Med.* 2020;180(2):223-230. doi:10.1001/jamainternmed.2019.5284

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