Cardiovascular Magnetic Resonance Examination Content Outline

(Outline Summary)

#	Domain	Percentage
1	Prepare for cardiovascular magnetic resonance (CMR) exams	10%
2	Select and perform appropriate protocols for specific clinical scenario	17%
3	Perform CMR exams	18%
4	Interpret CMR exams: normal and abnormal anatomy, function, and physiology	13%
5	Interpret CMR exams: ischemic and nonischemic heart disease	19%
6	Interpret CMR exams: cardiac masses, congenital heart disease, and vascular disease	12%
7	Supervise and/or perform post-processing tasks	11%

(Detailed Outline)

1	Prepare for Cardiovascular Magnetic Resonance (CMR) exams 10%	Knowledge, skill and/or ability related to preparation for CMR exams
1.A	Review medical history, clinical information, and prior studies; consult with referring providers; and perform or direct pretest patient evaluation and education	• Knowledge of clinical indications of CMR studies • Knowledge of appropriate use criteria for CMR • Knowledge of the advantages/disadvantages of CMR compared to other studies • Knowledge of type of information provided by CMR studies • Knowledge of other cardiovascular imaging modalities • Knowledge of MRI safety and classification system • Knowledge of appropriate patient preparation for various CMR studies • Knowledge of cardiovascular pathophysiology • Knowledge of indications/contraindications for contrast agents • Knowledge of indications/contraindications for stress testing • Knowledge of indications/contraindications for
1.B	Evaluate clinical indications considering appropriate use criteria	
1.C	Screen for contraindications for magnetic resonance imaging (MRI), contrast, stress testing, pharmacologic agents, etc.	
1.D	Select an appropriate protocol to answer the clinical question	
1.E	Ensure any implanted devices (e.g., implantable cardioverter defibrillator [ICD], pacemakers) are in magnetic resonance (MR) conditional modes	

		pharmacologic agents
		• Knowledge of MR conditional devices
		• Knowledge of the process for adjusting pulse sequences to image patients with MR conditional devices
		• Ability to recognize need to adjust the programming of an MR conditional device
		• Ability to integrate the most pertinent information from medical history to appropriately select, perform, and interpret CMR study
		• Ability to evaluate the appropriateness of the ordered study
		• Skill in identifying contraindications and recognizing potential risk
2	**Select and perform appropriate protocols for specific clinical scenarios 17%**	**Knowledge, skill and/or ability related to appropriate protocols for specific clinical scenarios**
2.A	Select and perform appropriate protocol for examinations for morphology and function	• Knowledge of which techniques/protocol elements (e.g., pulse sequence, views) best address the clinical question
2.B	Select and perform appropriate protocol for examinations for viability and cardiomyopathy	• Knowledge of MRI physics and instrumentation
2.C	Select and perform appropriate protocol for stress examinations	• Ability to optimize techniques and protocol elements to the specific patient
2.D	Select and perform appropriate protocol for tissue characterization (e.g., T1, T2, T2*) examinations	• Ability to assess a variety of cardiovascular diseases using CMR
2.E	Select and perform appropriate protocol for valvular examinations	
2.F	Select and perform appropriate protocol for examinations of the pericardium	
2.G	Select and perform appropriate protocol to examine masses	
2.H	Select and perform appropriate protocol for examination of implanted devices	
2.I	Select and perform appropriate protocol for examinations for simple congenital defects (e.g., atrial septal defect, ventricular septal defect)	
2.J	Select and perform appropriate protocol for examinations for complex congenital defects	
2.K	Select and perform appropriate protocol for coronary examinations	
2.L	Select and perform appropriate protocol for vascular examinations	
3	**Perform CMR exams 18%**	**Knowledge, skill and/or ability related to performance of CMR exams**
3.A	Monitor patient during study	• Knowledge of required safety procedures in an emergency
3.B	Manage gating and recognize arrhythmias	• Knowledge of pharmacologic agents' mechanisms and

3.C	Oversee the activities of technologists/medical personnel according to institutional protocols	the effects of these agents on the patient • Knowledge of contrast agents, including how they work and their expected effects on patient and CMR study
3.D	Monitor scan quality and findings, and modify protocol as needed	• Ability to safely and effectively administer pharmacologic stress and other agents
3.E	Troubleshoot scanning acquisition problems during study	• Ability to safely and effectively administer contrast agents
3.F	Follow safety guidelines (e.g., MRI safety, emergency situations, SAR)	• Ability to recognize and manage adverse reaction to contrast or other pharmacologic agents
3.G	Administer contrast, pharmacologic agents, etc.	• Ability to recognize arrhythmias and determine their effect on image quality
3.H	Manage reactions to contrast, pharmacologic agents, etc.	• Ability to optimize gating • Ability to modify protocol to differentiate normal variants from pathology
3.I	Understand MR physics	• Ability to identify and manage emergency situations
3.J	Understand physics and principles underlying pulse sequences	• Ability to ensure safety of patient and personnel in MR environment
3.K	Understand MR scanner hardware/instrumentation	• Ability to determine when to adapt or terminate study due to significant arrhythmias
3.L	Understand pulse sequences	• Ability to apply MR principles to optimize image acquisition • Knowledge of MR physics (e.g., basics of spin precession, Larmor equation/frequency, basic MR relaxation properties T1,T2,T2*) • Knowledge of physics and principles underlying pulse sequences (e.g. slice selection, frequency encoding, phase encoding, velocity encoding, saturation and inversion pulses, fat-saturation, gating modes, segmented vs. real-time acquisition) • Knowledge of MR scanner hardware/instrumentation (e.g., superconducting magnet, magnetic field gradient coils, radiofrequency [RF] coils, implications of field strength on CMR exam) • Knowledge of pulse sequences (e.g. gradient echo, spin echo, steady-state free precession, STIR, myocardial tagging, myocardial perfusion, late-gadolinium enhancement, MRA, flow imaging, parametric mapping (T1,T2,T2*), parallel imaging, common artifacts) • Knowledge of implications of field strength (e.g., 1.5T or 3T) on CMR exam • Knowledge of specific absorption rate (SAR) limits
4	**Interpret CMR exams: normal and abnormal anatomy, function, and physiology 13%**	**Knowledge, skill and/or ability related to anatomy, function, and physiology interpretation**
4.A	Assess significant extracardiac and extravascular findings	• Knowledge of the spectrum of normal anatomy and physiology
4.B	Recognize scan artifacts and distinguish from pathology	• Knowledge of standardized reporting protocols • Knowledge of SCMR (Society for Cardiovascular Magnetic Resonance) standardized reporting guidelines
4.C	Recognize normal variants and distinguish from pathology	

4.D	Assess cardiac function	• Knowledge of relevant CMR pathology-specific diagnostic criteria
4.E	Assess cardiac chambers	• Knowledge of prognostic significance of CMR findings
4.F	Assess native/artificial valves	• Knowledge of clinical implications of CMR findings
4.G	Assess pericardium	• Ability to synthesize prior clinical knowledge of the patient with CMR findings (qualitative and quantitative) to formulate a diagnosis
		• Ability to recognize common normal anatomic and physiologic variants
		• Ability to recognize and communicate findings that require immediate action
		• Ability to identify and communicate critical findings
		• Ability to generate differential diagnosis for CMR findings
		• Ability to distinguish artifact from pathology
		• Ability to diagnose pathology
		• Ability to determine breadth of associated findings and information to be reported for specific diagnosis (e.g., aortic aneurysm and coarctation in bicuspid aortic valve)
5	**Interpret CMR exams: ischemic and nonischemic heart disease 19%**	**Knowledge, skill and/or ability related to ischemic and nonischemic heart disease interpretation**
5.A	Assess for ischemia (stress testing)	• All knowledge and skills associated with Domain 4, plus the following:
5.B	Assess ischemic cardiomyopathy and viability	o Knowledge of imaging features of ischemic heart disease/ischemic cardiomyopathy
5.C	Assess nonischemic cardiomyopathy	o Knowledge of imaging features of nonischemic cardiomyopathies
5.D	Assess dilated cardiomyopathy/noncompaction cardiomyopathy	o Ability to distinguish ischemic from nonischemic cardiomyopathy
5.E	Assess iron-overload cardiomyopathy	o Ability to distinguish between different nonischemic cardiomyopathies
5.F	Assess amyloid cardiomyopathy	
5.G	Assess infiltrative cardiomyopathy	
5.H	Assess cardiac sarcoidosis	
5.I	Assess myocarditis	
5.J	Assess hypertrophic cardiomyopathy	
5.K	Assess arrhythmogenic right ventricular cardiomyopathy (ARVC)	
6	**Interpret CMR exams: cardiac masses, congenital heart disease, and vascular disease 12%**	**Knowledge, skill and/or ability related to cardiac masses, congenital heart disease, and vascular disease interpretation**
6.A	Assess cardiac masses (e.g., tumor, thrombus)	• All knowledge and skills associated with Domain 4, plus the following:
6.B	Assess for simple congenital defects (e.g., atrial septal defect, ventricular septal defect)	o Knowledge of common cardiac masses

6.C	Assess for complex congenital defects	○ Knowledge of common and complex congenital defects
6.D	Assess thoracic aorta	○ Knowledge of thoracic and abdominal vascular anatomy
6.E	Assess abdominal aorta	○ Ability to diagnose common congenital abnormalities
6.F	Assess pulmonary artery	○ Ability to differentiate thrombus from other masses
6.G	Assess pulmonary veins	
6.H	Assess coronary anatomy/anomalies	
6.I	Assess vascular anatomy/anomalies	
7	**Supervise and/or perform post-processing tasks 11%**	**Knowledge, skill and/or ability related to post-processing tasks**
7.A	Supervise and/or perform quantification of morphology, volume, and function	• Ability to quantify morphology, volume, and function • Ability to quantify velocity and flow • Ability to quantify vessel sizes (e.g., aorta, main pulmonary artery, pulmonary veins) • Ability to quantify perfusion • Ability to perform quantitative tissue characterization (e.g., T1, T2, extracellular volume [ECV]) • Ability to quantify iron (e.g., T2*) • Ability to perform quantitative LGE • Ability to perform three-dimensional post-processing (e.g., MPR, MIP)
7.B	Supervise and/or perform quantification of velocity and flow	
7.C	Supervise and/or perform quantification of vessel sizes (e.g., aorta, main pulmonary artery, pulmonary veins)	
7.D	Supervise and/or perform quantification of perfusion	
7.E	Supervise and/or perform quantitative tissue characterization (e.g., T1, T2, extracellular volume [ECV])	
7.F	Supervise and/or perform quantification of iron (e.g., T2*)	
7.G	Supervise and/or perform quantitative late gadolinium enhancement (LGE)	
7.H	Supervise and/or perform three-dimensional post-processing (e.g., multiplanar reformat [MPR], maximum intensity projection [MIP])	