Appropriate Use Criteria for Echocardiography
Online Appendix

Echocardiography AUC Update 2010

Second Round Ratings
Moderator Worksheet

#	Indication	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	Median	MADM	Rating	Agree	Disagree
1	Symptoms or conditions potentially related to suspected cardiac etiology including but not limited to chest pain, shortness of breath, palpitations, TIA, stroke, or peripheral embolic event	9	9	9	9	9	9	9	7	9	9	9	9	9	9	9	9	0.1	A	+	
2	Prior testing that is concerning for heart disease or structural abnormality including but not limited to chest X-ray, baseline scout images for stress echocardiogram, ECG, or cardiac biomarkers	9	8	9	9	8	8	9	8	9	9	8	9	8	9	9	9	0.3	A	+	
3	Infrequent APCs or infrequent VPCs without other evidence of heart disease	2	6	2	2	2	2	1	6	3	4	2	1	2	3	3	2	0.9	I	+	
4	Frequent VPCs or exercise-induced VPCs	7	9	9	4	7	8	7	9	9	9	8	9	7	7	8	8	0.9	A	+	
5	Sustained or nonsustained atrial fibrillation, SVT or VT	9	9	9	9	8	9	9	8	9	9	9	9	8	9	8	9	0.2	A	+	
6	Asymptomatic isolated sinus bradycardia	2	1	3	1	2	1	3	3	2	2	3	2	2	4	1	2	0.7	I	+	
7	Clinical symptoms or signs consistent with a cardiac diagnosis known to cause lightheadedness/pre-syncope/syncope (including but not limited to aortic stenosis, hypertrophic cardiomyopathy or heart failure)	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	0.1	A	+	
8	Lightheadedness/pre-sycnope when there are no other symptoms or signs of cardiovascular disease	2	3	3	2	4	2	3	6	5	5	3	5	3	3	2	3	0.7	I		
9	Syncope when there are no other symptoms or signs of cardiovascular disease	5	4	6	3	7	6	7	7	8	6	7	7	4	7	7	7	1.0	A		
10	Initial evaluation of ventricular function (e.g., screening) with no symptoms or signs of cardiovascular disease	2	1	2	2	3	3	3	2	2	2	3	1	3	3	2	2	0.5	I	+	
11	Routine surveillance of ventricular function with known coronary artery disease and no change in clinical status or cardiac exam	3	3	3	3	2	2	1	2	3	3	3	1	3	1	2	3	0.6	I	+	

12	Evaluation of left ventricular function with prior ventricular function evaluation showing normal function (such as prior echocardiogram, left ventriculogram, CT, SPECT, cardiac MRI) in patients in whom there has been no change in clinical status or cardiac exam	2	1	1	2	2	1	1	1	1	2	1	1	1	1	1	1	0.2	I	+	
13	Routine perioperative evaluation of ventricular function with no symptoms or signs of cardiovascular disease	2	1	2	3	2	3	1	3	2	2	3	1	1	3	1	2	0.7	I	+	
14	Routine perioperative evaluation of cardiac structure and function prior to non-cardiac solid organ transplant	4	5	7	6	4	7	7	7	6	5	6	6	3	7	4	6	0.9	U		
15	Evaluation of suspected pulmonary hypertension including evaluation of right ventricular function and estimated pulmonary artery pressure	9	9	9	9	8	9	9	8	9	8	9	9	9	9	8	9	0.2	A	+	
16	Routine surveillance (< 1 year) of known pulmonary hypertension without change in clinical status or cardiac exam	3	3	3	2	3	3	1	3	5	2	4	3	1	3	2	3	0.5	I	+	
17	Routine surveillance (≥ 1 year) of known pulmonary hypertension without change in clinical status or cardiac exam	6	7	7	7	7	7	7	7	6	5	7	5	4	3	7	7	0.8	A		
18	Re-evaluation of known pulmonary hypertension if change in clinical status or cardiac exam or to guide therapy	9	9	9	8	8	9	9	8	9	8	9	9	9	9	8	9	0.3	A	+	
19	Hypotension or hemodynamic instability of uncertain or suspected cardiac etiology	9	9	9	9	9	9	9	9	9	9	9	9	8	9	8	9	0.1	A	+	
20	Assessment of volume status in a critically ill patient	7	7	7	8	4	7	5	3	4	5	7	5	3	7	1	5	1.5	U		
21	Acute chest pain with suspected myocardial infarction and nondiagnostic ECG when a resting echocardiogram can be performed during pain	9	9	9	7	9	9	9	8	9	8	9	9	7	7	7	9	0.7	A	+	
22	Evaluation of a patient without chest pain but with other features of an ischemic equivalent or laboratory markers indicative of ongoing myocardial infarction	9	8	8	7	8	9	9	8	8	8	8	9	7	7	7	8	0.5	A	+	
23	Suspected complication of myocardial ischemia/infarction, including but not limited to acute mitral regurgitation, ventricular septal defect, free-wall rupture/tamponade, shock, right ventricular involvement, heart failure, or thrombus	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0.0	A	+	

24	Initial evaluation of ventricular function following ACS	9	9	9	8	9	9	9	7	8	8	9	9	8	9	7	9	0.5	A	+		
25	Re-evaluation of ventricular function following ACS during recovery phase when results will guide therapy	9	8	8	9	9	9	9	7	9	9	9	9	7	7	8	9	0.6	A	+		
26	Respiratory failure or hypoxemia of uncertain etiology	9	8	9	9	8	7	9	7	7	8	8	9	7	9	8	8	0.6	A	+		
27	Respiratory failure or hypoxemia when a non-cardiac etiology of respiratory failure has been established	6	5	8	6	4	5	5	7	6	5	6	5	3	7	4	5	0.9	U	+		
28	Suspected pulmonary embolism in order to establish diagnosis	7	1	2	6	4	1	1	3	2	3	5	3	1	2	2	2	1.3	I	+		
29	Known acute pulmonary embolism to guide therapy (e.g., thrombectomy and thrombolytics)	7	9	9	9	8	8	9	7	7	8	8	9	6	9	7	8	0.7	A	+		
30	Routine surveillance of prior pulmonary embolism with normal right ventricular function and pulmonary artery systolic pressure	2	1	3	3	1	1	1	3	1	2	2	1	1	1	2	1	0.7	I	+		
31	Re-evaluation of known pulmonary embolism after thrombolysis or thrombectomy for assessment of change in right ventricular function and/or pulmonary artery pressure	8	7	7	7	7	7	9	7	8	6	8	9	5	8	7	7	0.7	A	+		
32	Severe deceleration injury or chest trauma when valve injury, pericardial effusion or cardiac injury are possible or suspected	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	0.1	A	+		
33	Routine evaluation in the setting of mild chest trauma with no ECG changes or biomarker elevation	2	3	3	2	2	1	1	3	2	2	2	1	2	2	2	2	0.4	I	+		
34	Initial evaluation when there is a reasonable suspicion of valvular or structural heart disease	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0.0	A	+		
35	Initial evaluation when there are no other symptoms or signs of valvular or structural heart disease	2	1	3	8	2	3	1	2	3	2	3	1	2	3	1	2	0.9	I	+		
36	Re-evaluation in a patient without valvular disease on prior echocardiogram and no change in clinical status or cardiac exam	1	1	1	2	1	1	1	1	1	1	2	1	1	1	2	1	0.2	I	+		

37	Re-evaluation of known valvular heart disease with a change in clinical status or cardiac exam or to guide therapy	9	9	9	9	9	9	9	9	8	9	9	9	8	9	9	9	0.1	A	+	
38	Routine surveillance (< 3 year) of mild valvular stenosis without change in clinical status or cardiac exam	2	3	3	1	2	3	3	5	2	3	4	1	3	2	2	3	0.7	I	+	
39	Routine surveillance (≥ 3 year) of mild valvular stenosis without change in clinical status or cardiac exam	7	7	7	8	7	7	9	6	7	7	7	7	6	7	8	7	0.4	A	+	
40	Routine surveillance (< 1 year) of moderate or severe valvular stenosis without change in clinical status or cardiac exam	4	3	5	3	4	4	5	3	4	3	3	1	1	3	2	3	0.7	I		
41	Routine surveillance (≥ 1 year) of moderate or severe valvular stenosis without change in clinical status or cardiac exam	8	8	9	8	8	7	9	7	7	8	8	7	7	8	8	8	0.4	A	+	
42	Routine surveillance of trace valvular regurgitation	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	0.1	I	+	
43	Routine surveillance (< 3 years) of mild valvular regurgitation without change in clinical status or cardiac exam	2	1	3	2	2	2	1	3	2	3	3	1	1	2	3	2	0.6	I	+	
44	Routine surveillance (≥ 3 years) of mild valvular regurgitation without change in clinical status or cardiac exam	6	3	6	5	3	4	1	5	5	4	4	3	3	3	3	4	0.9	U		
45	Routine surveillance (< 1 year) of moderate or severe valvular regurgitation without change in clinical status or cardiac exam	5	8	7	7	7	6	5	6	5	5	7	5	4	8	7	6	0.9	U		
46	Routine surveillance (≥ 1 year) of moderate or severe valvular regurgitation without change in clinical status or cardiac exam	8	8	8	9	9	7	9	9	8	8	8	9	8	9	7	8	0.5	A	+	
47	Initial postoperative evaluation of prosthetic valve for establishment of baseline	9	9	9	9	9	7	9	8	9	8	9	9	7	9	7	9	0.5	A	+	
48	Routine surveillance of prosthetic valve if no known or suspected valve dysfunction (< 3 years after valve implantation)	3	3	4	5	3	3	1	3	3	2	4	1	5	3	2	3	0.8	I	+	
49	Routine surveillance of prosthetic valve if no known or suspected valve dysfunction (≥ 3 years after valve implantation)	7	7	7	8	7	6	5	6	5	5	7	5	7	6	7	7	0.7	A		
50	Evaluation of prosthetic valve with suspected dysfunction or a change in clinical status or cardiac exam	9	9	9	9	9	9	9	8	9	9	9	9	9	9	9	9	0.1	A	+	
51	Re-evaluation of known prosthetic valve dysfunction when it would change management or guide therapy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0.0	A	+	
52	Initial evaluation of suspected infective endocarditis with positive blood cultures or a new murmur	9	9	9	9	9	8	9	9	9	9	9	9	9	9	8	9	0.1	A	+	

53	Transient fever without evidence of bacteremia or new murmur	1	1	2	1	2	2	1	3	3	2	2	1	1	3	3	2	0.6	I	+	
54	Transient bacteremia with a pathogen not typically associated with infective endocarditis and/or documented non-endovascular source of infection	2	4	1	2	4	1	5	3	3	3	3	1	1	5	1	3	1.1	I	+	
55	Re-evaluation of infective endocarditis at high risk for progression or complication or with a change in clinical status or cardiac exam	9	9	9	9	9	9	9	9	8	9	9	9	9	8	8	9	0.1	A	+	
56	Routine surveillance of uncomplicated infective endocarditis when no change in management is contemplated	4	2	6	1	2	1	1	6	5	3	4	1	1	5	2	2	1.4	I		
57	Suspected cardiac mass	9	9	9	9	9	7	9	7	9	9	9	9	9	9	8	9	0.3	A	+	
58	Suspected cardiovascular source of embolus	8	9	9	9	9	7	9	8	8	8	8	9	9	9	8	9	0.5	A	+	
59	Suspected pericardial conditions	9	9	7	9	9	8	9	8	8	8	9	9	9	9	8	9	0.4	A	+	
60	Routine surveillance of known small pericardial effusion with no change in clinical status	2	3	3	1	1	1	1	3	2	3	3	1	2	6	1	2	0.9	I	+	
61	Re-evaluation of known pericardial effusion to guide management or therapy	8	9	9	9	8	8	9	7	8	9	9	9	8	8	8	8	0.5	A	+	
62	Guidance of percutaneous noncoronary cardiac procedures including but not limited to pericardiocentesis, septal ablation or RV biopsy	9	9	9	7	9	7	9	9	9	9	9	9	9	8	8	9	0.4	A	+	
63	Evaluation of the ascending aorta in the setting of a known or suspected connective tissue disease or genetic condition that predisposes to aortic aneurysm or dissection (e.g., Marfan syndrome)	9	9	7	9	9	9	5	8	9	8	9	9	9	9	8	9	0.6	A	+	
64	Re-evaluation of known ascending aortic dilation or history of aortic dissection to establish a baseline rate of expansion or when the rate of expansion is excessive	9	9	8	8	9	9	5	9	9	8	9	9	9	7	8	9	0.7	A	+	

65	Re-evaluation of known ascending aortic dilation or history of aortic dissection with a change in clinical status or cardiac exam or when findings may alter management or therapy	9	9	9	9	9	9	5	9	9	9	9	9	9	8	8	9	0.4	A	+	
66	Routine re-evaluation for surveillance of known ascending aortic dilation or history of aortic dissection without a change in clinical status or cardiac exam when findings would not change management or therapy	2	3	4	2	2	2	1	3	3	3	3	2	3	3	3	3	0.5	I	+	
67	Initial evaluation of suspected hypertensive heart disease	8	8	9	7	8	7	9	7	8	7	8	9	7	7	8	8	0.6	A	+	
68	Routine evaluation of systemic hypertension without symptoms or signs of hypertensive heart disease	3	4	3	3	3	1	1	3	3	2	3	1	1	5	2	3	0.9	I	+	
69	Re-evaluation of known hypertensive heart disease without a change in clinical status or cardiac exam	3	4	4	2	4	6	1	5	2	2	5	5	1	4	2	4	1.2	U		
70	Initial evaluation of known or suspected heart failure (systolic or diastolic) based on symptoms, signs or abnormal test results	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	0.1	A	+	
71	Re-evaluation of known heart failure (systolic or diastolic) with a change in clinical status or cardiac exam without a clear precipitating change in medication or diet	9	8	9	8	9	8	9	7	8	8	9	9	7	7	7	8	0.6	A	+	
72	Re-evaluation of known heart failure (systolic or diastolic) with a change in clinical status or cardiac exam with a clear precipitating change in medication or diet	5	4	5	7	3	5	9	3	4	3	4	2	5	7	2	4	1.4	U		
73	Re-evaluation of known heart failure (systolic or diastolic) to guide therapy	8	9	9	9	9	9	9	8	3	5	9	9	7	5	6	9	1.0	A	+	
74	Routine surveillance (< 1 year) of heart failure (systolic or diastolic) when there is no change in clinical status or cardiac exam	3	1	4	3	3	2	1	1	3	2	3	1	1	1	1	2	0.8	I	+	
75	Routine surveillance (≥ 1 year) of heart failure (systolic or diastolic) when there is no change in clinical status or cardiac exam	6	6	7	8	6	6	5	6	3	6	6	1	4	6	1	6	1.1	U		
76	Initial evaluation or re-evaluation after revascularization and/or optimal medical therapy to determine candidacy for device therapy and/or to determine optimal choice of device	9	9	9	9	8	9	9	8	8	9	9	9	7	9	7	9	0.3	A	+	
77	Initial evaluation for cardiac resynchronization therapy (CRT) device optimization after implantation	8	4	7	4	6	6	9	6	6	6	8	5	4	9	8	6	1.3	U		

78	Known implanted pacing device with symptoms possibly due to device complication or suboptimal pacing device settings	8	8	7	8	8	8	9	7	8	8	8	9	7	5	7	8	0.6	A	+	
79	Routine surveillance (< 1 year) of implanted device without change in clinical status or cardiac exam	1	1	3	2	3	1	1	3	1	1	3	1	1	1	1	1	0.5	I	+	
80	Routine surveillance (≥ 1 year) of implanted device without change in clinical status or cardiac exam	3	2	3	6	5	3	1	3	1	3	4	1	3	3	3	3	0.6	I	+	
81	To determine candidacy for ventricular assist device	9	9	9	9	9	9	9	7	9	9	9	9	7	9	8	9	0.3	A	+	
82	Optimization of ventricular assist device settings	7	7	9	7	8	8	9	7	7	8	8	6	5	8	7	7	0.7	A	+	
83	Re-evaluation of signs/symptoms suggestive of ventricular assist device-related complications	9	9	9	9	9	7	9	7	8	9	9	9	7	7	8	9	0.6	A	+	
84	Monitoring for rejection in a cardiac transplant recipient	7	9	7	7	8	7	1	8	8	8	8	5	4	7	7	7	1.1	A	+	
85	Cardiac structure and function evaluation in a potential heart donor	9	9	9	9	9	9	9	8	9	9	9	9	7	9	8	9	0.3	A	+	
86	Initial evaluation of known or suspected cardiomyopathy (e.g., restrictive, infiltrative, dilated, hypertrophic or genetic cardiomyopathy)	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0.0	A	+	
87	Re-evaluation of known cardiomyopathy with a change in clinical status or cardiac exam or to guide therapy	9	8	9	9	9	8	9	9	9	9	9	9	9	8	8	9	0.3	A	+	
88	Routine surveillance (< 1 year) of known cardiomyopathy without change in clinical status or cardiac exam	3	3	4	2	2	1	1	2	3	2	3	2	3	3	1	2	0.7	I	+	
89	Routine surveillance (≥ 1 year) of known cardiomyopathy without change in clinical status or cardiac exam	6	4	6	8	5	5	1	6	4	5	6	5	4	7	2	5	1.2	U	+	
90	Screening evaluation for structure and function in first-degree relatives of a patient with inherited cardiomyopathy	9	9	9	8	8	9	9	7	9	9	8	9	7	7	7	9	0.7	A	+	
91	Baseline and serial re-evaluations in patients undergoing therapy with cardiotoxic agents	9	9	9	9	9	9	9	7	9	8	8	9	7	8	8	9	0.5	A	+	
92	Initial evaluation of known or suspected adult congenital heart disease	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	0.1	A	+	

93	Known adult congenital heart disease with a change in clinical status or cardiac exam	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	0.1	A	+	
94	Re-evaluation to guide therapy in known adult congenital heart disease	9	9	9	9	9	9	9	9	8	9	9	9	9	8	8	9	0.1	A	+	
95	Routine surveillance (< 2 years) of adult congenital heart disease following complete repair • without residual structural or hemodynamic abnormality • without a change in clinical status or cardiac exam	3	5	4	3	4	6	1	3	3	3	3	5	3	6	1	3	1.0	I		
96	Routine surveillance (≥ 2 years) of adult congenital heart disease following complete repair • without residual structural or hemodynamic abnormality • without a change in clinical status or cardiac exam	7	7	6	8	7	9	1	6	6	5	6	5	5	7	7	6	1.1	U		
97	Routine (< 1 year) re-evaluation of congenital heart disease following incomplete or palliative repair • with residual structural or hemodynamic abnormality • without a change in clinical status or cardiac exam	5	5	6	3	6	6	1	5	6	3	6	5	7	5	2	5	1.1	U		
98	Routine (≥ 1 year) re-evaluation of congenital heart disease following incomplete or palliative repair • with residual structural or hemodynamic abnormality • without a change in clinical status or cardiac exam	8	8	7	9	8	9	9	7	8	8	8	7	7	7	8	8	0.5	A	+	
99	Use of TEE when there is a high likelihood of a non-diagnostic TTE due to patient characteristics or inadequate visualization of relevant structures	8	8	7	8	7	7	9	7	8	5	8	8	7	9	8	8	0.6	A	+	
100	Routine use of TEE when a diagnostic TTE is reasonably anticipated to resolve all diagnostic and management concerns	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1	1	0.1	I	+	
101	Re-evaluation of prior TEE finding for interval change (e.g., resolution of thrombus after anticoagulation, resolution of vegetation after antibiotic therapy) when a change in therapy is anticipated	8	8	9	8	8	8	9	7	8	8	8	8	7	8	8	8	0.3	A	+	
102	Surveillance of prior TEE finding for interval change (e.g., resolution of thrombus after anticoagulation, resolution of vegetation after antibiotic therapy) when no change in therapy is anticipated	2	1	2	2	3	2	1	3	3	3	3	1	1	3	2	2	0.5	I	+	
103	Guidance during percutaneous noncoronary cardiac interventions including but not limited to closure device placement, radiofrequency ablation, and percutaneous valve procedures	9	9	9	7	9	7	9	8	9	8	9	9	9	9	7	9	0.5	A	+	
104	Suspected acute aortic pathology including but not limited to dissection/transsection	9	9	9	9	9	9	9	8	9	8	9	9	9	8	8	9	0.3	A	+	
105	Routine assessment of pulmonary veins in an asymptomatic patient status post pulmonary vein isolation	5	1	3	2	4	2	1	3	3	3	3	1	2	3	1	3	0.9	I	+	

106	Evaluation of valvular structure and function to assess suitability for, and assist in planning of, an intervention	9	9	9	9	9	7	9	8	9	7	9	9	9	7	8	9	0.5	A	+	
107	To diagnose infective endocarditis with a low pretest probability (e.g., transient fever, known alternative source of infection or negative blood cultures/atypical pathogen for endocarditis)	3	3	1	2	3	2	1	1	3	3	3	3	1	6	3	3	0.9	I	+	
108	To diagnose infective endocarditis with a moderate or high pre-test probability (e.g., staph bacteremia, fungemia, prosthetic heart valve, or intracardiac device)	9	9	9	9	9	8	9	7	9	8	9	9	9	9	8	9	0.3	A	+	
109	Evaluation for cardiovascular source of embolus with no identified non-cardiac source	9	9	7	9	8	7	9	7	7	7	7	7	7	9	7	7	0.7	A	+	
110	Evaluation for cardiovascular source of embolus with a previously identified non-cardiac source	5	6	5	4	6	4	1	4	4	5	4	4	5	6	6	5	0.8	U	+	
111	Evaluation for cardiovascular source of embolus with a known cardiac source in which a TEE would not change management	1	1	1	1	2	1	1	3	2	2	2	1	1	3	2	1	0.5	I	+	
112	Evaluation to facilitate clinical decision-making with regards to anticoagulation, cardioversion and/or radiofrequency ablation	9	9	8	7	9	7	9	8	8	9	9	9	7	9	7	9	0.7	A	+	
113	Evaluation when a decision has been made to anticoagulate and not to perform cardioversion	3	1	1	2	1	1	1	2	2	1	2	1	2	3	2	2	0.5	I	+	
114	• Low pre-test probability of CAD • ECG interpretable AND able to exercise	4	3	4	3	2	3	1	3	3	2	6	1	2	3	1	3	0.9	I	+	
115	• Low pre-test probability of CAD • ECG uninterpretable OR unable to exercise	8	4	8	4	7	7	5	7	8	5	7	5	7	7	8	7	1.0	A		
116	• Intermediate pre-test probability of CAD • ECG interpretable AND able to exercise	7	7	7	7	7	7	5	7	7	7	7	5	7	7	7	7	0.3	A	+	
117	• Intermediate pre-test probability of CAD • ECG uninterpretable OR unable to exercise	9	9	9	9	9	9	9	8	9	9	9	9	9	7	8	9	0.3	A	+	

118	• High pre-test probability of CAD • Regardless of ECG interpretability and ability to exercise	8	7	7	7	7	7	9	6	8	8	7	5	6	8	7	7	0.6	A	+	
119	• Possible ACS • ECG: no ischemic changes or with LBBB or electronically paced ventricular rhythm • Low-risk TIMI score • Negative troponin levels	8	7	9	7	7	7	9	7	8	7	9	7	7	7	7	7	0.5	A	+	
120	• Possible ACS • ECG: no ischemic changes or with LBBB or electronically paced ventricular rhythm • Low-risk TIMI score • Peak troponin: borderline, equivocal, minimally elevated	8	9	8	7	8	7	9	7	7	7	8	7	6	7	7	7	0.5	A	+	
121	• Possible ACS • ECG: no ischemic changes or with LBBB or electronically paced ventricular rhythm • High-risk TIMI score • Negative troponin levels	8	7	8	4	8	8	9	7	7	7	8	7	7	7	7	7	0.6	A	+	
122	• Possible ACS • ECG: no ischemic changes or with LBBB or electronically paced ventricular rhythm • High-risk TIMI score • Peak troponin: borderline, equivocal, minimally elevated	8	7	8	4	7	8	1	7	5	8	7	5	7	7	7	7	1.0	A	+	
123	Definite ACS	1	1	1	1	2	1	1	3	2	6	1	1	1	3	2	1	0.7	I	+	
124	Low Global CHD risk	1	1	2	1	1	1	1	3	1	1	2	1	1	1	2	1	0.3	I	+	
125	• Intermediate Global CHD risk • ECG interpretable	3	1	3	3	2	3	1	3	3	2	3	1	1	2	2	2	0.7	I	+	

126	• Intermediate Global CHD risk • ECG uninterpretable	5	3	5	4	5	5	1	6	5	3	3	5	3	6	2	5	1.2	U		
127	High Global CHD risk	7	5	7	5	6	6	5	6	7	5	5	5	4	6	4	5	0.6	U	+	
128	No prior CAD evaluation AND no planned coronary angiography	9	7	7	7	8	7	9	7	7	7	8	7	9	7	8	7	0.5	A	+	
129	Sustained VT	8	6	7	7	9	6	1	6	7	5	7	4	7	5	8	7	1.2	A		
130	Frequent PVCs, exercise induced VT, or nonsustained VT	9	9	7	4	8	7	9	7	9	7	8	9	7	7	7	7	0.8	A	+	
131	Infrequent PVCs	3	3	3	1	3	3	1	3	2	2	4	3	3	6	2	3	0.7	I	+	

132	New-onset atrial fibrillation	7	4	6	4	6	5	5	7	9	4	7	9	7	8	2	6	1.4	U		
133	Low Global CHD risk	4	3	4	4	3	3	5	3	3	3	4	5	1	3	2	3	0.7	I		
134	Intermediate or High Global CHD risk	8	7	7	8	8	7	9	7	8	7	8	7	7	7	8	7	0.4	A	+	
135	Troponin elevation without symptoms or additional evidence of ACS	7	8	7	7	7	6	7	7	8	7	7	5	4	7	7	7	0.5	A	+	
136	Coronary calcium Agatston score < 100	2	1	1	1	1	1	1	3	3	2	4	1	2	2	2	2	0.6	I	+	
137	• Low to Intermediate Global CHD risk • Coronary calcium Agatston score between 100 – 400	5	4	6	6	4	4	9	4	5	3	7	5	4	6	2	5	1.2	U	+	
138	• High Global CHD risk • Coronary calcium Agatston score between 100 – 400	7	6	7	6	5	7	9	6	7	5	8	5	4	7	4	6	1.0	U		
139	Coronary calcium Agatston score > 400	7	7	8	6	6	7	9	7	7	5	8	7	4	8	3	7	1.0	A		

140	Abnormal Carotid Intimal Medial Thickness (IMT thickness ≥ 0.9 mm and/or the presence of plaque encroaching into the arterial lumen)	6	7	6	6	5	6	5	2	5	2	7	5	4	6	2	5	1.3	U		
141	Coronary artery stenosis of unclear significance	9	8	7	8	8	8	9	7	6	7	9	8	6	7	8	8	0.6	A	+	
142	• Low Global CHD risk • Last stress imaging study < 2 years ago	1	1	1	1	1	1	1	3	2	1	2	1	1	1	2	1	0.3	I	+	
143	• Low Global CHD risk • Last stress imaging study ≥ 2 years ago	3	2	3	2	2	3	1	3	3	2	3	2	1	3	2	2	0.5	I	+	
144	• Intermediate to High Global CHD risk • Last stress imaging study < 2 years ago	3	1	2	2	2	3	1	3	3	3	4	1	1	6	2	2	0.9	I	+	
145	• Intermediate to High Global CHD risk • Last stress imaging study ≥ 2 years ago	6	3	5	2	5	5	1	4	4	5	6	2	3	7	2	4	1.4	U		
146	• Known CAD on coronary angiography OR prior abnormal stress imaging study • Last stress imaging study < 2 years ago	3	3	5	2	2	3	1	3	3	3	5	1	1	5	2	3	0.9	I	+	
147	• Known CAD on coronary angiography OR prior abnormal stress imaging study • Last stress imaging study ≥ 2 years ago	6	4	6	4	5	5	9	3	5	5	6	2	3	6	2	5	1.3	U		
148	Low Risk Treadmill Score (e.g., Duke)	2	1	2	1	1	1	1	1	2	1	2	1	1	1	2	1	0.3	I	+	
149	Intermediate Risk Treadmill Score (e.g., Duke)	7	8	7	8	7	8	9	7	7	7	8	7	4	7	7	7	0.6	A	+	

150	High Risk Treadmill Score (e.g., Duke)	8	8	5	5	8	7	9	3	8	6	7	7	5	7	2	7	1.3	A		
151	Abnormal coronary angiography OR abnormal prior stress imaging study	9	7	7	7	8	7	9	7	9	7	9	9	4	6	7	7	0.8	A	+	
152	Normal coronary angiography OR normal prior stress imaging study	6	8	8	7	7	6	9	6	5	5	6	8	4	2	1	6	1.5	U		
153	Equivocal, borderline or discordant stress testing where obstructive CAD remains a concern	8	8	9	9	7	7	9	7	8	8	9	9	7	7	7	8	0.7	A	+	
154	Perioperative evaluation for risk assessment	1	1	3	1	1	1	1	3	2	2	2	1	1	3	2	1	0.6	I	+	
155	Moderate to good functional capacity (≥ 4 METs)	3	1	3	3	2	1	1	3	3	3	4	1	2	3	1	3	0.8	I	+	
156	No clinical risk factors	2	1	4	3	2	1	1	3	3	3	3	1	2	3	1	2	0.8	I	+	
157	• Greater than or equal to 1 clinical risk factor • Poor or unknown functional capacity (< 4 METs)	7	7	6	6	7	5	9	6	5	5	6	5	4	5	3	6	0.9	U		
158	Asymptomatic < 1 year post normal catheterization, non-invasive test, or previous revascularization	2	1	4	3	2	1	1	3	1	1	2	1	2	1	1	1	0.7	I	+	

159	Moderate to good functional capacity (≥ 4 METs)	3	3	4	3	3	3	1	3	3	3	5	1	3	3	1	3	0.6	I	+		
160	No clinical risk factors	2	1	6	3	2	3	1	2	2	2	3	1	3	5	1	2	1.0	I	+		
161	• Greater than or equal to 1 clinical risk factor • Poor or unknown functional capacity (< 4 METs)	8	7	8	7	8	5	9	6	7	7	7	7	6	7	4	7	0.7	A	+		
162	Asymptomatic < 1 year post normal catheterization, non-invasive test, or previous revascularization	2	1	4	3	2	1	1	3	2	2	2	1	1	3	1	2	0.7	I	+		
163	• Primary PCI with complete revascularization • No recurrent symptoms	2	1	3	2	3	3	1	1	2	2	3	1	1	3	3	2	0.7	I	+		
164	• Hemodynamically stable, no recurrent chest pain symptoms or no signs of HF • To evaluate for inducible ischemia • No prior coronary angiography since the index event	8	9	7	6	8	7	9	7	7	7	9	7	7	4	8	7	0.8	A	+		
165	Hemodynamically unstable, signs of cardiogenic shock, or mechanical complications	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	0.1	I	+		
166	• Hemodynamically stable, no recurrent chest pain symptoms or no signs of HF • To evaluate for inducible ischemia • No prior coronary angiography since the index event	9	9	9	7	8	7	9	6	8	7	9	7	7	7	8	8	0.9	A	+		

167	Prior to hospital discharge in a patient who has been adequately revascularized	1	1	2	1	1	1	1	3	2	1	2	1	1	1	3	1	0.4	I	+	
168	Prior to initiation of cardiac rehabilitation (as a stand-alone indication)	3	2	6	6	3	3	5	3	2	5	4	1	1	3	2	3	1.1	I		
169	Ischemic equivalent	9	9	9	8	8	7	9	7	8	8	9	9	9	7	8	8	0.7	A	+	
170	• Incomplete revascularization • Additional revascularization feasible	7	7	9	5	7	7	9	8	9	5	8	7	4	7	2	7	1.2	A	+	
171	< 5 years after CABG	5	3	4	2	2	2	1	4	3	2	3	1	1	5	2	2	1.0	I	+	
172	≥ 5 years after CABG	7	6	7	3	5	5	9	7	7	3	6	5	6	7	3	6	1.2	U		
173	< 2 years after PCI	3	3	3	2	2	1	1	2	3	2	4	1	1	5	2	2	0.8	I	+	
174	≥ 2 years after PCI	6	6	6	3	5	4	9	4	3	3	6	5	4	7	3	5	1.3	U		
175	Prior to initiation of cardiac rehabilitation (as a stand-alone indication)	3	2	6	6	3	3	5	3	2	5	3	1	1	3	1	3	1.1	I	+	

176	• Known moderate or severe LV dysfunction • Patient eligible for revascularization • Use of dobutamine only	9	9	9	7	8	9	9	7	8	7	8	9	7	7	8	8	0.7	A	+	
177	Mild mitral stenosis	2	1	2	1	3	3	1	3	3	2	3	1	4	7	2	2	0.9	I	+	
178	Moderate mitral stenosis	5	6	7	5	5	6	9	7	3	5	7	5	4	7	3	5	1.1	U		
179	Severe mitral stenosis	8	7	5	7	8	6	1	7	2	5	3	7	3	7	8	7	1.4	A		
180	Mild aortic stenosis	2	1	2	1	3	3	1	3	3	2	3	1	4	5	3	3	0.9	I	+	
181	Moderate aortic stenosis	5	6	6	6	4	6	9	6	3	6	6	5	4	5	3	6	0.7	U	+	
182	Severe aortic stenosis	8	7	7	5	5	1	1	7	1	3	2	9	3	3	8	5	2.2	U		-
183	Mild mitral regurgitation	2	1	1	1	3	1	1	3	3	1	2	1	4	7	3	2	1.1	I	+	
184	Moderate mitral regurgitation	5	3	6	2	5	6	1	6	5	3	6	5	4	7	3	5	1.3	U		
185	• Severe mitral regurgitation • LV size and function not meeting surgical criteria	7	9	9	7	9	7	9	8	7	6	8	7	3	7	7	7	0.9	A	+	
186	Mild aortic regurgitation	2	1	2	1	3	1	1	3	3	2	2	1	4	5	3	2	0.8	I	+	

187	Moderate aortic regurgitation	5	3	6	3	5	6	1	6	3	3	6	5	4	7	3	5	1.3	U		
188	• Severe aortic regurgitation • LV size and function not meeting surgical criteria	8	9	8	7	9	7	9	8	5	5	7	7	3	7	7	7	0.9	A	+	
189	Mild mitral stenosis	3	8	6	2	7	7	1	7	5	3	3	7	7	5	5	5	1.7	U		-
190	Moderate mitral stenosis	8	8	7	7	7	3	1	8	7	7	8	7	7	7	5	7	1.1	A	+	
191	Severe mitral stenosis	1	1	3	2	2	3	1	4	3	5	3	3	1	3	3	3	0.8	I	+	
192	Severe aortic stenosis	1	1	1	2	2	1	1	2	1	1	2	1	1	3	2	1	0.4	I	+	
193	• Evaluation of equivocal aortic stenosis • Evidence of low cardiac output or LV systolic dysfunction (“low gradient AS”) • Use of dobutamine only	8	8	9	6	8	9	9	9	7	7	8	7	7	8	8	8	0.6	A	+	
194	Mild mitral regurgitation	5	3	5	1	4	1	1	6	7	2	3	1	7	6	8	4	1.9	U		
195	Moderate mitral regurgitation	7	5	7	7	7	7	1	7	7	7	8	7	7	7	8	7	0.7	A	+	
196	• Severe mitral regurgitation • Severe LV enlargement or LV systolic dysfunction	4	1	5	2	2	1	1	4	1	2	4	3	3	4	5	3	1.1	I		
197	Acute moderate or severe mitral or aortic regurgitation	3	1	3	2	1	3	1	3	2	2	3	3	3	3	1	3	0.5	I	+	

198	• Suspected pulmonary hypertension • Normal or borderline elevated estimated RVSP on resting echo study	3	4	6	7	5	6	9	5	6	2	5	5	5	7	5	5	1.1	U		
199	Routine evaluation of patients with known resting pulmonary hypertension	3	1	3	3	4	2	1	3	3	2	2	1	1	5	3	3	0.9	I	+	
200	Re-evaluation of patient with exercise induced pulmonary hypertension to evaluate response to therapy	6	4	7	7	6	4	9	7	5	5	6	5	4	5	4	5	1.1	U	+	
201	• Routine use of contrast • All left ventricular segments visualized on noncontrast images	1	1	1	1	1	1	1	3	1	1	2	1	3	1	1	1	0.3	I	+	
202	• Selective use of contrast • Greater than or equal to 2 contiguous left ventricular segments are NOT seen on noncontrast images	7	9	9	7	8	9	9	7	9	7	8	9	7	7	8	8	0.7	A	+	

# Appropriate		97
# Uncertain		34
# Inappropriate		71
Agreement		160
Disagreement		2
Neither + or -		40

Appropriate Use Criteria for Echocardiography: Related Guideline Recommendations and References

Table 1: TTE for General Evaluation of Cardiac Structure and Function

Indication		ACC/AHA Clinical Document Recommendations
Suspected Cardiac Etiology – General		
1.	Symptoms or conditions potentially related to suspected cardiac etiology including but not limited to chest pain, shortness of breath, palpitations, TIA, stroke, or peripheral embolic event	***Valvular Heart Disease (p. e11)*** **2.1.4. Echocardiography** **Class I** Echocardiography is recommended for patients with heart murmurs and symptoms or signs of heart failure, myocardial ischemia/infarction, syncope, thromboembolism, infective endocarditis, or other clinical evidence of structural heart disease. (Level of Evidence: C). **Heart Failure (p. e9)** **3.1 Recommendations for Initial Clinical Assessment of Patients Presenting With Heart Failure** **Class I** Two-dimensional echocardiography with Doppler should be performed during initial evaluation of patients presenting with HF to assess LVEF, left ventricular size, wall thickness, and valve function. Radionuclide ventriculography can be performed to assess LVEF and volumes. (Level of Evidence: C).
2.	Prior testing that is concerning for heart disease or structural abnormality including but not limited to chest X-ray, baseline scout images for stress echocardiogram, ECG, or cardiac biomarkers	***Valvular Heart Disease (p. e11)*** **2.1.4. Echocardiography** **Class IIa** Echocardiography can be useful for the evaluation of asymptomatic patients with murmurs associated with other abnormal cardiac physical findings or murmurs associated with an abnormal ECG or chest X-ray. (Level of Evidence: C).
Arrhythmias		
3.	Infrequent APCs or infrequent VPCs without other evidence of heart disease	**Not addressed in AHA/ACC Clinical documents**

4.	Frequent VPCs or exercise-induced VPCs	***Ventricular Arrhythmias (p. 1073)*** ***Left Ventricular Function and Imaging*** **Class I** Echocardiography is recommended in patients with ventricular arrhythmias who are suspected of having structural heart disease. (Level of Evidence: B). ***Stable Angina (p. 33)*** **Recommendations for Measurement of Rest LV Function by Echocardiography or Radionuclide Angiography in Patients With Chronic Stable Angina** **Class I** Echocardiography or RNA in patients with complex ventricular arrhythmias to assess LV function. (Level of Evidence: B).
5.	Sustained or nonsustained atrial fibrillation, SVT or VT	***Ventricular Arrhythmias (p. 1073)*** ***Left Ventricular Function and Imaging*** **Class I** Echocardiography is recommended in patients with ventricular arrhythmias who are suspected of having structural heart disease. (Level of Evidence B). ***Stable Angina (p. 33)*** **Recommendations for Measurement of Rest LV Function by Echocardiography or Radionuclide Angiography in Patients With Chronic Stable Angina** **Class I** Echocardiography or RNA in patients with complex ventricular arrhythmias to assess LV function. (Level of Evidence: B). ***Atrial Fibrillation (p.e169, Table 6)*** **Clinical Evaluation of patients with atrial fibrillation** Minimum evaluation includes transthoracic echocardiography, to identify: valvular heart disease, LA/RA size, LV size/function, RV pressure, LV hypertrophy, LA thrombus (low sensitivity), pericardial disease. (No Level of Evidence available).
6.	Asymptomatic isolated sinus bradycardia	**Not addressed in AHA/ACC Clinical documents**
Lightheadedness/Pre-Syncope/Syncope		

7.	Clinical symptoms or signs consistent with a cardiac diagnosis known to cause lightheadedness/pre-syncope/syncope (including but not limited to aortic stenosis, hypertrophic cardiomyopathy or heart failure)	***2006 AHA/ACC Statement on Syncope (p. 475)*** An echocardiogram is a helpful screening test if the history, physical examination, and ECG do not provide a diagnosis or if underlying heart disease is suspected. The echocardiogram is an excellent way to identify underlying heart disease, including valvular disease. It can also suggest pulmonary embolism if pulmonary hypertension or right ventricular enlargement is present. (No Level of Evidence available). ***Valvular Heart Disease (p. e11)*** **2.1.4. Echocardiography** **Class I** Echocardiography is recommended for patients with heart murmurs and symptoms or signs of heart failure, myocardial ischemia/infarction, syncope, thromboembolism, infective endocarditis, or other clinical evidence of structural heart disease. (Level of Evidence: C).
8.	Lightheadedness/pre-sycnope when there are no other symptoms or signs of cardiovascular disease	***2006 AHA/ACC Statement on Syncope 2006 (p. 475)*** An echocardiogram is a helpful screening test if the history, physical examination, and ECG do not provide a diagnosis or if underlying heart disease is suspected. The echocardiogram is an excellent way to identify underlying heart disease, including valvular disease. It can also suggest pulmonary embolism if pulmonary hypertension or right ventricular enlargement is present. (No Level of Evidence available).
9.	Syncope when there are no other symptoms or signs of cardiovascular disease	***2006 AHA/ACC Statement on Syncope 2006 (p. 475)*** An echocardiogram is a helpful screening test if the history, physical examination, and ECG do not provide a diagnosis or if underlying heart disease is suspected. The echocardiogram is an excellent way to identify underlying heart disease, including valvular disease. It can also suggest pulmonary embolism if pulmonary hypertension or right ventricular enlargement is present. (No Level of Evidence available).
Evaluation of Ventricular Function		
10.	Initial evaluation of ventricular function (e.g., screening) with no symptoms or signs of cardiovascular disease	**Not addressed in AHA/ACC Clinical documents**

11.	Routine surveillance of ventricular function with known coronary artery disease and no change in clinical status or cardiac exam	***Stable Angina (p. 33)*** **Resting LV Function (Echocardiographic/Radionuclide Imaging)** **Recommendations for Measurement of Rest LV** **Function by Echocardiography or Radionuclide** **Angiography in Patients With Chronic Stable Angina** **Class III** Routine periodic reassessment of stable patients for whom no new change in therapy is contemplated. (Level of Evidence: C).
12.	Evaluation of left ventricular function with prior ventricular function evaluation showing normal function (such as prior echocardiogram, left ventriculogram, CT, SPECT, cardiac MRI) in patients in whom there has been no change in clinical status or cardiac exam	**Not addressed in AHA/ACC Clinical documents**
Perioperative Evaluation		
13.	Routine perioperative evaluation of ventricular function with no symptoms or signs of cardiovascular disease	***Perioperative Guideline (p. 1711)*** **Assessment of LV Function** **Class III** **Recommendations for Preoperative Noninvasive** **Evaluation of LV Function** Routine perioperative evaluation of LV function in patients is not recommended. (Level of Evidence: B).
14.	Routine perioperative evaluation of cardiac structure and function prior to non-cardiac solid organ transplant	***Perioperative Guideline (p. 1711)*** **Assessment of LV Function** **Class III** **Recommendations for Preoperative Noninvasive** **Evaluation of LV Function** Routine perioperative evaluation of LV function in patients is not recommended. (Level of Evidence: B).
Pulmonary Hypertension		

15.	Evaluation of suspected pulmonary hypertension including evaluation of right ventricular function and estimated pulmonary artery pressure	***2009 ACC/AHA Expert Consensus Document Pulmonary Hypertension (p. 1585)*** If pulmonary hypertension is suspected based on the history, risk factor assessment, and physical examination, an echocardiogram is the next appropriate study. (No Level of Evidence available). **(p.1592)** The most appropriate initial study to evaluate patients in whom pulmonary hypertension is suspected is a Doppler echocardiogram. (No Level of Evidence available).
16.	Routine surveillance (< 1 year) of known pulmonary hypertension without change in clinical status or cardiac exam	***2009 ACC/AHA Expert Consensus Document Pulmonary Hypertension (p. 1601)*** Clinical Course Stable: no increase in symptoms and/or decompensation Echocardiogram Q 12 months or center dependent. (No Level of Evidence available).
17.	Routine surveillance (≥ 1 year) of known pulmonary hypertension without change in clinical status or cardiac exam	***2009 ACC/AHA Expert Consensus Document Pulmonary Hypertension (p. 1601)*** Clinical Course Stable: no increase in symptoms and/or decompensation Echocardiogram Q 12 months or center dependent. (No Level of Evidence available).
18.	Re-evaluation of known pulmonary hypertension if change in clinical status or cardiac exam or to guide therapy	***2009 ACC/AHA Expert Consensus Document Pulmonary Hypertension (p. 1601)*** Unstable: increase in symptoms and/or decompensation Echocardiogram Q 6 to 12 months or center dependent. (No Level of Evidence available).

Table 1 References:

1. Bonow RO, Carabello BA, Chatterjee K, et al. 2008 focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease. J Am Coll Cardiol 2008;52:e1-142.
2. Fuster V, Rydén LE, Cannom DS, et al. ACC/AHA/ESC 2006 Guidelines for the management of patients with atrial fibrillation. J Am Coll Cardiol 2006;48:854-906.
3. McLaughlin VV, Archer SL, Badesch DB, et al. ACCF/AHA 2009 expert consensus document on pulmonary hypertension. J Am Coll Cardiol 2009;53:1573-1619.
4. Strickberger SA, Benson DW, Biaggioni I, et al. AHA/ACCF scientific statement on the evaluation of syncope. J Am Coll Cardiol 2006;47:473-84.
5. Zipes DP, Camm AJ, Borggrefe M, et al. ACC/AHA/ESC 2006 Guidelines for Management of Patients With Ventricular Arrhythmias and

the Prevention of Sudden Cardiac Death. J Am. Coll. Cardiol. 2006; 48: 1064-1108.

Table 2: TTE for Cardiovascular Evaluation in an Acute Setting

Indication		ACC/AHA Clinical Document Recommendations
Hypotension or Hemodynamic Instability		
19.	Hypotension or hemodynamic instability of uncertain or suspected cardiac etiology	**STEMI (p. e95)** **7.6.2. Hypotension** **Class I** Echocardiography should be used to evaluate mechanical complications unless these are assessed by invasive measures. (Level of Evidence: C). ***STEMI (p. e95)*** **7.6.3. Low-Output State** **Class I** Left ventricular function and potential presence of a mechanical complication should be assessed by echocardiography if these have not been evaluated by invasive measures. (Level of Evidence: C). ***STEMI (p. e135)*** ***7.11.1.2. Role of Echocardiography*** **Class I** Echocardiography should be used in patients with STEMI not undergoing LV angiography to assess baseline LV function, especially if the patient is hemodynamically unstable. (Level of Evidence C).
20.	Assessment of volume status in a critically ill patient	**Not addressed in AHA/ACC Clinical documents**
Myocardial Ischemia/Infarction		

21.	Acute chest pain with suspected myocardial infarction and nondiagnostic ECG when a resting echocardiogram can be performed during pain	***Stable Angina (p. 21)*** **Recommendations for Echocardiography for Diagnosis of Cause of Chest Pain in Patients With Suspected Chronic Stable Angina Pectoris** **Class I** Evaluation of extent (severity) of ischemia (e.g., LV segmental wall-motion abnormality) when the echocardiogram can be obtained during pain or within 30 min after its abatement. (Level of Evidence: C). ***STEMI (p. e34)*** **6.2.6. Imaging** **Class I** Imaging studies such as a high-quality portable chest X-ray, transthoracic and/or transesophageal echocardiography, and a contrast chest CT scan or magnetic resonance imaging scan should be used for differentiating STEMI from aortic dissection in patients for whom this distinction is initially unclear. (Level of Evidence: B). **Class IIa** Portable echocardiography is reasonable to clarify the diagnosis of STEMI and allow risk stratification of patients with chest pain who present to the ED, especially if the diagnosis of STEMI is confounded by LBBB or pacing or if there is suspicion of posterior STEMI with anterior ST depressions. (Level of Evidence: B).
22.	Evaluation of a patient without chest pain but with other features of an ischemic equivalent or laboratory markers indicative of ongoing myocardial infarction	***STEMI (p. e34)*** **6.2.6. Imaging** **Class IIa** Portable echocardiography is reasonable to clarify the diagnosis of STEMI and allow risk stratification of patients with chest pain who present to the ED, especially if the diagnosis of STEMI is confounded by LBBB or pacing or if there is suspicion of posterior STEMI with anterior ST depressions. (Level of Evidence: B).
23.	Suspected complication of myocardial ischemia/infarction, including but not limited to acute mitral regurgitation, ventricular septal defect, free-wall	***STEMI (p. e135)*** ***7.11.1.2. Role of Echocardiography*** **Class I** Echocardiography should be used to evaluate patients with inferior STEMI, clinical instability,

	rupture/tamponade, shock, right ventricular involvement, heart failure, or thrombus	and clinical suspicion of RV infarction. (Level of Evidence: C). Echocardiography should be used in patients with STEMI to evaluate suspected complications, including acute MR, cardiogenic shock, infarct expansion, VSD, intracardiac thrombus, and pericardial effusion. (Level of Evidence: C). ***STEMI (p. e95)*** **7.6.2. Hypotension** **Class I** Echocardiography should be used to evaluate mechanical complications unless these are assessed by invasive measures. (Level of Evidence: C). ***STEMI (p. e98)*** **7.6.5. Cardiogenic Shock** **Class I** Echocardiography should be used to evaluate mechanical complications unless these are assessed by invasive measures. (Level of Evidence: C).
Evaluation of Ventricular Function after Acute Coronary Syndrome (ACS)		
24.	Initial evaluation of ventricular function following ACS	***STEMI (p. e135)*** **7.11.1.2. Role of Echocardiography** **Class I** Echocardiography should be used in patients with STEMI not undergoing LV angiography to assess baseline LV function, especially if the patient is hemodynamically unstable. (Level of Evidence: C).
25.	Re-evaluation of ventricular function following ACS during recovery phase when results will guide therapy	***STEMI (p. e134)*** **7.11.1.2. Role of Echocardiography** **Class IIa** Echocardiography is reasonable in patients with STEMI to re-evaluate ventricular function during recovery when results are used to guide therapy. (Level of Evidence: C).
Respiratory Failure		

26.	Respiratory failure or hypoxemia of uncertain etiology	***STEMI (p. e95)*** **7.6.3. Low-Output State** **Class I** Left ventricular function and potential presence of a mechanical complication should be assessed by echocardiography if these have not been evaluated by invasive measures. (Level of Evidence: C).
27.	Respiratory failure or hypoxemia when a non-cardiac etiology of respiratory failure has been established	**Not addressed in AHA/ACC Clinical documents**
Pulmonary Embolism		
28.	Suspected pulmonary embolism in order to establish diagnosis	**Not addressed in AHA/ACC Clinical documents**
29.	Known acute pulmonary embolism to guide therapy (e.g., thrombectomy and thrombolytics)	**Not addressed in AHA/ACC Clinical documents**
30.	Routine surveillance of prior pulmonary embolism with normal right ventricular function and pulmonary artery systolic pressure	**Not addressed in AHA/ACC Clinical documents**
31.	Re-evaluation of known pulmonary embolism after thrombolysis or thrombectomy for assessment of change in right ventricular function and/or	**Not addressed in AHA/ACC Clinical documents**

	pulmonary artery pressure	
Cardiac Trauma		
32.	Severe deceleration injury or chest trauma when valve injury, pericardial effusion or cardiac injury are possible or suspected	**Not addressed in AHA/ACC Clinical documents**
33.	Routine evaluation in the setting of mild chest trauma with no ECG changes or biomarker elevation	**Not addressed in AHA/ACC Clinical documents**

Table 2 References:

1. Antman EM, Anbe DT, Armstrong PW, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction. J Am Coll Cardiol 2004;44:e1-e211.
2. Johnson SB, Kearney PA, Smith MD. Echocardiography in the evaluation of thoracic trauma. Surg Clin North Am 1995;75:193-205.
3. Kushner FG, Hand M, Smith SC Jr, et al. 2009 focused updates: ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction (updating the 2004 guideline and 2007 focused update) and ACC/AHA/SCAI guidelines on percutaneous coronary intervention (updating the 2005 guideline and 2007 focused update) a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2009;54:2205-41.
4. Mollema SA, Nucifora G, Bax JJ. Prognostic value of echocardiography after acute myocardial infarction. Heart 2009;95:1732-45.
5. Mookadam F, Jiamsripong P, Goel R, Warsame TA, Emani UR, Khandheria BK. Critical appraisal on the utility of echocardiography in the management of acute pulmonary embolism. Cardiol Rev 2010;18:29-37.
6. Picard MH, Davidoff R, Sleeper LA, et al. Echocardiographic predictors of survival and response to early revascularization in cardiogenic shock. Circulation 2003;107:279-284.
7. Piérard LA, Lancellotti P. Echocardiography in the emergency room: non-invasive imaging. Heart 2009;95:164-70.
8. Sia YT, O'Meara E, Ducharme A. Role of echocardiography in acute myocardial infarction. Curr Heart Fail Rep 2008;5:189-96.
9. Subramaniam B, Talmor D. Echocardiography for management of hypotension in the intensive care unit. Crit Care Med 2007;35(8 Suppl):S401-7.

10. Torbicki A, Perrier A, Konstantinides S, et al. Guidelines on the diagnosis and management of acute pulmonary embolism: the Task Force for the Diagnosis and Management of Acute Pulmonary Embolism of the European Society of Cardiology (ESC). Eur Heart J 2008;29:2276-315.

Table 3: TTE for Evaluation of Valvular Function

Indication		ACC/AHA Clinical Document Recommendations
Murmur or Click		
34.	Initial evaluation when there is a reasonable suspicion of valvular or structural heart disease	***Valvular Heart Disease (p. e11)*** **2.1.4. Echocardiography** **Class I** Echocardiography is recommended for patients with heart murmurs and symptoms or signs of heart failure, myocardial ischemia/infarction, syncope, thromboembolism, infective endocarditis, or other clinical evidence of structural heart disease. (Level of Evidence: C). ***Valvular Heart Disease (p. e57)*** ***3.6.3.3 Indications for Transthoracic Echocardiography*** **Class I** Transthoracic echocardiography is indicated for baseline evaluation of LV size and function, RV and left atrial size, pulmonary artery pressure, and severity of MR in any patient suspected of having MR. (Level of Evidence: C). ***Stable Angina (p. 21)*** **Recommendations for Echocardiography for Diagnosis of Cause of Chest Pain in Patients With Suspected Chronic Stable Angina Pectoris** **Class I** Patients with systolic murmur suggestive of aortic stenosis or hypertrophic cardiomyopathy. (Level of Evidence: C).
35.	Initial evaluation when there are no other symptoms or signs of valvular or	***Valvular Heart Disease (p. e11)*** **2.1.4. Echocardiography**

	structural heart disease	**Class III** Echocardiography is not recommended for patients who have a grade 2 or softer midsystolic murmur identified as innocent or functional by an experienced observer. (Level of Evidence: C).
36.	Re-evaluation in a patient without valvular disease on prior echocardiogram and no change in clinical status or cardiac exam	**Not addressed in AHA/ACC Clinical documents**
37.	Re-evaluation of known valvular heart disease with a change in clinical status or cardiac exam or to guide therapy	***Valvular Heart Disease (p. e20)*** **3.1.4.1. Echocardiography (Imaging, Spectral, and Color Doppler) in Aortic Stenosis** **Class I** Echocardiography is recommended for re-evaluation of patients with known AS and changing symptoms or signs (Level of Evidence B). ***Valvular Heart Disease (p. e40)*** **3.4.2. Indications for Echocardiography in Mitral Stenosis** **Class I** Echocardiography should be performed for re-evaluation in patients with known MS and changing symptoms or signs. (Level of Evidence: B). ***Valvular Heart Disease (p. e57)*** ***3.6.3.3 Indications for Transthoracic Echocardiography*** **Class I** Transthoracic echocardiography is indicated in patients with MR to evaluate the MV apparatus and LV function after a change in signs or symptoms. (Level of Evidence: C).
Native Valvular Stenosis		
38.	Routine surveillance (< 3 year) of mild valvular stenosis without change in clinical status or cardiac exam	***Valvular Heart Disease (p. e20)*** **3.1.4.1. Echocardiography (Imaging, Spectral, and Color Doppler) in Aortic Stenosis** **Class I** Transthoracic echocardiography is recommended for re-evaluation of asymptomatic patients: every year for severe AS; every 1 to 2 years for moderate AS; and every 3 to 5 years for mild AS.

		(Level of Evidence: B). **3.4.2. Indications for Echocardiography in Mitral Stenosis (p. e40)** **Class IIa** Echocardiography is reasonable in the re-evaluation of asymptomatic patients with MS and stable clinical findings to assess pulmonary artery pressure (for those with severe MS, every year; moderate MS, every 1 to 2 years; and mild MS, every 3 to 5 years). (Level of Evidence: C).
39.	Routine surveillance (≥ 3 year) of mild valvular stenosis without change in clinical status or cardiac exam	***Valvular Heart Disease (p. e20)*** **3.1.4.1. Echocardiography (Imaging, Spectral, and Color Doppler) in Aortic Stenosis** **Class I** Transthoracic echocardiography is recommended for re-evaluation of asymptomatic patients: every year for severe AS; every 1 to 2 years for moderate AS; and every 3 to 5 years for mild AS. (Level of Evidence: B). **3.4.2. Indications for Echocardiography in Mitral Stenosis (p. e40)** **Class IIa** Echocardiography is reasonable in the re-evaluation of asymptomatic patients with MS and stable clinical findings to assess pulmonary artery pressure (for those with severe MS, every year; moderate MS, every 1 to 2 years; and mild MS, every 3 to 5 years). (Level of Evidence: C).
40.	Routine surveillance (< 1 year) of moderate or severe valvular stenosis without change in clinical status or cardiac exam	***Valvular Heart Disease (p. e20)*** **3.1.4.1. Echocardiography (Imaging, Spectral, and Color Doppler) in Aortic Stenosis** **Class I** Transthoracic echocardiography is recommended for re-evaluation of asymptomatic patients: every year for severe AS; every 1 to 2 years for moderate AS; and every 3 to 5 years for mild AS. (Level of Evidence: B). **3.4.2. Indications for Echocardiography in Mitral Stenosis (p. e40)** **Class IIa** Echocardiography is reasonable in the re-evaluation of asymptomatic patients with MS and stable clinical findings to assess pulmonary artery pressure (for those with severe MS, every year; moderate MS, every 1 to 2 years; and mild MS, every 3 to 5 years). (Level of Evidence: C).

41.	Routine surveillance (≥ 1 year) of moderate or severe valvular stenosis without change in clinical status or cardiac exam	***Valvular Heart Disease (p. e20)*** **3.1.4.1. Echocardiography (Imaging, Spectral, and Color Doppler) in Aortic Stenosis** **Class I** Transthoracic echocardiography is recommended for re-evaluation of asymptomatic patients: every year for severe AS; every 1 to 2 years for moderate AS; and every 3 to 5 years for mild AS. (Level of Evidence: B). **3.4.2. Indications for Echocardiography in Mitral Stenosis (p. e40)** **Class IIa** Echocardiography is reasonable in the re-evaluation of asymptomatic patients with MS and stable clinical findings to assess pulmonary artery pressure (for those with severe MS, every year; moderate MS, every 1 to 2 years; and mild MS, every 3 to 5 years). (Level of Evidence: C).
Native Valvular Regurgitation		
42.	Routine surveillance of trace valvular regurgitation	***Valvular Heart Disease (p. e57)*** **Indications for Transthoracic Echocardiography** **Class III** Transthoracic echocardiography is not indicated for routine follow-up evaluation of asymptomatic patients with mild MR and normal LV size and systolic function. (Level of Evidence: C).
43.	Routine surveillance (< 3 years) of mild valvular regurgitation without change in clinical status or cardiac exam	***Valvular Heart Disease (p. e57)*** **Indications for Transthoracic Echocardiography** **Class III** Transthoracic echocardiography is not indicated for routine follow-up evaluation of asymptomatic patients with mild MR and normal LV size and systolic function. (Level of Evidence: C).
44.	Routine surveillance (≥ 3 years) of mild valvular regurgitation without change in clinical status or cardiac exam	***Valvular Heart Disease (p. e57)*** **Indications for Transthoracic Echocardiography** **Class III** Transthoracic echocardiography is not indicated for routine follow-up evaluation of asymptomatic patients with mild MR and normal LV size and systolic function. (Level of

		Evidence: C).
45.	Routine surveillance (< 1 year) of moderate or severe valvular regurgitation without change in clinical status or cardiac exam	***Valvular Heart Disease (p. e57)*** ***3.6.3.3 Indications for Transthoracic Echocardiography*** **Class I** Transthoracic echocardiography is indicated for annual or semiannual surveillance of LV function (estimated by ejection fraction and end-systolic dimension) in asymptomatic patients with moderate to severe MR. (Level of Evidence: C).
46.	Routine surveillance (≥ 1 year) of moderate or severe valvular regurgitation without change in clinical status or cardiac exam	***Valvular Heart Disease (p. e57)*** ***3.6.3.3 Indications for Transthoracic Echocardiography*** **Class I** Transthoracic echocardiography is indicated for annual or semiannual surveillance of LV function (estimated by ejection fraction and end-systolic dimension) in asymptomatic patients with moderate to severe MR. (Level of Evidence: C).
Prosthetic Valve		
47.	Initial postoperative evaluation of prosthetic valve for establishment of baseline	***Valvular Heart Disease (p. e109)*** ***9.3. Follow-Up Visits*** **Class I** For patients with prosthetic heart valves, a history, physical examination, and appropriate tests should be performed at the first postoperative outpatient evaluation, 2 to 4 weeks after hospital discharge. This should include a transthoracic Doppler echocardiogram if a baseline echocardiogram was not obtained before hospital discharge. (Level of Evidence: C).
48.	Routine surveillance of prosthetic valve if no known or suspected valve dysfunction (< 3 years after valve implantation)	***Valvular Heart Disease (p. e109)*** ***9.3. Follow-Up Visits*** **Class III** Routine annual echocardiograms are not indicated in the absence of a change in clinical status in patients with mechanical heart valves or during the first 5 years after valve replacement with a bioprosthetic valve. (Level of Evidence: C).

49.	Routine surveillance of prosthetic valve if no known or suspected valve dysfunction (≥ 3 years after valve implantation)	***Valvular Heart Disease (p. e109)*** ***9.3. Follow-Up Visits*** **Class IIb** Patients with bioprosthetic valves may be considered for annual echocardiograms after the first 5 years in the absence of a change in clinical status. (Level of Evidence: C).
50.	Evaluation of prosthetic valve with suspected dysfunction or a change in clinical status or cardiac exam	***Valvular Heart Disease (p. e109)*** ***9.3. Follow-Up Visits*** **Class I** For patients with prosthetic heart valves, routine follow-up visits should be conducted annually, with earlier re-evaluations (with echocardiography) if there is a change in clinical status. (Level of Evidence: C).
51.	Re-evaluation of known prosthetic valve dysfunction when it would change management or guide therapy	***Valvular Heart Disease (p. e109)*** ***9.3. Follow-Up Visits*** **Class I** For patients with prosthetic heart valves, routine follow-up visits should be conducted annually, with earlier re-evaluations (with echocardiography) if there is a change in clinical status. (Level of Evidence: C).
Infective Endocarditis (Native or Prosthetic Valves)		
52.	Initial evaluation of suspected infective endocarditis with positive blood cultures or a new murmur	***Valvular Heart Disease (p. e73)*** **Transthoracic Echocardiography in Endocarditis** **Class I** Transthoracic echocardiography to detect valvular vegetations with or without positive blood cultures is recommended for the diagnosis of infective endocarditis. (Level of Evidence: B).
53.	Transient fever without evidence of bacteremia or new murmur	**Not addressed in AHA/ACC Clinical documents**
54.	Transient bacteremia with a pathogen not typically associated with infective	**Not addressed in AHA/ACC Clinical documents**

	endocarditis and/or documented non-endovascular source of infection	
55.	Re-evaluation of infective endocarditis at high risk for progression or complication or with a change in clinical status or cardiac exam	***Valvular Heart Disease (p. e73)*** **4.4.1 Transthoracic Echocardiography in Endocarditis** **Class I** Transthoracic echocardiography is recommended for assessment of complications of infective endocarditis (e.g., abscesses, perforation, and shunts). (Level of Evidence: B). Transthoracic echocardiography is recommended to characterize the hemodynamic severity of valvular lesions in known infective endocarditis. (Level of Evidence: B). Transthoracic echocardiography is recommended for reassessment of high-risk patients (e.g., those with a virulent organism, clinical deterioration, persistent or recurrent fever, new murmur, or persistent bacteremia). (Level of Evidence: C).
56.	Routine surveillance of uncomplicated infective endocarditis when no change in management is contemplated	***Valvular Heart Disease (p. e73)*** **4.4.1 Transthoracic Echocardiography in Endocarditis** **Class III** Transthoracic echocardiography is not indicated to re-evaluate uncomplicated (including no regurgitation on baseline echocardiogram) native valve endocarditis during antibiotic treatment in the absence of clinical deterioration, new physical findings or persistent fever. (Level of Evidence: C). **Class IIb** Transthoracic echocardiography may be considered for the re-evaluation of prosthetic valve endocarditis during antibiotic therapy in the absence of clinical deterioration. (Level of Evidence: C).

Table 3 References:

1. Baddour LM, Wilson WR, Bayer AS, et al. Infective endocarditis: diagnosis, antimicrobial therapy, and management of complications: a statement for healthcare professionals from the Committee on Rheumatic Fever, Endocarditis, and Kawasaki Disease, Council on Cardiovascular Disease in the Young, and the Councils on Clinical Cardiology, Stroke, and Cardiovascular Surgery and Anesthesia, American Heart Association: endorsed by the Infectious Diseases Society of America. Circulation 2005;111:e394-e434.

2. Bonow RO, Carabello BA, Chatterjee K, et al. 2008 focused update incorporated into the ACC/AHA 2006 guidelines for the management of patients with valvular heart disease. J Am Coll Cardiol 2008;52:e1-142.
3. Baumgartner H, Hung J, Bermejo J, et al. American Society of Echocardiography; European Association of Echocardiography. Echocardiographic assessment of valve stenosis: EAE/ASE recommendations for clinical practice. J Am Soc Echocardiogr 2009;22:1-23.
4. Bekeredjian R, Grayburn PA. Valvular heart disease: aortic regurgitation. Circulation. 2005;112:125-34.
5. Otto CM. Valvular aortic stenosis: disease severity and timing of intervention. J Am Coll Cardiol 2006;47:2141-51.
6. Zoghbi WA, Chambers JB, Dumesnil JG, et al. American Society of Echocardiography's Guidelines and Standards Committee; Task Force on Prosthetic Valves; J Am Soc Echocardiogr 2009;22:975-1014.

Table 4: TTE for Evaluation of Intracardiac and Extracardiac Structures and Chambers

Indication		**ACC/AHA Clinical Document Recommendations**
57.	Suspected cardiac mass	**Not addressed in AHA/ACC Clinical documents**
58.	Suspected cardiovascular source of embolus	**Not addressed in AHA/ACC Clinical documents**
59.	Suspected pericardial conditions	**Not addressed in AHA/ACC Clinical documents**
60.	Routine surveillance of known small pericardial effusion with no change in clinical status	**Not addressed in AHA/ACC Clinical documents**
61.	Re-evaluation of known pericardial effusion to guide management or therapy	**Not addressed in AHA/ACC Clinical documents**
62.	Guidance of percutaneous noncoronary cardiac procedures including but not limited to pericardiocentesis, septal ablation or RV biopsy	**2009 ASE Recommendations for Clinical Practice: Echocardiography Guided Interventions (p.217)** Echocardiography-guided pericardiocentesis with extended catheter drainage can be performed safely and with efficacy at centers with staff members experienced in this technique.

		Using echocardiography to guide the procedure avoids the radiation associated with fluoroscopy and allows the procedure to be performed in the catheterization laboratory, at the bedside, or in the echocardiography laboratory. Increased safety and markedly lower cost compared with surgery ensure that echocardiography directed pericardiocentesis is a procedure of choice. (No Level of Evidence available). **(p.217)** Echocardiography, particularly TTE, is useful as an adjunctive imaging modality in patients undergoing intracardiac and intravascular biopsy procedures. Although TEE and ICE may offer improved imaging over TTE, the additional risk and cost must be outweighed by significant procedural benefits, and the modalities are recommended for use only in highly selected patients. (No Level of Evidence available). **(p. 222)** Echocardiography is recommended in selecting the appropriate septal perforator during alcohol injection during septal ablation for HOCM. Both TTE and TEE can be used. They provide an assessment of immediate procedural results and allow monitoring for complications. (No Level of Evidence available).

Table 4 References:

1. Appleton CP, Hatle LK, Popp RL. Cardiac Tamponade and pericardial effusion: respiratory variation in transvalvular flow velocities studied by Doppler echocardiography. J Am Coll Cardiol 1988;11:1020-1030.
2. Hoit BD. Pericardial disease and pericardial tamponade. Crit Care Med 2007;35(8 Suppl):S355-64.
3. Lerakis S, Nicholson WJ. Part I: Use of echocardiography in the evaluation of patients with suspected cardioembolic stroke. Am J Med Sci 2005;329:310-6.
4. Nicholson WJ, Triantafyllou A, Helmy T, Lerakis S. Part 2: use of echocardiography in the evaluation of patients with suspected cardioembolic stroke. Am J Med Sci 2005;330:243-6. Review. No abstract available.
5. Silvestry FE, Kerber RE, Brook MM, et al. ASE Recommendations for Clinical Practice: Echocardiography-guided interventions. J Am Soc Echocardiogr 2009;22:213-31.
6. Tsang TS, Enriquez-Sarano M, Freeman WK, et al. Consecutive 1127 therapeutic echocardiographically guided pericardiocenteses: clinical profile, practice patterns and outcomes spanning 21 years. Mayo Clin Proc 2002;77:429-436.

Table 5: TTE for Evaluation of Aortic Disease

Indication		ACC/AHA Clinical Document Recommendations
63.	Evaluation of the ascending aorta in the setting of a known or suspected connective tissue disease or genetic condition that predisposes to aortic aneurysm or dissection (e.g., Marfan syndrome)	***Thoracic Aortic Disease (p. 1519)*** **5.1 Recommendations for Genetic Syndromes** **Class I** An echocardiogram is recommended at the time of diagnosis of Marfan syndrome to determine the aortic root and ascending aortic diameters and 6 months thereafter to determine the rate of enlargement of the aorta. (Level of Evidence: C). Patients with Loeys-Dietz syndrome or a confirmed genetic mutation known to predispose to aortic aneurysms and aortic dissections (*TGFBR1, TGFBR2, FBN1, ACTA2,* or *MYH11*) should undergo complete aortic imaging at initial diagnosis and 6 months thereafter to establish if enlargement is occurring. (Level of Evidence: C). Patients with Turner syndrome should undergo imaging of the heart and aorta for evidence of bicuspid aortic valve, coarctation of the aorta, or dilatation of the ascending thoracic aorta. (Level of Evidence: C). Aortic imaging is recommended for first-degree relatives of patients with thoracic aortic aneurysm and/or dissection to identify those with asymptomatic disease. (Level of Evidence: B). **6.1. Recommendations for Bicuspid Aortic Valve and Associated Congenital Variants in Adults (p.1521)** **Class I** First-degree relatives of patients with a bicuspid aortic valve, premature onset of thoracic aortic disease with minimal risk factors, and/or a familial form of thoracic aortic aneurysm and dissection should be evaluated for the presence of a bicuspid aortic valve and asymptomatic thoracic aortic disease. (Level of Evidence: C). All patients with a bicuspid aortic valve should have both the aortic root and ascending thoracic aorta evaluated for evidence of aortic dilatation. (Level of Evidence: B).

		Valvular Heart Disease (p. e38) **3.3. Bicuspid Aortic Valve With Dilated Ascending Aorta** **Class I** Patients with known bicuspid aortic valves should undergo an initial transthoracic echocardiogram to assess the diameters of the aortic root and ascending aorta. (Level of Evidence: B).
64.	Re-evaluation of known ascending aortic dilation or history of aortic dissection to establish a baseline rate of expansion or when the rate of expansion is excessive	***Thoracic Aortic Disease (p. 1519*)** **5.1 Recommendations for Genetic Syndromes** **Class I** An echocardiogram is recommended at the time of diagnosis of Marfan syndrome to determine the aortic root and ascending aortic diameters and 6 months thereafter to determine the rate of enlargement of the aorta. (Level of Evidence: C). Annual imaging is recommended for patients with Marfan syndrome if stability of the aortic diameter is documented. If the maximal aortic diameter is 4.5 cm or greater, or if the aortic diameter shows significant growth from baseline, more frequent imaging should be considered. (Level of Evidence: C). Patients with Loeys-Dietz syndrome or a confirmed genetic mutation known to predispose to aortic aneurysms and aortic dissections (*TGFBR1, TGFBR2, FBN1, ACTA2,* or *MYH11*) should undergo complete aortic imaging at initial diagnosis and 6 months thereafter to establish if enlargement is occurring. (Level of Evidence: C).
65.	Re-evaluation of known ascending aortic dilation or history of aortic dissection with a change in clinical status or cardiac exam or when findings may alter management or therapy	***Thoracic Aortic Disease (p. 1519)*** **5.1 Recommendations for Genetic Syndromes** **Class I** Annual imaging is recommended for patients with Marfan syndrome if stability of the aortic diameter is documented. If the maximal aortic diameter is 4.5 cm or greater, or if the aortic diameter shows significant growth from baseline, more frequent imaging should be considered. (Level of Evidence: C). Patients with Loeys-Dietz syndrome or a confirmed genetic mutation known to predispose to aortic aneurysms and aortic dissections (*TGFBR1, TGFBR2, FBN1, ACTA2,* or *MYH11*) should undergo complete aortic imaging at initial diagnosis and 6 months thereafter to establish if enlargement is occurring. (Level of Evidence: C).

		Patients with Turner syndrome should undergo imaging of the heart and aorta for evidence of bicuspid aortic valve, coarctation of the aorta, or dilatation of the ascending thoracic aorta. If initial imaging is normal and there are no risk factors for aortic dissection, repeat imaging should be performed every 5 to 10 years or if otherwise clinically indicated. If abnormalities exist, annual imaging or follow-up imaging should be done. (Level of Evidence: C). ***Thoracic Aortic Disease (p. 1532)*** **20. Counseling and Management of Chronic Aortic Diseases in Pregnancy** **Class I** For all pregnant women with known aortic root or ascending aortic dilatation, monthly or bimonthly echocardiographic measurements of the ascending aortic dimensions are recommended to detect aortic expansion until birth. (Level of Evidence: C). ***Adults with Congenital Heart Disease (p. e190)*** **6.7. Recommendations for Key Issues to Evaluate and Follow-Up** **Class I** Serial imaging assessment of aortic root anatomy is recommended for all patients with BAV, regardless of severity. The frequency of imaging would depend on the size of the aorta at initial assessment: if less than 40 mm, it should be reimaged approximately every 2 years; if greater than or equal to 40 mm, it should be reimaged yearly or more often as progression of root dilation warrants or whenever there is a change in clinical symptoms or findings. (Level of Evidence: B).
66.	Routine re-evaluation for surveillance of known ascending aortic dilation or history of aortic dissection without a change in clinical status or cardiac exam when findings would not change management or therapy	**Not addressed in AHA/ACC Clinical documents**

Table 5 References:

1. Biner S, Rafique AM, Ray I, Cuk O, Siegel RJ, Tostrup K. Aortopathy is prevalent in relatives of bicuspid valve patients. J Am Coll Cardiol 2009;53:2296-7.

2. Goldstein SA, Mintz GS, Lindsay J Jr. Aorta: comprehensive evaluation by echocardiography and transesophageal echocardiography. J Am Soc

Echocardiogr 1993;6:634-59.
3. Hiratzka LF, Bakris GL, Beckman JA, et al. 2010 ACCF/AHA/AATS/ ACR/ ASA/ SCA/ SCAI/ SIR/ STS/ SVM Guidelines for the diagnosis and management of patients with thoracic aortic disease: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. J Am Coll Cardiol 2010;55:1509-1544.

Table 6. TTE for Evaluation of Hypertension, Heart Failure, or Cardiomyopathy

Indication		**ACC/AHA Clinical Document Recommendations**
	Hypertension	
67.	Initial evaluation of suspected hypertensive heart disease	**Not addressed in AHA/ACC Clinical documents**
68.	Routine evaluation of systemic hypertension without symptoms or signs of hypertensive heart disease	**Not addressed in AHA/ACC Clinical documents**
69.	Re-evaluation of known hypertensive heart disease without a change in clinical status or cardiac exam	**Not addressed in AHA/ACC Clinical documents**
	Heart Failure	
70.	Initial evaluation of known or suspected heart failure (systolic or diastolic) based on symptoms, signs or abnormal test results	***Heart Failure (p. e9)*** **Recommendations for the Initial Clinical Assessment of Patients Presenting With HF** **Class I** Two-dimensional echocardiography with Doppler should be performed during initial evaluation of patients presenting with HF to assess LVEF, left ventricular size, wall thickness, and valve function. Radionuclide ventriculography can be performed to assess LVEF and volumes. (Level of Evidence: C).
71.	Re-evaluation of known heart failure (systolic or diastolic) with a change in	***Heart Failure (p. e10)*** **Recommendations for Serial Clinical Assessment of Patients Presenting With HF**

	clinical status or cardiac exam without a clear precipitating change in medication or diet	**Class IIa** Repeat measurement of EF and the severity of structural remodeling can provide useful information in patients with HF who have had a change in clinical status or who have experienced or recovered from a clinical event or received treatment that might have had a significant effect on cardiac function. (Level of Evidence: C).
72.	Re-evaluation of known heart failure (systolic or diastolic) with a change in clinical status or cardiac exam with a clear precipitating change in medication or diet	**Not addressed in AHA/ACC Clinical documents**
73.	Re-evaluation of known heart failure (systolic or diastolic) to guide therapy	**Not addressed in AHA/ACC Clinical documents**
74.	Routine surveillance (< 1 year) of heart failure (systolic or diastolic) when there is no change in clinical status or cardiac exam	**Not addressed in AHA/ACC Clinical documents**
75.	Routine surveillance (≥ 1 year) of heart failure (systolic or diastolic) when there is no change in clinical status or cardiac exam	**Not addressed in AHA/ACC Clinical documents**
Device Evaluation (including pacemaker, ICD or CRT)		
76.	Initial evaluation or re-evaluation after revascularization and/or optimal medical therapy to determine candidacy for device therapy and/or to determine optimal choice of device	***Heart Failure*** **(p. e22)** **Patients With Current or Prior Symptoms of HF** **Class I** Implantable cardioverter-defibrillator therapy is recommended for primary prevention of sudden cardiac death to reduce total mortality in patients with nonischemic dilated cardiomyopathy or ischemic heart disease at least 40 days post-MI, a LVEF less than or equal to 35%, and NYHA functional class II or III symptoms while receiving chronic optimal medical therapy, and who have reasonable expectation of survival with a good functional status for more than 1 year. (Level of Evidence: A).

		Ventricular Arrhythmias and Sudden Cardiac Death **(p.1073)** **VIII. Left Ventricular Function and Imaging** **Class I** Echocardiography is recommended for the subset of patients at high risk for development of serious VA or SCD, such as those with dilated, hypertrophic, or right ventricular (RV) cardiomyopathies, acute myocardial infarction (MI) survivors, or relatives of patients with inherited disorders associated with SCD. (Level of Evidence: B).
77.	Initial evaluation for cardiac resynchronization therapy (CRT) device optimization after implantation	***Ventricular Arrhythmias and Sudden Cardiac Death*** **(p.1074)** **VIII. Left Ventricular Function and Imaging** **Class IIa** LV imaging can be useful in patients undergoing biventricular pacing. (Level of Evidence: C) **2008 ASE Expert Consensus Statement for Echo for CRT (p. 207)** A simplified Doppler screening protocol after CRT implantation is proposed using pulsed Doppler mitral inflow, because no consensus currently exists for the routine performance of AV optimization after CRT. (No Level of Evidence available).
78.	Known implanted pacing device with symptoms possibly due to device complication or suboptimal pacing device settings	**Not addressed in AHA/ACC Clinical documents**
79.	Routine surveillance (< 1 year) of implanted device without change in clinical status or cardiac exam	**Not addressed in AHA/ACC Clinical documents**
80.	Routine surveillance (≥ 1 year) of implanted device without change in clinical status or cardiac exam	**Not addressed in AHA/ACC Clinical documents**
Ventricular Assist Devices and Cardiac Transplantation		
81.	To determine candidacy for ventricular assist device	***STEMI (p. e95)*** **7.6.3. Low-Output State** **Class I**

		Left ventricular function and potential presence of a mechanical complication should be assessed by echocardiography if these have not been evaluated by invasive measures. (Level of Evidence: C).
82.	Optimization of ventricular assist device settings	**Not addressed in AHA/ACC Clinical documents**
83.	Re-evaluation of signs/symptoms suggestive of ventricular assist device-related complications	**Not addressed in AHA/ACC Clinical documents**
84.	Monitoring for rejection in a cardiac transplant recipient	**Not addressed in AHA/ACC Clinical documents**
85.	Cardiac structure and function evaluation in a potential heart donor	**Not addressed in AHA/ACC Clinical documents**
Cardiomyopathies		
86.	Initial evaluation of known or suspected cardiomyopathy (e.g., restrictive, infiltrative, dilated, hypertrophic or genetic cardiomyopathy)	***Ventricular Arrhythmias and Sudden Cardiac Death*** **(p.1073)** **VIII. Left Ventricular Function and Imaging** **Class I** Echocardiography is recommended for the subset of patients at high risk for development of serious VA or SCD, such as those with dilated, hypertrophic, or right ventricular (RV) cardiomyopathies, acute myocardial infarction (MI) survivors, or relatives of patients with inherited disorders associated with SCD. (Level of Evidence: B).
87.	Re-evaluation of known cardiomyopathy with a change in clinical status or cardiac exam or to guide therapy	***Heart Failure (p. e10)*** **Recommendations for Serial Clinical Assessment of Patients Presenting With HF** **Class IIa** Repeat measurement of EF and the severity of structural remodeling can provide useful information in patients with HF who have had a change in clinical status or who have experienced or recovered from a clinical event or received treatment that might have had a significant effect on cardiac function. (Level of Evidence: C).

88.	Routine surveillance (< 1 year) of known cardiomyopathy without change in clinical status or cardiac exam	**Not addressed in AHA/ACC Clinical documents**
89.	Routine surveillance (≥ 1 year) of known cardiomyopathy without change in clinical status or cardiac exam	**Not addressed in AHA/ACC Clinical documents**
90.	Screening evaluation for structure and function in first-degree relatives of a patient with inherited cardiomyopathy	***Heart Failure (p. e16)*** ***1.1. Patients at High Risk for Developing HF*** **Class I** Healthcare providers should perform a noninvasive evaluation of LV function (i.e., LVEF) in patients with a strong family history of cardiomyopathy or in those receiving cardiotoxic interventions. (Level of Evidence: C). ***Ventricular Arrhythmias and Sudden Cardiac Death* (p.1073)** **VIII. Left Ventricular Function and Imaging** **Class I** Echocardiography is recommended for the subset of patients at high risk for development of serious VA or SCD, such as those with dilated, hypertrophic, or right ventricular (RV) cardiomyopathies, acute myocardial infarction (MI) survivors, or relatives of patients with inherited disorders associated with SCD. (Level of Evidence: B).
91.	Baseline and serial re-evaluations in patients undergoing therapy with cardiotoxic agents	***Heart Failure (p. e16)*** ***1.2. Patients at High Risk for Developing HF*** **Class I** Healthcare providers should perform a noninvasive evaluation of LV function (i.e., LVEF) in patients with a strong family history of cardiomyopathy or in those receiving cardiotoxic interventions. (Level of Evidence: C).

Table 6 References:

1. Adams KF, Lindenfeld J, Arnold JMO, et al. Heart Failure Society of America comprehensive heart failure practice guideline. J Cardiac Failure 2006;12:10-38.

2. Chumnanvej S, Wood MJ, MacGillivray TE, Melo MF. Preoperative echocardiographic evaluation for ventricular assist device implantation. Anesth Analg 2007;105:583-601.

3. Dellsperger KC. Transthoracic echocardiography for evaluation of hypertensive heart disease. Echocardiography 1993;10:295-302.

4. Epstein AE, DiMarco JP, Ellenbogen KA, et al. ACC/AHA/HRS 2008 guidelines for device-based therapy of cardiac rhythm abnormalities. J Am Coll Cardiol 2008;51:e1-62.

5. Gorcsan J 3rd, Abraham T, Agler DA, et al. ASE Expert Consensus Statement: Echocardiography for cardiac resynchronization therapy: recommendations for performance and reporting. J Am Soc Echocardiogr 2008;21:191-213.

6. Horton SC, Khodaverdian R, Chetelain P, et al. Left ventricular assist device malfunction: an approach to diagnosis by echocardiography. J Am Coll Cardiol 2005;45:1435-40.

7. Hunt SA, Abraham WT, Chin MH, et al. 2009 focused update incorporated into the ACC/AHA 2005 guidelines for diagnosis and management of heart failure: a report of the ACCF/AHA Task Force on practice guidelines. J Am Coll Cardiol. 2009 Apr 14;53(15):e1-e90.

8. Mullens W, Tang WH, Grimm RA. Using echocardiography in cardiac resynchronization therapy. Am Heart J 2007;154:1011-20.

9. Oh JK, Hatle L, Tajik AJ, Little WC. Diastolic heart failure can be diagnosed by comprehensive two-dimensional and doppler echocardiography. J Am Coll Cardiol 2006;47:500-6.

10. Thorn EM, De Filippi CR. Echocardiography in the cardiac transplant recipient. Heart Failure Clinics 2007;3:51-67.

11. Zipes DP, Camm AJ, Borggrefe M, et al. ACC/AHA/ESC 2006 guidelines for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: a report of the American College of Cardiology/American Heart Association Task Force and the European Society of Cardiology Committee for Practice Guidelines (Writing Committee to Develop Guidelines for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death). J Am Coll Cardiol 2006;48:e247-346.

Table 7. TTE for Adult Congenital Heart Disease

Indication		ACC/AHA Clinical Document Recommendations
92.	Initial evaluation of known or suspected adult congenital heart disease	***Guidelines for Adults with CHD*** **6.4 Recommendations for the Unoperated Patient (p. e186)** **Class I** Primary imaging and hemodynamic assessment of AS and aortic valve disease are recommended by echocardiography Doppler to evaluate the presence and severity of AS or AR; LV size, function, and mass; and dimensions and anatomy of the ascending aorta and associated lesions. (Level of Evidence: B). **7.5 Recommendations for the Unoperated Patient (p. e198)** **Class I** Two-dimensional echocardiography-Doppler, chest x-ray, and ECG are recommended for the initial evaluation of patients with valvular PS. (Level of Evidence: C). **12.5. Recommendations for Evaluation and Follow-Up of Patients With Congenitally Corrected Transposition of the Great Arteries** **Class I (p. e230).** The following diagnostic evaluations are recommended for patients with CCTGA: a. ECG. (*Level of Evidence: C*) b. Chest x-ray. (*Level of Evidence: C*) c. Echocardiography-Doppler study. (*Level of Evidence: C*) **13.5. Recommendations for Diagnostic Tests (p. e234)** **Class I** ECG, chest x-ray, and echocardiography-Doppler are recommended for the diagnostic evaluation of Ebstein's anomaly in adult patients. (Level of Evidence: C).
93.	Known adult congenital heart disease with a change in clinical status or cardiac exam	***Guidelines for Adults with CHD*** **6.4 Recommendations for the Unoperated Pateint (p. e186)** **Class I** Echocardiography is recommended for reevaluation of patients with AS who experience a change in signs or symptoms and for assessment of changes in AS hemodynamics during

		pregnancy. (Level of Evidence: B).
94.	Re-evaluation to guide therapy in known adult congenital heart disease	***Guidelines for Adults with CHD*** **6.8.7.2. Recommendations for Surgical Intervention (p. e191)** **Class I** Surgical intervention is recommended for patients with subvalvular aortic stenosis and a peak instantaneous gradient of 50 mm Hg or a mean gradient of 30 mm Hg on echocardiography Doppler. (Level of Evidence: C). . **6.11. Management Strategies for Supravalvular Left Ventricular Outflow Tract (p. e193)** **Class I** Operative intervention should be performed for patients with supravalvular LVOT obstruction (discrete or diffuse) with symptoms (ie, angina, dyspnea, or syncope) and/or mean gradient greater than 50 mm Hg or peak instantaneous gradient by Doppler echocardiography greater than 70 mm Hg. (Level of Evidence: B).
95.	Routine surveillance (< 2 years) of adult congenital heart disease following complete repair • without residual structural or hemodynamic abnormality • without a change in clinical status or cardiac exam	***Guidelines for Adults with CHD (p. e183)*** **Atrioventricular Septal Defect** **4.5.2. Evaluation and Follow-Up of the Repaired Patient** Appropriate imaging (2-dimensional and Doppler echocardiography in most patients) should be undertaken by staff trained in imaging of complex congenital heart defects and should include serial observation of AV valve function and evaluation of the LVOT. (No Level of Evidence available).
96.	Routine surveillance (≥ 2 years) of adult congenital heart disease following complete repair • without residual structural or hemodynamic abnormality • without a change in clinical	***Guidelines for Adults with CHD (p. e183)*** **Atrioventricular Septal Defect** **4.5.2. Evaluation and Follow-Up of the Repaired Patient** Appropriate imaging (2-dimensional and Doppler echocardiography in most patients) should be undertaken by staff trained in imaging of complex congenital heart defects and should include serial observation of AV valve function and evaluation of the LVOT. (No Level of Evidence available).

	status or cardiac exam	
97.	Routine (< 1 year) re-evaluation of congenital heart disease following incomplete or palliative repair • with residual structural or hemodynamic abnormality • without a change in clinical status or cardiac exam	***Guidelines for Adults with CHD*** ***7.13.2 Recommendation for Evaluation and Follow-Up After Right Ventricular–Pulmonary Artery Conduit or Prosthetic Valve (p. e204)*** **Class I** After surgical relief of RVOT obstruction with a conduit or prosthetic valve, patients should be followed up on a 1- to 2-year basis with echocardiography-Doppler assessment of RV systolic pressure and function, as well as a measurement of the gradient across the RVOT. (Level of Evidence: C). ***10.4.1. Recommendation for Imaging (p. e217)*** **Class 1** Comprehensive echocardiographic imaging should be performed in a regional ACHD center to evaluate the anatomy and hemodynamics in patients with repaired tetralogy of Fallot. (Level of Evidence: B). ***11.4.4.1. Recommendations for Imaging for Dextro-Transposition of the Great Arteries After Atrial Baffle Procedure (p. e222)*** **Class IIa** Echocardiography contrast injection with agitated saline can be useful to evaluate baffle anatomy and shunting in patients with previously repaired d-TGA after atrial baffle. (Level of Evidence: B). ***12.5. Recommendations for Evaluation and Follow-Up of Patients With Congenitally Corrected Transposition of the Great Arteries (p. e230)*** **Class I** Echocardiography-Doppler study and/or MRI should be performed yearly or at least every other year by staff trained in imaging complex CHD. (Level of Evidence: C).
98.	Routine (≥ 1 year) re-evaluation of congenital heart disease following incomplete or palliative repair • with residual structural or hemodynamic abnormality • without a change in clinical	***Guidelines for Adults with CHD*** ***7.13.2 Recommendation for Evaluation and Follow-Up After Right Ventricular–Pulmonary Artery Conduit or Prosthetic Valve (p. e204)*** **Class I** After surgical relief of RVOT obstruction with a conduit or prosthetic valve, patients should be followed up on a 1- to 2-year basis with echocardiography-Doppler assessment of RV systolic

	status or cardiac exam	pressure and function, as well as a measurement of the gradient across the RVOT. (Level of Evidence: C). ***10.4.1. Recommendation for Imaging (p. e217)*** **Class 1** Comprehensive echocardiographic imaging should be performed in a regional ACHD center to evaluate the anatomy and hemodynamics in patients with repaired tetralogy of Fallot. (Level of Evidence: B). ***Guidelines for Adults with CHD*** ***11.4.4.1. Recommendations for Imaging for Dextro-Transposition of the Great Arteries After Atrial Baffle Procedure (p. e222)*** **Class IIa** Echocardiography contrast injection with agitated saline can be useful to evaluate baffle anatomy and shunting in patients with previously repaired d-TGA after atrial baffle. (Level of Evidence: B). ***12.5. Recommendations for Evaluation and Follow-Up of Patients With Congenitally Corrected Transposition of the Great Arteries (p. e230)*** **Class I** Echocardiography-Doppler study and/or MRI should be performed yearly or at least every other year by staff trained in imaging complex CHD. (Level of Evidence: C).

Table 7 References:

1. Lim ZS, Vettukattil JJ. Role of echocardiography in the assessment of adolescents and adults with congenital heart disease. Minerva Cardioangiol 2009;57:389-413.

2. Warnes CA. The adult with congenital heart disease: born to be bad? J Am Coll Cardiol 2005;46:1-8.

3. Warnes CA, Williams RG, Bashore TM, et al. ACC/AHA 2008 Guidelines for the management of adults with congenital heart disease. J Am Coll Cardiol 2008;52:e143-263.

Table 8. Transesophageal Echocardiogram (TEE)

Indication		ACC/AHA Clinical Document Recommendations
TEE as Initial or Supplemental Test – General Uses		
99.	Use of TEE when there is a high likelihood of a non-diagnostic TTE due to patient characteristics or inadequate visualization of relevant structures	**Not addressed in AHA/ACC Clinical documents**
100.	Routine use of TEE when a diagnostic TTE is reasonably anticipated to resolve all diagnostic and management concerns	**Not addressed in AHA/ACC Clinical documents**
101.	Re-evaluation of prior TEE finding for interval change (e.g., resolution of thrombus after anticoagulation, resolution of vegetation after antibiotic therapy) when a change in therapy is anticipated	**Not addressed in AHA/ACC Clinical documents**
102.	Surveillance of prior TEE finding for interval change (e.g., resolution of thrombus after anticoagulation, resolution of vegetation after antibiotic therapy) when no change in therapy is anticipated	**Not addressed in AHA/ACC Clinical documents**
103.	Guidance during percutaneous noncoronary cardiac interventions including but not limited to closure device placement, radiofrequency ablation, and percutaneous valve	**2009 ASE Recommendations for Clinical Practice: Echocardiography Guided Interventions (p. 220)** Echocardiography is recommended to guide PTC of PFO and ASDs. All modalities of echocardiography can be used, but ICE should be considered when suitable expertise is available. Numerous factors must be considered when choosing the ideal echocardiographic modality for procedure guidance, including the patient population, specific anatomy, and local

	procedures	expertise. (No Level of Evidence available).
104.	Suspected acute aortic pathology including but not limited to dissection/transsection	***STEMI (p. e34)*** **6.2.6. Imaging** **Class I** Imaging studies such as a high-quality portable chest X-ray, transthoracic and/or transesophageal echocardiography, and a contrast chest CT scan or magnetic resonance imaging scan should be used for differentiating STEMI from aortic dissection in patients for whom this distinction is initially unclear. (Level of Evidence: B). **Thoracic aortic disease (p. 1524)** **8.6.1.3. Recommendations for Screening Tests** **Class I** Urgent and definitive imaging of the aorta using transesophageal echocardiogram, computed tomographic imaging, or magnetic resonance imaging is recommended to identify or exclude thoracic aortic dissection in patients at high risk for the disease by initial screening. (Level of Evidence: B).
105.	Routine assessment of pulmonary veins in an asymptomatic patient status post pulmonary vein isolation	**Not addressed in AHA/ACC Clinical documents**
TEE as Initial or Supplemental Test – Valvular Disease		
106.	Evaluation of valvular structure and function to assess suitability for, and assist in planning of, an intervention	***Valvular Heart Disease (p. e58)*** **3.6.3.4. Indications for Transesophageal Echocardiography** **Class I** Transesophageal echocardiography is indicated for evaluation of MR patients in whom transthoracic echocardiography provides nondiagnostic information regarding severity of MR, mechanism of MR, and/or status of LV function. (Level of Evidence: B). **Class IIa** Preoperative transesophageal echocardiography is reasonable in asymptomatic patients with severe MR who are considered for surgery to assess feasibility of repair. (Level of Evidence: C).
107.	To diagnose infective endocarditis with	**Not addressed in AHA/ACC Clinical documents**

	a low pretest probability (e.g., transient fever, known alternative source of infection or negative blood cultures/atypical pathogen for endocarditis)	
108.	To diagnose infective endocarditis with a moderate or high pre-test probability (e.g., staph bacteremia, fungemia, prosthetic heart valve, or intracardiac device)	***Valvular Heart Disease (p. e73-e74)*** **4.4.2. Transesophageal Echocardiography in Endocarditis** **Class I** Transesophageal echocardiography is recommended to assess the severity of valvular lesions in symptomatic patients with infective endocarditis, if transthoracic echocardiography is nondiagnostic. (Level of Evidence: C). **Class I** Transesophageal echocardiography is recommended to diagnose infective endocarditis in patients with valvular heart disease and positive blood cultures, if transthoracic echocardiography is nondiagnostic. (Level of Evidence: C). **Class I** Transesophageal echocardiography is recommended to diagnose complications of infective endocarditis with potential impact on prognosis and management (e.g., abscesses, perforation, and shunts). (Level of Evidence: C). **Class I** Transesophageal echocardiography is recommended as first-line diagnostic study to diagnose prosthetic valve endocarditis and assess for complications. (Level of Evidence: C). **Class I** Transesophageal echocardiography is recommended for preoperative evaluation in patients with known infective endocarditis, unless the need for surgery is evident on transthoracic imaging and unless preoperative imaging will delay surgery in urgent cases. (Level of Evidence: C). **Class IIa** Transesophageal echocardiography is reasonable to diagnose possible infective endocarditis in

		patients with persistent staphylococcal bacteremia without a known source. (Level of Evidence: C). **Infective Endocarditis (p. e399)** **Echocardiography** **Class I** Echocardiography should be performed in all cases of suspected IE. Whether TTE or TEE should be performed first depends on the clinical scenario. (Level of Evidence: A). **Class I (p. e400)** If the initial TTE images are negative and the diagnosis of IE is still being considered, then TEE should be performed as soon as possible. (Level of Evidence A). **Class I (p. e400)** Among patients with an initial positive TTE and a high risk for cardiac complications including perivalvular extension of infection, TEE should be obtained as soon as possible. (Level of Evidence: A). **Class I (p. e400)** Repeating TEE 7 to 10 days after an initial "negative" result is often advisable when clinical suspicion of IE persists. (Level of Evidence: B). **Class I (p. e400)** Repeat TEE also may be useful when a patient with an initially positive TEE develops worrisome clinical features during antibiotic therapy (Level of Evidence: A). **Cardiovascular Implantable Electronic Device (CIED) Infections (p. 463)** **Recommendations for Diagnosis of CIED Infection and Associated Complications** **Class I** Patients with suspected CIED infection who either have positive blood cultures or who have negative blood cultures but have had recent antimicrobial therapy before blood cultures were obtained should undergo TEE for CIED infection. (Level of Evidence: C). **Class I** All adults suspected of having CIED-related endocarditis should undergo TEE to evaluate the

		left-sided heart valves, even if transthoracic views have demonstrated lead-adherent masses. In pediatric patients with good views, transthoracic echocardiography may be sufficient. (Level of Evidence: B).
TEE as Initial or Supplemental Test – Embolic Event		
109.	Evaluation for cardiovascular source of embolus with no identified non-cardiac source	**Not addressed in AHA/ACC Clinical documents**
110.	Evaluation for cardiovascular source of embolus with a previously identified non-cardiac source	**Not addressed in AHA/ACC Clinical documents**
111.	Evaluation for cardiovascular source of embolus with a known cardiac source in which a TEE would not change management	**Not addressed in AHA/ACC Clinical documents**
TEE as Initial Test – Atrial Fibrillation/Flutter		
112.	Evaluation to facilitate clinical decision-making with regards to anticoagulation, cardioversion and/or radiofrequency ablation	***Atrial Fibrillation (p. e170)*** **7.2.2. Transesophageal Echocardiography** TEE is not part of the standard initial investigation of patients with AF. By placing a high-frequency ultrasound transducer close to the heart, however, TEE provides high-quality images of cardiac structure and function. It is the most sensitive and specific technique to detect sources and potential mechanisms for cardiogenic embolism. The technology has been used to stratify stroke risk in patients with AF and to guide cardioversion. (No Level of Evidence available) ***Atrial Fibrillation (e206)*** **8.2.7. Prevention of Thromboembolism in Patients With Atrial Fibrillation Undergoing Cardioversion** **Class IIa** As an alternative to anticoagulation prior to cardioversion of AF, it is reasonable to perform

		transesophageal echocardiography in search of thrombus. For patients with no identifiable thrombus, cardioversion is reasonable immediately after anticoagulation. (Level of Evidence: B).
113.	Evaluation when a decision has been made to anticoagulate and not to perform cardioversion	**Not addressed in AHA/ACC Clinical documents**

Table 8 References:

1. Bach DS. Transesophageal echocardiographic (TEE) evaluation of prosthetic valves. Cardiol Clin 2000;18:751-71.

2. Baddour LM, Epstein AE, Erickson CC, et al. American Heart Association Rheumatic Fever, Endocarditis, and Kawasaki Disease Committee; Council on Cardiovascular Disease in Young; Council on Cardiovascular Surgery and Anesthesia; Council on Cardiovascular Nursing; Council on Clinical Cardiology; Interdisciplinary Council on Quality of Care; American Heart Association. Update on cardiovascular implantable electronic device infections and their management: a scientific statement from the American Heart Association. Circulation 2010;26;121:458-77. Epub 2010 Jan. 4.

3.Baddour LM, Wilson WR, Bayer AS, et al. Infective endocarditis: diagnosis, antimicrobial therapy, and management of complications: a statement for healthcare professionals from the Committee on Rheumatic Fever, Endocarditis, and Kawasaki Disease, Council on Cardiovascular Disease in the Young, and the Councils on Clinical Cardiology, Stroke, and Cardiovascular Surgery and Anesthesia, American Heart Association: endorsed by the Infectious Diseases Society of America. Circulation 2005;111:e394-e434.

4. Bossone E, Evangelista A, Isselbacher E, et al. International Registry of Acute Aortic Dissection Investigators. Prognostic role of transesophageal echocardiography in acute type A aortic dissection. Am Heart J 2007;153:1013-20.

5. Calkins H, Brugada J, Packer DL, et al. HRS/EHRA/ECAS expert consensus statement on catheter and surgical ablation of atrial fibrillation. Heart Rhythm 2007;4:816-61.

6. Daniel WG, Mugge A, Grote J, Nonsast-Daniel B. Evaluation of endocarditis and its complications by biplane and multiplanetransesophageal echocardiography. Am J Card Imaging 1995;9:100-5.

7. de Bruijn SF, Agema WR, Lammers GJ, et al. Transesophageal echocardiography is superior to transthoracic echocardiography in management of patients of any age with transient ischemic attack or stroke. Stroke 2006;37:2531-4.

8. Easton JD, Saver JL, Albers GW, et al. Definition and evaluation of transient ischemic attack: a scientific statement for healthcare professionals from the American Heart Association/American Stroke Association Stroke Council; Council on Cardiovascular Surgery and Anesthesia; Council on

Cardiovascular Radiology and Intervention; Council on Cardiovascular Nursing; and the Interdisciplinary Council on Peripheral Vascular Disease. The American Academy of Neurology affirms the value of this statement as an educational tool for neurologists. Stroke 2009;40:2276-93.

9. Erbel R. Role of transesophageal echocardiography in dissection of the aorta and evaluation of degenerative aortic disease. Cardiol Clin 1993;11:461-73.

10. Fuster V, Rydén LE, Cannom DS, et al. ACC/AHA/ESC 2006 Guidelines for the management of patients with atrial fibrillation. J Am Coll Cardiol 2006;48:e149-e246.

11. Reynolds HR, Tunick PA, Kronzon I. Role of transesophageal echocardiography in the evaluation of patients with stroke. Curr Opin Cardiol 2003;18:340-5.

12. Ryan EW, Bolger AF. Transesophageal echocardiography (TEE) in the evaluation of infective endocarditis. Cardiol Clin 2000;18:773-87.

13. Silvestry FE, Kerber RE, Brook MM, et al. ASE recommendations for clinical practice: echocardiographic- guided interventions. J Am Soc Echocardiogr 2009;22:213-31.

Table 9. Stress Echocardiography for Detection of CAD/Risk Assessment: Symptomatic or Ischemic Equivalent

Indication	ACC/AHA Clinical Document Recommendations
Evaluation of Ischemic Equivalent	
114. • Low pre-test probability of CAD • ECG interpretable AND able to exercise	***Stable Ischemic Heart Disease Guideline Draft*** ***1.10.3.1. Recommendations for Use of Echocardiographic and Radionuclide Stress Imaging for the Initial Diagnosis of SIHD in Patients Who are Able to Exercise*** **Class III – No Benefit** Myocardial perfusion imaging or dobutamine echocardiography is not recommended as the initial diagnostic test for suspected IHD in patients with a low pretest probability who are able to exercise and have an interpretable ECG without LBBB. *(Level of Evidence: C)* **2.3.2. Recommendations for Cardiac Stress Testing as the Initial Test to Assess Risk in Patients Who Are Able to Exercise** **Class IIb** In Patients with SIHD who are able to exercise and who have an ECG that can be interpreted during exercise and are at intermediate or low risk, exercise myocardial perfusion imaging or exercise echocardiography may be considered. *(Level of Evidence: B)* ***Stable Angina (p. 22)*** **Recommendations for Cardiac Stress Imaging Initial Test for Diagnosis in Patients With Chronic Stable Angina Who Are Able to Exercise** **Class IIb** Exercise myocardial perfusion imaging, exercise echocardiography, adenosine or dipyridamole myocardial perfusion imaging, or dobutamine echocardiography as the initial stress test in a patient with a normal rest ECG who is not taking digoxin. (Level of Evidence: B).
115. • Low pre-test probability of CAD • ECG uninterpretable OR unable to exercise	***Stable Ischemic Heart Disease Guideline Draft*** ***1.10.3.1. Recommendations for Use of Echocardiographic and Radionuclide Stress Imaging for the Initial Diagnosis of SIHD in Patients Who are Able to Exercise*** **Class IIb** 1. Exercise myocardial perfusion imaging or exercise echocardiography may be reasonable in patients with a low or high probability of CAD who have 1 of the following baseline ECG

	abnormalities (Level of Evidence: C): • Pre-excitation (Wolff-Parkinson-White) syndrome. • More than 1 mm of ST depression. 2. Stress myocardial perfusion imaging with a vasodilator may be reasonable in patients with a low or high probability of CAD and 1 of the following baseline ECG abnormalities (Level of Evidence: C): • Electronically paced ventricular rhythm. • LBBB. • **1.10.3.2. Recommendations for Use of Cardiac Stress Imaging as the Initial Test for Diagnosis of SIHD in Patients Who Are Unable to Exercise** **Class IIa** Stress myocardial perfusion imaging with vasodilator is probably indicated in patients with a low or a high probability of CAD and 1 of the following baseline ECG abnormalities *(Level of Evidence: C):* • Electronically paced ventricular rhythm. • LBBB. **2.3.2. Recommendations for Cardiac Stress Testing as the Initial Test to Assess Risk in Patients Who Are Able to Exercise** **Class I** In SIHD patients who are able to exercise and who have an ECG that cannot be interpreted during exercise, including those with an electronically paced ventricular rhythm, pharmacologic myocardial perfusion imaging with a vasodilator or exercise echocardiography is recommended. *(Level of Evidence: B)* **2.3.3. Recommendations for Cardiac Stress Testing as the Initial Test to Assess Risk in Patients With SIHD Who Are Unable to Exercise** Class I 1. In patients with SIHDwho are unable to exercise and who have LBBB or electronically-paced ventricular rhythm, stress myocardial perfusion imaging with a vasodilator is recommended *(Level of Evidence: B)* 2. In patients with SIHDwho are unable to exercise and who do not have LBBB or electronically-paced ventricular rhythm, stress myocardial perfusion imaging with a vasodilator or dobutamine

		echocardiography is recommended. *(Level of Evidence: B)* ***Stable Angina (p. 22)*** **Recommendations for Cardiac Stress Imaging Initial Test for Diagnosis in Patients With Chronic Stable Angina Who Are Unable to Exercise** **Class IIb** ▪ Adenosine or dipyridamole stress myocardial perfusion imaging or dobutamine echocardiography in patients with a low or high probability of CAD in the absence of electronically paced ventricular rhythm or left bundle-branch block. (Level of Evidence: B).
116.	• Intermediate pre-test probability of CAD • ECG interpretable AND able to exercise	***Stable Ischemic Heart Disease Guideline Draft*** **1.10.3.1. Recommendations for Use of Echocardiographic and Radionuclide Stress Imaging for the Initial Diagnosis of SIHD in Patients Who are Able to Exercise** **Class IIb** In patients with have an interpretable rest ECG and an intermediate probability of CAD, myocardial perfusion imaging or exercise echocardiography may be considered. (Level of Evidence: C) **2.3.2. Recommendations for Cardiac Stress Testing as the Initial Test to Assess Risk in Patients Who Are Able to Exercise** **Class IIb** In Patients with SIHD who are able to exercise and who have an ECG that can be interpreted during exercise and are at intermediate or low risk, exercise myocardial perfusion imaging or exercise echocardiography may be considered. *(Level of Evidence: B)* ***Stable Angina (p. 22)*** **Recommendations for Cardiac Stress Imaging as the Initial Test for Diagnosis in Patients With Chronic Stable Angina Who Are Able to Exercise** **Class IIb** Exercise myocardial perfusion imaging, exercise echocardiography, adenosine or dipyridamole myocardial perfusion imaging, or dobutamine echocardiography as the initial stress test in a patient with a normal rest ECG who is not taking digoxin. (Level of Evidence: B).

117.	• Intermediate pre-test probability of CAD • ECG uninterpretable OR unable to exercise	***Stable Ischemic Heart Disease Guideline Draft*** **1.10.3.1. Recommendations for Use of Echocardiographic and Radionuclide Stress Imaging for the Initial Diagnosis of SIHD in Patients Who are Able to Exercise** **Class I** 1. Exercise myocardial perfusion imaging or exercise echocardiography is recommended for the diagnosis of SIHD in patients with an intermediate pretest probability of IHD (who have 1 of the following baseline ECG abnormalities (Level of Evidence: C): • Pre-excitation (Wolff-Parkinson-White) syndrome. • More than 1 mm of ST depression at rest. ***Class IIb*** 3. Exercise myocardial perfusion imaging or exercise echocardiography may be reasonable in patients with an intermediate probability of CAD who have 1 of the following (Level of Evidence: C): • Digoxin use with less than 1 mm ST depression on the baseline ECG. • LV hypertrophy with less than 1 mm ST depression on the baseline ECG. 3.Dobutamine echocardiography may be considered in patients with LBBB. *(Level of Evidence: C)* **1.10.3.2. Recommendations for Use of Cardiac Stress Imaging as the Initial Test for Diagnosis of SIHD in Patients Who Are Unable to Exercise** **Class I** 1. Myocardial perfusion imaging with a vasodilator or dobutamine echocardiography is recommended in patients with an intermediate pretest probability of CAD. (Level of Evidence: C) **2.3.2. Recommendations for Cardiac Stress Testing as the Initial Test to Assess Risk in Patients Who Are Able to Exercise** **Class I** In SIHD patients who are able to exercise and who have an ECG that cannot be interpreted during exercise, including those with an electronically paced ventricular rhythm, pharmacologic myocardial perfusion imaging with a vasodilator or exercise echocardiography is recommended (31, 263, 265, 267, 281-285). *(Level of Evidence: B)* **2.3.3. Recommendations for Cardiac Stress Testing as the Initial Test to Assess Risk in Patients With SIHD Who Are Unable to Exercise**

	Class I 1. In patients with SIHDwho are unable to exercise and who have LBBB or electronically-paced ventricular rhythm, stress myocardial perfusion imaging with a vasodilator is recommended *(Level of Evidence: B)* 2. In patients with SIHDwho are unable to exercise and who do not have LBBB or electronically-paced ventricular rhythm, stress myocardial perfusion imaging with a vasodilator or dobutamine echocardiography is recommended. *(Level of Evidence: B)* ***Stable Angina (p. 22)*** **Recommendations for Cardiac Stress Imaging as the Initial Test for Diagnosis in Patients With Chronic Stable Angina Who Are Unable to Exercise** **Class I** Adenosine or dipyridamole myocardial perfusion imaging or dobutamine echocardiography in patients with an intermediate pretest probability of CAD. (Level of Evidence: B). ***Stable Angina (p. 22)*** **Recommendations for Cardiac Stress Imaging as the Initial Test for Diagnosis in Patients With Chronic Stable Angina Who Are Able to Exercise** **Class I** ▪ Exercise myocardial perfusion imaging or exercise echocardiography in patients with an intermediate pretest probability of CAD who have one of the following baseline ECG abnormalities: o Pre-excitation (Wolff-Parkinson-White) syndrome. (Level of Evidence: B). o More than 1 mm of ST depression at rest. (Level of Evidence: B). ▪ Adenosine or dipyridamole myocardial perfusion imaging in patients with an intermediate pretest probability of CAD and one of the following baseline ECG abnormalities: o Electronically paced ventricular rhythm. (Level of Evidence: C). o Left bundle-branch block. (Level of Evidence: B). **Class IIb** Exercise myocardial perfusion imaging or exercise echocardiography in patients with an intermediate probability of CAD who have one of the following: a. Digoxin use with less than 1 mm ST depression on the baseline ECG. (Level of Evidence: B).

	b. LVH with less than 1 mm ST depression on the baseline ECG. (Level of Evidence: B).
118. • High pre-test probability of CAD • Regardless of ECG interpretability and ability to exercise	***Stable Ischemic Heart Disease Guideline Draft*** **1.10.3.1. Recommendations for Use of Echocardiographic and Radionuclide Stress Imaging for the Initial Diagnosis of SIHD in Patients Who are Able to Exercise** **Class IIa** Exercise myocardial perfusion imaging or exercise echocardiography may be reasonable in patients with high probability of CAD and an interpretable ECG without LBBB. **1.10.3.2. Recommendations for Use of Cardiac Stress Imaging as the Initial Test for Diagnosis of SIHD in Patients Who Are Unable to Exercise** **Class IIa** Stress myocardial perfusion imaging with a vasodilator or dobutamine echocardiography is probably indicated in patients with high probability of CAD in the absence of electronically paced ventricular rhythm or LBBB. *(Level of Evidence: C)* **1.10.3.2. Recommendations for Use of Cardiac Stress Imaging as the Initial Test for Diagnosis of SIHD in Patients Who Are Unable to Exercise** **Class IIa** Stress myocardial perfusion imaging with vasodilator is probably indicated in patients with a low or a high probability of CAD and 1 of the following baseline ECG abnormalities *(Level of Evidence: C):* • Electronically paced ventricular rhythm. • LBBB. **2.3.2. Recommendations for Cardiac Stress Testing as the Initial Test to Assess Risk in Patients Who Are Able to Exercise** **Class I** In SIHD patients who are able to exercise and who have an ECG that cannot be interpreted during exercise, including those with an electronically paced ventricular rhythm, pharmacologic myocardial perfusion imaging with a vasodilator or exercise echocardiography is recommended (31, 263, 265, 267, 281-285). *(Level of Evidence: B)* **Class IIa** In patients with SIHD who are able to exercise and who have an ECG that can be interpreted

	during exercise and are at high risk based upon clinical characteristics, an exercise test with imaging is probably recommended. (Level of Evidence: B) **2.3.3. Recommendations for Cardiac Stress Testing as the Initial Test to Assess Risk in Patients With SIHD Who Are Unable to Exercise** **Class I** 1. In patients with SIHDwho are unable to exercise and who have LBBB or electronically-paced ventricular rhythm, stress myocardial perfusion imaging with a vasodilator is recommended *(Level of Evidence: B)* 2. In patients with SIHDwho are unable to exercise and who do not have LBBB or electronically-paced ventricular rhythm, stress myocardial perfusion imaging with a vasodilator or dobutamine echocardiography is recommended. *(Level of Evidence: B)* ***Stable Angina (p. 22)*** **Recommendations for Cardiac Stress Imaging as the Initial Test for Diagnosis in Patients With Chronic Stable Angina Who Are Able to Exercise** **Class IIb** Exercise myocardial perfusion imaging, exercise echocardiography, adenosine or dipyridamole myocardial perfusion imaging, or dobutamine echocardiography as the initial stress test in a patient with a normal rest ECG who is not taking digoxin. (Level of Evidence: B). Exercise myocardial perfusion imaging or exercise echocardiography in patients with a low or high probability of CAD who have one of the following baseline ECG abnormalities: a. Pre-excitation (Wolff-Parkinson-White) syndrome. (Level of Evidence: B). b. More than 1 mm of ST depression. (Level of Evidence: B). **Recommendations for Cardiac Stress Imaging as the Initial Test for Diagnosis in Patients With Chronic Stable Angina Who Are Unable to Exercise** **Class IIb** Adenosine or dipyridamole stress myocardial perfusion imaging or dobutamine echocardiography in patients with a low or high probability of CAD in the absence of electronically paced ventricular rhythm or left bundle-branch block. (Level of Evidence: B).
Acute Chest Pain	

119.	• Possible ACS • ECG: no ischemic changes or with LBBB or electronically ventricular paced rhythm • Low-risk TIMI score • Negative troponin levels	***UA/NSTEMI (p. e31)*** **Immediate Management** **Class I** In patients with suspected ACS in whom ischemic heart disease is present or suspected, if the follow up 12-lead ECG and biomarker measurements are normal, a stress test (exercise or pharmacological) to provoke ischemia should be performed in the ED, in a chest pain unit, or on an outpatient basis in a timely fashion (within 72 h) as an alternative to inpatient admission. Low-risk patients with a negative stress diagnostic test can be managed as outpatients. (Level of Evidence: C). Patients with possible ACS and negative cardiac biomarkers who are unable to exercise or who have an abnormal resting ECG should undergo a pharmacological stress test. (Level of Evidence: B).
120.	• Possible ACS • ECG: no ischemic changes or with LBBB or electronically ventricular paced rhythm • Low-risk TIMI score • Peak troponin: borderline, equivocal, minimally elevated	**Not addressed in AHA/ACC Clinical documents**
121.	• Possible ACS • ECG: no ischemic changes or with LBBB or electronically ventricular paced rhythm • High-risk TIMI score • Negative troponin levels	**Not addressed in AHA/ACC Clinical documents**

122. • Possible ACS • ECG: no ischemic changes or with LBBB or electronically ventricular paced rhythm • High-risk TIMI score • Peak troponin: borderline, equivocal, minimally elevated	
123. Definite ACS	

Table 9 References:

1. Bholasingh R, Cornel JH, Kamp O, et al. Prognostic value of predischarge dobutamine stress echocardiography in chest pain patients with a negative cardiac troponin T. J Am Coll Cardiol 2003;41:596-602.

2. Conti A, Sammicheli L, Gallini C, et al. Assessment of patients with low-risk chest pain in the emergency department: head-to-head comparison of exercise stress echocardiography and exercise myocardial SPECT. Am Heart J 2005;149:894-901.

3. Elhendy A, Mahoney DW, Burger, KN, et al. Prognostic value of exercise echocardiography in patients with classic angina pectoris. Am J Cardiol 2004;94:559-63.

4. Gibbons RJ, Abrams J, Chatterjee K, et al. ACC/AHA 2002 Guideline Update for the Management of Patients With Chronic Stable Angina. www.acc.org. 2002, p.1-125.

5. Iglesias-Garriz I, Rodriguez MA, Garcia-Porrero E, et al. Emergency nontraumatic chest pain: use of stress echocardiography to detect significant coronary artery stenosis. J Am Soc Echocardiogr 2005;18:1181-6.

6. Jeetley P, Burden L, Senior R. Stress echocardiography is superior to exercise ECG in the risk stratification of patients presenting with acute chest pain with negative Troponin. Eur J Echocardiogr 2006;7:155-64.

7. Nucifora G. Badano LP. Sarraf-Zadegan N. Karavidas A. Comparison of early dobutamine stress echocardiography and exercise electrocardiographic testing for management of patients presenting to the emergency department with chest pain. Am J Cardiol 2007;100:1068-73.

8. Pellikka PA, Nagueh SF, Elhendy AA, Kuehl CA, Sawada SG. American Society of Echocardiography recommendations for performance, interpretation, and application of stress echocardiography. J Am Soc Echocardiogr 2007;20:1021-41.

Table 10. Stress Echocardiography for Detection of CAD/Risk Assessment: Asymptomatic (Without Ischemic Equivalent)

Indication	ACC/AHA Clinical Document Recommendations
General Patient Populations	
124. Low Global CHD risk	***Draft CV Risk Guideline*** ***Recommendation for Stress Echocardiography*** **Class III – No Benefit** Stress echocardiography is not indicated for cardiovascular risk assessment in the low- or intermediate-risk asymptomatic adult. *(Level of Evidence: C)* ***Stable Angina (p. 43)*** **Recommendations for Cardiac Stress Imaging as the Initial Test for Risk Stratification in Asymptomatic Patients** **Class III** Exercise myocardial perfusion imaging, exercise echocardiography, adenosine or dipyridamole myocardial perfusion imaging, or dobutamine echocardiography as the initial stress test in an asymptomatic patient with a normal rest ECG who is not taking digoxin. (Level of Evidence: C). Adenosine or dipyridamole myocardial perfusion imaging or dobutamine echocardiography in asymptomatic patients who are able to exercise. (Level of Evidence: C).

125.	• Intermediate Global CHD risk • ECG interpretable	***Draft CV Risk Guideline*** ***Recommendation for Stress Echocardiography*** **Class III – No Benefit** Stress echocardiography is not indicated for cardiovascular risk assessment in the low- or intermediate-risk asymptomatic adult. *(Level of Evidence: C)* ***Stable Angina (p. 43)*** **Recommendations for Cardiac Stress Imaging as the Initial Test for Risk Stratification in Asymptomatic Patients** **Class III** ▪ Exercise myocardial perfusion imaging, exercise echocardiography, adenosine or dipyridamole myocardial perfusion imaging, or dobutamine echocardiography as the initial stress test in an asymptomatic patient with a normal rest ECG who is not taking digoxin. (Level of Evidence: C). ▪ Adenosine or dipyridamole myocardial perfusion imaging or dobutamine echocardiography in asymptomatic patients who are able to exercise. (Level of Evidence: C).
126.	• Intermediate Global CHD risk • ECG uninterpretable	***Draft CV Risk Guideline*** ***Recommendation for Stress Echocardiography*** **Class III – No Benefit** Stress echocardiography is not indicated for cardiovascular risk assessment in the low- or intermediate-risk asymptomatic adult. *(Level of Evidence: C)* ***Stable Angina (p. 43)*** **Recommendations for Cardiac Stress Imaging as the Initial Test for Risk Stratification in Asymptomatic Patients** **Class III** ▪ Exercise myocardial perfusion imaging, exercise echocardiography, adenosine or dipyridamole myocardial perfusion imaging, or dobutamine echocardiography as the initial stress test in an asymptomatic patient with a normal rest ECG who is not taking digoxin. (Level of Evidence: C). ▪ Adenosine or dipyridamole myocardial perfusion imaging or dobutamine echocardiography in asymptomatic patients who are able to exercise. (Level of Evidence: C).

127. High Global CHD risk	**Not addressed in AHA/ACC Clinical documents**

Table 10 References:

1. Anthony D. Diagnosis and screening of coronary artery disease. Prim Care 2005;32:931-46.

2. Gibbons RJ, Balady GJ, Bricker JT, et al. ACC/AHA 2002 Guideline Update for Exercise Testing A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Exercise Testing). 2002. www.acc.org \

3. Mastouri R, Mahenthiran J, Sawada SG. The role of stress echocardiography and competing technologies for the diagnostic and prognostic assessment of coronary artery disease. Minerva Cardioangiol 2009;57:367-87.

4. Metz LD, Beattie M, Hom R, Redberg RF, Grady D, Fleischmann KE. The prognostic value of normal exercise myocardial perfusion imaging and exercise echocardiography: a meta-analysis. J Am Coll Cardiol 2007;49:227-37.

5. Peteiro JC, Monserrat L, et al. Risk stratification by treadmill exercise echocardiography. J Am Soc Echocardiogr 2006;19:894-901.

6. Yao S, Bangalore S, Ahuja A, Chaudhry FA. Stress echocardiography: risk stratification, prognosis, patient outcomes and cost-effectiveness. Minerva Cardioangiol. 2009;57:315-31.

7. Young LH, Wackers FJ, Chyun DA, Davet JA, Baerrett EJ, Taillefer R, Heller GV, Iskandrian AE, Wittlin SD, Filipchuk N, Ratner RE, Inzucchi DE. Cardiac outcomes after screening for asymptomatic coronary artery disease in patients with type 2 diabetes: the DIAD study: a randomized controlled trial. JAMA 2009;301:1547-55.

Table 11. Stress Echocardiography for Detection of CAD/Risk Assessment: Asymptomatic (Without Ischemic Equivalent) in Patient Populations with Defined Comorbidities

Indication	ACC/AHA Clinical Document Recommendations
New-Onset or Newly Diagnosed Heart Failure or LV Systolic Dysfunction	
128. No prior CAD evaluation AND no planned coronary angiography	***Heart Failure (p. e10)*** **Recommendations for the Initial Clinical Assessment of Patients Presenting with HF** **Class IIb** Noninvasive imaging may be considered to define the likelihood of coronary artery disease in patients with HF and LV dysfunction. (Level of Evidence: C).
Arrhythmias	
129. Sustained VT	***Ventricular Arrhythmias (p. 1073)*** **Recommendations for Left Ventricular Function and Imaging** **Class I** Exercise testing with an imaging modality (echocardiography or nuclear perfusion [single-photon emission computed tomography (SPECT)]) is recommended to detect silent ischemia in patients with ventricular arrhythmias who have an intermediate probability of having CHD by age, symptoms, and gender and in whom ECG assessment is less reliable because of digoxin use, LVH, greater than 1-mm ST-segment depression at rest, WPW syndrome, or LBBB. (Level of Evidence: B). Pharmacological stress testing with an imaging modality (echocardiography or myocardial perfusion SPECT) is recommended to detect silent ischemia in patients with ventricular arrhythmias who have an intermediate probability of having CHD by age, symptoms, and gender and are physically unable to perform a symptom limited exercise test. (Level of Evidence: B).

130. Frequent PVCs, exercise induced VT, or nonsustained VT	**Ventricular Arrhythmias (p. 1073)** **Recommendations for Left Ventricular Function and Imaging** **Class I** Exercise testing with an imaging modality (echocardiography or nuclear perfusion [single-photon emission computed tomography (SPECT)]) is recommended to detect silent ischemia in patients with ventricular arrhythmias who have an intermediate probability of having CHD by age, symptoms, and gender and in whom ECG assessment is less reliable because of digoxin use, LVH, greater than 1-mm ST-segment depression at rest, WPW syndrome, or LBBB. (Level of Evidence: B). Pharmacological stress testing with an imaging modality (echocardiography or myocardial perfusion SPECT) is recommended to detect silent ischemia in patients with ventricular arrhythmias who have an intermediate probability of having CHD by age, symptoms, and gender and are physically unable to perform a symptomlimited exercise test. (Level of Evidence: B).
131. Infrequent PVCs	**Ventricular Arrhythmias (p. 1073)** **Recommendations for Left Ventricular Function and Imaging** **Class I** Exercise testing with an imaging modality (echocardiography or nuclear perfusion [single-photon emission computed tomography (SPECT)]) is recommended to detect silent ischemia in patients with ventricular arrhythmias who have an intermediate probability of having CHD by age, symptoms, and gender and in whom ECG assessment is less reliable because of digoxin use, LVH, greater than 1-mm ST-segment depression at rest, WPW syndrome, or LBBB. (Level of Evidence: B). Pharmacological stress testing with an imaging modality (echocardiography or myocardial perfusion SPECT) is recommended to detect silent ischemia in patients with ventricular arrhythmias who have an intermediate probability of having CHD by age, symptoms, and gender and are physically unable to perform a symptom limited exercise test. (Level of Evidence: B).
132. New onset Atrial Fibrillation	***Atrial Fibrillation (p. e170)*** ***7.2.1. Electrocardiogram Monitoring and Exercise Testing*** Exercise testing should be performed if myocardial ischemia is suspected and prior to initiating type IC antiarrhythmic drug therapy. (No Level of Evidence available).
Syncope	

133. Low Global CHD risk	**2006 AHA/ACC scientific statement on Syncope (p. 475)** An evaluation for ischemia is appropriate in patients at risk for or with a history of coronary artery disease. Exercise testing should be performed in the patient with unexplained syncope, especially if the episode was exercise related. Exercise testing provides the opportunity to monitor pulse and blood pressure. In patients less than 40 years of age, a drop in blood pressure or failure of blood pressure to rise with exercise raises the question of hypertrophic obstructive cardiomyopathy or left main coronary artery disease; in the elderly patient, it may be a manifestation of autonomic failure. Exercise testing also screens for catecholaminergic polymorphic ventricular tachycardia. (No Level of Evidence available).
134. Intermediate or High Global CHD risk	**2006 AHA/ACC scientific statement on Syncope (p. 475)** An evaluation for ischemia is appropriate in patients at risk for or with a history of coronary artery disease. Exercise testing should be performed in the patient with unexplained syncope, especially if the episode was exercise related. Exercise testing provides the opportunity to monitor pulse and blood pressure. In patients less than 40 years of age, a drop in blood pressure or failure of blood pressure to rise with exercise raises the question of hypertrophic obstructive cardiomyopathy or left main coronary artery disease; in the elderly patient, it may be a manifestation of autonomic failure. Exercise testing also screens for catecholaminergic polymorphic ventricular tachycardia. (No Level of Evidence available).
Elevated Troponin	
135. Troponin elevation without symptoms or additional evidence of ACS	**Not addressed in AHA/ACC Clinical documents**

Table 11 References:

1. Bouzas-Mosquera A, Peteiro J, Alvarez-García N, et al. Prognostic value of exercise echocardiography in patients with left bundle branch block.JACC Cardiovasc Imaging 2009;2:251-9.

2. Moya A, Sutton R, Ammirati F, et al. Guidelines for the diagnosis and management of syncope (version 2009): the Task Force for the Diagnosis and Management of Syncope of the European Society of Cardiology (ESC). Eur Heart J 2009;30:2631-71.

3. Otasevic P, Popovic ZB, Vasiljevic JD, et al. Head-to-head comparison of indices of left ventricular contractile reserve assessed by high-dose dobutamine stress echocardiography in idiopathic dilated cardiomyopathy: five-year follow up. Heart 2006;92:1253-8.

4. Poldermans D, Bax JJ, Elhendy A, et al. Long-term prognostic value of dobutamine stress echocardiography in patients with atrial fibrillation.

Chest 2001;119:144-9.

5. Pratali L, Otasevic P, Neskovic A, Molinaro S, Picano E. Prognostic value of pharmacologic stress echocardiography in patients with idiopathic dilated cardiomyopathy: a prospective, head-to-head comparison between dipyridamole and dobutamine test. J Card Fail 2007;13:836-42.

6. Sicari R, Nihoyannopoulos P, Evangelista A, et al. Stress echocardiography expert consensus statement: European Association of Echocardiography. Eur J Echocardiogr 2008;9:415-37.

7. Strickberger SA, Benson DW, Biaggioni I, et al. AHA/ACCF scientific statement on the evaluation of syncope. J Am Coll Cardiol 2006;47:473-84.

Table 12. Stress Echocardiography Following Prior Test Results

Indication	ACC/AHA Clinical Document Recommendations
Asymptomatic: Prior Evidence of Subclinical Disease	
136. Coronary calcium Agatston score < 100	**Not addressed in AHA/ACC Clinical documents**
137. • Low to Intermediate Global CHD risk • Coronary calcium Agatston score between 100 – 400	**Not addressed in AHA/ACC Clinical documents**
138. • High Global CHD risk • Coronary calcium Agatston score between 100 – 400	**Not addressed in AHA/ACC Clinical documents**

139.	Coronary calcium Agatston score > 400	***Stable Angina (p. 27)*** **Recommendations for Cardiac Stress Imaging as the Initial Test for Diagnosis in Asymptomatic Patients** **Class IIb** Exercise perfusion imaging or exercise echocardiography in asymptomatic patients with severe coronary calcification on EBCT who are able to exercise and have one of the following baseline ECG abnormalities: a. Pre-excitation (Wolff-Parkinson-White) syndrome. (Level of Evidence: C). b. More than 1 mm of ST depression at rest. (Level of Evidence: C). Adenosine or dipyridamole myocardial perfusion imaging or dobutamine echocardiography in patients with possible myocardial ischemia on ambulatory ECG monitoring or with severe coronary calcification on EBCT who are unable to exercise. (Level of Evidence: C).
140.	Abnormal Carotid Intimal Medial Thickness (IMT thickness ≥ 0.9 mm and/or the presence of plaque encroaching into the arterial lumen)	**Not addressed in AHA/ACC Clinical documents**
	Coronary Angiography (Invasive or Non-Invasive)	
141.	Coronary artery stenosis of unclear significance	***Draft Stable Ischemic Heart Disease Guideline*** **2.3.4. Other Recommendations for Cardiac Stress Testing** **Class I** When a patient is being considered for revascularization and has a known coronary stenosis of unclear physiologic significance, exercise ECG, myocardial perfusion imaging, or stress echocardiography is recommended (263, 286). *(Level of Evidence: B)*
	Asymptomatic OR Stable Symptoms Normal Prior Stress Imaging Study	
142.	• Low Global CHD risk • Last stress imaging study < 2 years ago	**Not addressed in AHA/ACC Clinical documents**
143.	• Low Global CHD risk • Last stress imaging study ≥ 2 years ago	**Not addressed in AHA/ACC Clinical documents**

144. • Intermediate to High Global CHD risk • Last stress imaging study < 2 years ago	**Not addressed in AHA/ACC Clinical documents**
145. • Intermediate to High Global CHD risk • Last stress imaging study ≥ 2 years ago	**Not addressed in AHA/ACC Clinical documents**
Asymptomatic OR Stable Symptoms With Abnormal Coronary Angiography OR Abnormal Prior Stress Study, No Prior Revascularization	
146. • Known CAD on coronary angiography OR prior abnormal stress imaging study • Last stress imaging study < 2 years ago	**Not addressed in AHA/ACC Clinical documents**
147. • Known CAD on coronary angiography OR prior abnormal stress imaging study • Last stress imaging study ≥ 2 years ago	**Not addressed in AHA/ACC Clinical documents**
Treadmill ECG Stress Test	
148. Low Risk Treadmill Score (e.g., Duke)	**Stable Angina (p. 27)** **Recommendations for Cardiac Stress Imaging After Exercise ECG Testing for Diagnosis in Asymptomatic Patients** **Class III** Exercise myocardial perfusion imaging, exercise echocardiography, adenosine or dipyridamole myocardial perfusion imaging, or dobutamine echocardiography in asymptomatic patients with a low-risk Duke treadmill score on exercise ECG testing. (Level of Evidence: C).

149. Intermediate Risk Treadmill Score (e.g., Duke)	***Stable Angina (p. 91)*** **Recommendations for Echocardiography, Treadmill Exercise Testing, Stress Radionuclide Imaging, Stress Echocardiography Studies, and Coronary Angiography During Patient Follow-up** **Class I** Stress radionuclide imaging or stress echocardiography procedures for patients who have a significant change in clinical status and required a stress imaging procedure on their initial evaluation because of equivocal or intermediate-risk treadmill results. (Level of Evidence: C).
150. High Risk Treadmill Score (e.g., Duke)	**Stable Angina (p. 27)** **Recommendations for Cardiac Stress Imaging After Exercise ECG Testing for Diagnosis in Asymptomatic Patients** **Class IIb** Exercise myocardial perfusion imaging or exercise echocardiography in asymptomatic patients with an intermediate-risk or high-risk Duke treadmill score on exercise ECG testing. (Level of Evidence: C).
New or Worsening Symptoms	

151. Abnormal coronary angiography OR abnormal prior stress imaging study	***Draft Stable Ischemic Heart Disease Guideline*** ***4.1. Recommendations for Clinical Evaluation, Echocardiography, Treadmill Exercise Testing, Stress Radionuclide Imaging, Stress Echocardiography Studies, and Coronary Angiography During Patient Follow-up*** ***Class I*** Pharmacologic myocardial perfusion imaging with a vasodilator is recommended for patients without prior revascularization who have a significant change in clinical status and who are unable to exercise or have left bundle-branch block or an electronically paced ventricular rhythm. (Level of Evidence: C) Exercise myocardial perfusion imaging or exercise echocardiography is recommended for patients without prior revascularization who have a significant change in clinical status, are able to exercise, and have an ECG that cannot be interpreted during exercise but who do not have left bundle-branch block or an electronically paced ventricular rhythm. (Level of Evidence: C) ***Stable Angina (p. 91)*** **Recommendations for Echocardiography, Treadmill Exercise Testing, Stress Imaging Studies, and Coronary Angiography During Patient Follow-up** **Class I** Stress radionuclide imaging or stress echocardiography procedures for patients without prior revascularization who have a significant change in clinical status and are unable to exercise or have one of the following ECG abnormalities: a. Pre-excitation (Wolff-Parkinson-White) syndrome. (Level of Evidence: C). b. Electronically paced ventricular rhythm. (Level of Evidence: C). c. More than 1 mm of rest ST depression. (Level of Evidence: C). d. Complete left bundle-branch block. (Level of Evidence: C). ***Stable Angina (p. 91)*** **Recommendations for Echocardiography, Treadmill Exercise Testing, Stress Radionuclide Imaging, Stress Echocardiography Studies, and Coronary Angiography During Patient Follow-up** **Class I** Stress radionuclide imaging or stress echocardiography procedures for patients who have a significant change in clinical status and required a stress imaging procedure on their initial evaluation because of equivocal or intermediate-risk treadmill results. (Level of Evidence: C).

152. Normal coronary angiography OR normal prior stress imaging study	**Not addressed in AHA/ACC Clinical documents**
Prior Noninvasive evaluation	
153. Equivocal, borderline or discordant stress testing where obstructive CAD remains a concern	***Stable Angina (p. 91)*** **Recommendations for Echocardiography, Treadmill Exercise Testing, Stress Radionuclide Imaging, Stress Echocardiography Studies, and Coronary Angiography During Patient Follow-up** **Class I** Stress radionuclide imaging or stress echocardiography procedures for patients who have a significant change in clinical status and required a stress imaging procedure on their initial evaluation because of equivocal or intermediate-risk treadmill results. (Level of Evidence: C).

Table 12 References:

1. Bangalore S, Yao SS, Puthumana J, Chaudhry FA. Incremental prognostic value of stress echocardiography over clinical and stress electrocardiographic variables in patients with prior myocardial infarction: "warranty time" of a normal stress echocardiogram. Echocardiography 2006;23:455-464.

2. Ho J, FitzGerald S, Cannaday J, et al. Relation of AV calcium to myocardial ischemic perfusion in individuals with a low coronary artery calcium score. Am J Cardiol 2007;99:1535-37.

3. Marwick TH, Case C, Vasey C, et al. Prediction of mortality by exercise echocardiography: a strategy for combination with the duke treadmill score. Circulation 2001;103:2566-71.

4. Peteiro J, Monserrrat L, Piñeiro M, et al. Comparison of exercise echocardiography and the Duke treadmill score for risk stratification in patients with known or suspected coronary artery disease and normal resting electrocardiogram. Am Heart J 2006;151:1324 e1-10.

5. Ramakrishna G, Breen JF, Mulvagh SL, McCully RB, Pellikka PA. Relationship between coronary artery calcification detected by electron-beam computed tomography and abnormal stress echocardiography: association and prognostic implications. J Am Coll Cardiol 2006;48:2125-31.

6. Schinkel AF, Elhendy A, Bax JJ, et al. Prognostic implications of a normal stress technetium-99m-tetrofosmin myocardial perfusion study in patients with a healed myocardial infarct and/or previous coronary revascularization.Am J Cardiol 2006;97:1-6.

7. Yao SS, Qureshi E, Sherrid MV, et al. Practical applications in stress echocardiography: risk stratification and prognosis in patients with known or suspected ischemic heart disease. J Am Coll Cardiol 2003;42:1084-90.

Table 13. Risk Assessment: Preoperative Evaluation for Noncardiac Surgery without Active Cardiac Conditions

Indication	ACC/AHA Clinical Document Recommendations
Low-Risk Surgery	
154. Perioperative evaluation for risk assessment	***Peri-operative (pg. 1716)*** Peri-op guideline flow chart (Figure 1) ***Peri-operative (pg. e1711)*** **Recommendations for Noninvasive Stress Testing Before Noncardiac Surgery** **Class III** Noninvasive testing is not useful for patients undergoing low-risk noncardiac surgery (Level of Evidence: C). ***Peri-operative Errata*** **Recommendations for Perioperative Cardiac Assessment** **Class I** Patients who are at low risk for surgery are recommended to proceed to planned surgery (Level of Evidence: B).
Intermediate-Risk Surgery	
155. Moderate to good functional capacity (≥ 4 METs)	***Peri-operative (pg. 1716)*** Peri-op guideline flow chart (Figure 1) ***Peri-operative*** **Recommendations for Perioperative Cardiac Assessment** **Class IIa** It is probably recommended that patients with functional capacity greater than or equal to 4 METs without symptoms proceed to planned surgery. (Level of Evidence: B).

156.	No clinical risk factors	***Peri-operative (pg. 1716)*** Peri-op guideline flow chart (Figure 1) ***Peri-operative (pg. 1711)*** **Recommendations for Noninvasive Stress Testing Before Noncardiac Surgery** **Class III** Noninvasive testing is not useful for patients with no clinical risk factors undergoing intermediate-risk noncardiac surgery (Level of Evidence: C).
157.	• Greater than or equal to 1 clinical risk factor • Poor or unknown functional capacity (< 4 METs)	***Peri-operative (pg. e1716)*** Peri-op guideline flow chart (Figure 1) ***Peri-operative Errata*** **Recommendations for Perioperative Cardiac Assessment** **Class IIa** Patients with poor (less than 4 METs) or unknown functional capacity and 3 or more clinical risk factors who are scheduled for intermediate risk surgery are probably recommended to proceed with planned surgery with heart rate control. (Level of Evidence: B). Patients with poor (less than 4 METs) or unknown functional capacity and 1 or 2 clinical risk factors who are scheduled for vascular or intermediate risk surgery are probably recommended to proceed with planned surgery with heart rate control. (Level of Evidence: B). **Class IIb** Noninvasive testing might be considered if it will change management for patients with poor (less than 4 METs) or unknown functional capacity and 3 or more clinical risk factors who are scheduled for intermediate risk surgery. (Level of Evidence: B). Noninvasive testing might be considered if it will change management for patients with poor (less than 4 METs) or unknown functional capacity and 1 or 2 clinical risk factors who are scheduled for vascular or intermediate risk surgery. (Level of Evidence: B).
158.	Asymptomatic < 1 year post normal catheterization, non invasive test, or previous revascularization	**Not addressed in AHA/ACC Clinical documents**

Vascular Surgery	
159. Moderate to good functional capacity (≥ 4 METs)	***Peri-operative*** **Recommendations for Perioperative Cardiac Assessment** **Class IIa** It is probably recommended that patients with functional capacity greater than or equal to 4 METs without symptoms proceed to planned surgery. (Level of Evidence: B).
160. No clinical risk factors	***Peri-operative (pg. 1716)*** Peri-op guideline flow chart (Figure 1) ***Peri-operative Errata*** **Recommendations for Perioperative Cardiac Assessment** **Class I** Patients with poor (less than 4 METs) or unknown functional capacity and no clinical risk factors should proceed with planned surgery. (Level of Evidence: B).
161. • Greater than or equal to 1 clinical risk factor • Poor or unknown functional capacity (< 4 METs)	***Peri-operative (pg. 1716)*** Peri-op guideline flow chart (Figure 1) ***Peri-operative*** **Recommendations for Perioperative Cardiac Assessment** **Class IIa** It is probably recommended that patients with poor (less than 4 METs) or unknown functional capacity and 1 or 2 clinical risk factors who are scheduled for vascular or intermediate risk surgery proceed with planned surgery with heart rate control. (Level of Evidence: B). It is probably recommended that patients with poor (less than 4 METs) or unknown functional capacity and 3 or more clinical risk factors who are scheduled for vascular surgery consider testing if it will change management. (Level of Evidence: B). **Class IIb** Noninvasive testing might be considered if it will change management for patients with poor (less than 4 METs) or unknown functional capacity and 1 or 2 clinical risk factors who are scheduled for vascular or intermediate risk surgery. (Level of Evidence: B).

162. Asymptomatic < 1 year post normal catheterization, non-invasive test, or previous revascularization	**Not addressed in AHA/ACC Clinical documents**

Table 13 References:

1. Boersma E, Poldermans D, Bax JJ, et al. Predictors of cardiac events after major vascular surgery: Role of clinical characteristics, dobutamine echocardiography, and beta-blocker therapy. JAMA 2001;285:1865-73.

2.Feringa HH, Bax JJ, Schouten O. Ischemic heart disease in renal transplant candidates: towards non-invasive approaches for preoperative risk stratification. Eur J Echocardiogr 2005;6:313-6.

3.Fleisher LA, Beckman JA, Brown KA, et al. ACC/AHA 2007 guidelines of perioperative cardiovascular evaluation and care for noncardiac surgery. J Am Coll Cardiol 2007;50:1707-32.

4.Kertai MD, Boersma E, Bax JJ, et al. Optimizing long-term cardiac management after major vascular surgery: Role of beta-blocker therapy, clinical characteristics, and dobutamine stress echocardiography to optimize long-term cardiac management after major vascular surgery. Arch Intern Med 2003;163:2230-5.

5.Kertai MD, Poldermans D. The utility of dobutamine stress echocardiography for perioperative and long-term cardiac risk assessment. Journal of Cardiothoracic & Vascular Anesthesia. 2005;19:520-8.

6.Umphrey LG, Hurst RT, Eleid MF. Preoperative dobutamine stress echocardiographic findings and subsequent short-term adverse cardiac events after orthotopic liver transplantation. Liver Transplantation 2008;14:886-92.

7.Wesorick DH, Eagle KA. The preoperative cardiovascular evaluation of the intermediate-risk patient: new data, changing strategies. Am J Med 2005;118:1413.

Table 14. Stress Echocardiography for Risk Assessment: Within 3 Months of an Acute Coronary Syndrome

Indication	ACC/AHA Clinical Document Recommendations
STEMI	
163. • Primary PCI with complete revascularization • No recurrent symptoms	**Not addressed in AHA/ACC Clinical documents**
164. • Hemodynamically stable, no recurrent chest pain symptoms or no signs of HF • To evaluate for inducible ischemia • No prior coronary angiography since the index event	**Not addressed in AHA/ACC Clinical documents**
165. Hemodynamically unstable signs of cardiogenic shock	
UA/NSTEMI	
166. • Hemodynamically stable, no recurrent chest pain symptoms or no signs of HF • To evaluate for inducible ischemia • No prior coronary angiography since the index event	***UA/NSTEMI (p.e79)*** **3.4. Risk Stratification Before Discharge** **Class I** ▪ Noninvasive stress testing in low-risk patients who have been free of ischemia at rest or with low level activity and of CHF for a minimum of 12 to 24 h. (Level of Evidence: C). ▪ An imaging modality is added in patients with resting ST-segment depression (greater than or equal to 0.10 mV), LV hypertrophy, bundle-branch block, intraventricular conduction defect, preexcitation, or digoxin who are able to exercise. In patients undergoing a low level exercise test, imaging modality may add sensitivity. (Level of Evidence: B). ▪ Pharmacological stress testing with imaging when physical limitations (e.g., arthritis, amputation, severe peripheral vascular disease, severe COPD, general debility) preclude adequate exercise stress. (Level of Evidence: B).

ACS-Asymptomatic Post-Revascularization (PCI or CABG)		
167.	Prior to hospital discharge in a patient who has been adequately revascularized	**Not addressed in AHA/ACC Clinical documents**
Cardiac Rehabilitation		
168.	Prior to initiation of cardiac rehabilitation (as a stand alone indication)	**Not addressed in AHA/ACC Clinical documents**

Table 14 References:

1. Anderson JL, Adams CD, Antman EM, et al. ACC/AHA 2007 guidelines for management of patients with unstable angina/non ST elevation myocardial infarction: executive summary of the ACC/AHA task force on practice guidelines (Writing Committee to revise 2002 guidelines for management of patients with unstable angina/nonST elevation myocardial infarction). J Am Coll Cardiol 2007;50;e1-e157

2. Bangalore S, Yao SS, Puthumana J, et al. Incremental prognostic value of stress echocardiography over clinical and stress electrocardiographic variables in patients with prior myocardial infarction: "warranty time" of a normal stress echocardiogram. Echocardiography 2006;23:455-64.

3. Desideri A, Fioretti PM, Cortigiani L , et al. (2005). Pre-discharge stress echocardiography and exercise ECG for risk stratification after uncomplicated acute myocardial infarction: results of the COSTAMI-II (cost of strategies after myocardial infarction) trial. Heart 2005;91:146-51.

4. Lancellotti P, Benoit T, Rigo P, et al. Dobutamine stress echocardiography versus quantitative technetium-99m sestamibi SPECT for detecting residual stenosis and multivessel disease after myocardial infarction. Heart 2001;86:510-5.

5. Sicari R, Landi P, Picano E, et al. Exercise-electrocardiography and/or pharmacological stress echocardiography for non-invasive risk stratification early after uncomplicated myocardial infarction. A prospective international large scale multicentre study. Eur Heart J 2002;23:1030-7.

6. Sitges M, Pare C, Azqueta M, et al. Feasibility and prognostic value of dobutamine-atropine stress echocardiography early in unstable angina. Eur Heart J 2000;21:1063-71.

Table 15. Stress Echocardiography for Risk Assessment: Post-Revascularization (PCI or CABG)

Indication	ACC/AHA Clinical Document Recommendations
Symptomatic	
169. • Ischemic equivalent	***Draft Stable Ischemic Heart Disease Guideline*** ***4.1. Recommendations for Clinical Evaluation, Echocardiography, Treadmill Exercise Testing, Stress Radionuclide Imaging, Stress Echocardiography Studies, and Coronary Angiography During Patient Follow-up*** ***Class I*** Stress radionuclide imaging or stress echocardiography is recommended for patients who have a significant change in clinical status and required a stress imaging procedure on their initial evaluation because of equivocal or intermediate-risk exercise ECG results. (Level of Evidence: C) Stress radionuclide imaging or stress echocardiography is recommended for patients with prior revascularization who have a significant change in clinical status. (Level of Evidence: C) ***Stable Angina (p. 22)*** **Recommendations for Cardiac Stress Imaging as the Initial Test for Diagnosis in Patients With Chronic Stable Angina Who Are Able to Exercise** **Class I** Exercise myocardial perfusion imaging or exercise echocardiography in patients with prior revascularization (either PCI or CABG). (Level of Evidence: B). ***Stable Angina (p. 22)*** **Recommendations for Cardiac Stress Imaging as the Initial Test for Diagnosis in Patients With Chronic Stable Angina Who Are Unable to Exercise** **Class I** Adenosine or dipyridamole stress myocardial perfusion imaging or dobutamine echocardiography in patients with prior revascularization (either PCI or CABG). (Level of Evidence: B).
Asymptomatic	

170. • Incomplete revascularization • Additional revascularization feasible	***Draft Stable Ischemic Heart Disease Guideline*** ***4.1. Recommendations for Clinical Evaluation, Echocardiography, Treadmill Exercise Testing, Stress Radionuclide Imaging, Stress Echocardiography Studies, and Coronary Angiography During Patient Follow-up*** **Class IIb** Cardiac stress imaging at 2 year or longer intervals between studies may be considered for patients who have had a prior MI or who have undergone revascularization but in whom revascularization was determined to be incomplete. *(Level of Evidence: C)*
171. < 5 years after CABG	**Not addressed in AHA/ACC Clinical documents**
172. ≥ 5 years after CABG	**Not addressed in AHA/ACC Clinical documents**
173. < 2 years after PCI	**Not addressed in AHA/ACC Clinical documents**
174. ≥ 2 years after PCI	**Not addressed in AHA/ACC Clinical documents**
Cardiac Rehabilitation	
175. Prior to initiation of cardiac rehabilitation (as a stand alone indication)	**Not addressed in AHA/ACC Clinical documents**

Table 15 References:

1. Bountioukos M, Elhendy A, van Domburg RT, et al. Prognostic value of dobutamine stress echocardiography in patients with previous coronary revascularisation. Heart 2004;90:1031-5.

2. Cortigiani L, Sicari R, Bigi R, et al. Usefulness of stress echocardiography for risk stratification of patients after percutaneous coronary intervention. Am J Cardiol. 2008;102:1170-4.

Table 16. Stress Echocardiography for Assessment of Viability/Ischemia

Indication	ACC/AHA Clinical Document Recommendations
Ischemic Cardiomyopathy/Assessment of Viability	
176. • Known moderate or severe LV dysfunction • Patient eligible for revascularization • Use of dobutamine only	***Heart Failure (p. e9)*** **Recommendations for the Initial Clinical Assessment of Patients Presenting with HF** **Class IIa** Noninvasive imaging to detect myocardial ischemia and viability is reasonable in patients presenting with HF who have known coronary artery disease and no angina, unless the patient is not eligible for revascularization of any kind. (Level of Evidence: C).

Table 16 References:

1. Allman KC, Shaw LJ, Hachamovitch R, Udelson JE. Myocardial viability testing and impact of revascularization on prognosis in patients with coronary artery disease and left ventricular dysfunction: a meta-analysis. J Am Coll Cardiol 2002;39:1151-1158.

2. Armstrong WF, Zoghbi WA. Stress echocardiography: current methodology and clinical applications. J Am Coll Cardiol 2005;45:1739-1747.

3. Pellikka PA, Nagueh SF, Elhendy AA, Kuehl CA, Sawada SG. American Society of Echocardiography recommendations for performance, interpretation, and application of stress echocardiography. J Am Soc Echocardiogr 2007;20:1021-41.

4. Rizello V, Poldermans D, Biagini E, et al. Prognosis of patients with ischaemic cardiomyopathy after coronary revascularisation: relation to viability and improvement in left ventricular ejection fraction. Heart 2009;95:1273-7.

Table 17. Stress Echocardiography for Hemodynamics (Includes Doppler During Stress)

Indication	ACC/AHA Clinical Document Recommendations
Chronic Valvular disease - Asymptomatic	
177. Mild mitral stenosis	**Not addressed in AHA/ACC Clinical documents**
178. Moderate mitral stenosis	**Not addressed in AHA/ACC Clinical documents**
179. Severe mitral stenosis	***Valvular Heart Disease 2008 (p. e40)*** **Indications for Echocardiography in Mitral Stenosis** **Class I** Echocardiography should be performed for assessment of the hemodynamic response of the mean gradient and pulmonary artery pressure by exercise Doppler echocardiography in patients with MS when there is a discrepancy between resting Doppler echocardiographic findings, clinical findings, symptoms, and signs. (Level of Evidence: C).
180 • Mild aortic stenosis	
180. • Mild or aortic regurgitation	**Not addressed in AHA/ACC Clinical documents**
181 • Moderate aortic stenosis	
182 • Severe aortic stenosis	
183 • Mild mitral regurgitation	
184 • Moderate mitral regurgitation	
185. • Severe mitral regurgitation • LV size and function not meeting surgical criteria	***Valvular Heart Disease 2008 (p. e57)*** **Class IIa** Exercise Doppler echocardiography is reasonable in asymptomatic patients with severe MR to assess exercise tolerance and the effects of exercise on pulmonary artery pressure and MR severity. (Level of Evidence: C).

186	• Mild aortic regurgitation	
187	• Moderate aortic regurgitation	
188	• Severe aortic regurgitation • LV size and function not meeting surgical criteria	
Chronic Valvular disease - Symptomatic		
189.	• Mild mitral stenosis	***Valvular Heart Disease 2008 (p. e41)*** **Indications for Echocardiography in Mitral Stenosis** **Class I** Echocardiography should be performed for assessment of the hemodynamic response of the mean gradient and pulmonary artery pressure by exercise Doppler echocardiography in patients with MS when there is a discrepancy between resting Doppler echocardiographic findings, clinical findings, symptoms, and signs. (Level of Evidence: C).
190	• Moderate mitral stenosis	
191.	• Severe mitral stenosis	**Not addressed in AHA/ACC Clinical documents**
192	• Severe aortic stenosis	***Valvular Heart Disease 2008 (p. e21)*** **3.1.4.2 Exercise Testing** **Class III** Exercise testing should not be performed in symptomatic patients with AS. (Level of Evidence: B).

193.	• Evaluation of equivocal aortic stenosis • Evidence of low cardiac output or LV systolic dysfunction ("low gradient AS")Use of dobutamine only	***Valvular Heart Disease 2008 (p. e22)*** **Low-Flow/Low-Gradient Aortic Stenosis** **Class IIa** Dobutamine stress echocardiography is reasonable to evaluate patients with low-flow/low-gradient AS and LV dysfunction. (Level of Evidence: B).
194.	• Mild mitral regurgitation	
195.	• Moderate mitral regurgitation	**Not addressed in AHA/ACC Clinical documents**
196.	• Severe mitral regurgitation • Severe LV enlargement or LV systolic dysfunction	**Not addressed in AHA/ACC Clinical documents**
	Acute Valvular disease	
197.	Acute moderate or severe mitral or aortic regurgitation	**Not addressed in AHA/ACC Clinical documents**
	Pulmonary Hypertension	
198.	• Suspected pulmonary hypertension • Normal or borderline elevated estimated RVSP on resting echo study	***ACC/AHA Expert Consensus Document on Pulmonary Hypertension (p.1592)*** The most appropriate initial study to evaluate patients in whom PH is suspected is a Doppler echocardiogram. (No Level of Evidence available). ***ACC/AHA Expert Consensus Document on Pulmonary Hypertension (p. 1586)*** The consensus is that no treatment decisions can be made on the basis of exercise-induced PH alone. (No Level of Evidence available).
199.	Routine evaluation of patients with known resting pulmonary hypertension	***ACC/AHA Expert Consensus Document on Pulmonary Hypertension (p. 1586)*** The consensus is that no treatment decisions can be made on the basis of exercise-induced PH alone. (No Level of Evidence available).
200.	Re evaluation of patient with exercise induced pulmonary hypertension to evaluate response to therapy	**Not addressed in AHA/ACC Clinical documents**

Table 17 References:

1. Baumgartner H, Hung J, Bermejo J, et al. American Society of Echocardiography; European Association of Echocardiography. Echocardiographic assessment of valve stenosis: EAE/ASE recommendations for clinical practice. J Am Soc Echocardiogr. 2009;22:1-23.

2. Ennezat PV, Maréchaux S, Iung B, Chauvel C, LeJemtel TH, Pibarot P. Exercise testing and exercise stress echocardiography in asymptomatic aortic valve stenosis. Heart 2009;95:877-84.

3. Lancellotti P, Lebois F, Simon M, et al. Prognostic importance of quantitative exercise Doppler echocardiography in asymptomatic valvular aortic stenosis. Circulation 2005;112: I377-82.

4. Lange RA, Hillis LD. Dobutamine stress echocardiography in patients with low-gradient aortic stenosis. Circulation 2006;113:1718-20.

5.Pellikka PA, Nagueh SF, Elhendy AA, Kuehl CA, Sawada SG. American Society of Echocardiography recommendations for performance, interpretation, and application of stress echocardiography. J Am Soc Echocardiogr 2007;20:1021-41.

6.Picano E, Pibarot P, Lancellotti P, Monin JL, Bonow RO. The emerging role of exercise testing and stress echocardiography in valvular heart disease. J Am Coll Cardiol 2009;54:2251-60.

7.Pierard L, Lancellotti P. Stress testing in valve disease. Heart 2007;93:766-772.

8.Rafique AM, Biner S, Ray I, Forrester JS, Tolstrup K, Siegel RJ. Meta-analysis of prognostic value of stress testing in patients with asymptomatic severe aortic stenosis. Am J Cardiol 2009;104:972-7.

9.Reis G, Motta MS, Barbosa MM, et al. Dobutamine stress echocardiography for noninvasive assessment and risk stratification of patients with rheumatic mitral stenosis. J Am Coll Cardiol 2004;43:393-401.

10.Wu WC, Aziz GF, Sadaniantz A. The use of stress echocardiography in the assessment of mitral valvular disease. Echocardiography 2004;21:451-8.

Table 18. Contrast Use in TTE/TEE or Stress Echocardiography

Indication	ACC/AHA Clinical Document Recommendations
Use of Contrast With Stress Echo	
201. • Routine use of contrast • All left ventricular segments visualized on noncontrast images	***2008 ASE Consensus Statement on the Clinical Application of Ultrasonic Contrast Agents in Echocardiography*** **SYNOPSIS OF SUGGESTED APPLICATIONS FOR ULTRASOUND CONTRAST AGENT USE** In difficult-to-image patients presenting for rest echocardiography with reduced image quality -To enable improved endocardial visualization and assessment of left ventricular (LV) structure and function when ≥2 contiguous segments are not seen on noncontrast images In difficult-to-image patients presenting for stress echocardiography with reduced image quality -To obtain diagnostic assessment of segmental wall motion and thickening at rest and stress -To increase the proportion of diagnostic studies -To increase reader confidence in interpretation (No Level of Evidence available)
202. • Selective use of contrast • Greater than or equal to 2 contiguous left ventricular segments are NOT seen on noncontrast images	***2008 ASE Consensus Statement on the Clinical Application of Ultrasonic Contrast Agents in Echocardiography*** **SYNOPSIS OF SUGGESTED APPLICATIONS FOR ULTRASOUND CONTRAST AGENT USE** In difficult-to-image patients presenting for rest echocardiography with reduced image quality -To enable improved endocardial visualization and assessment of left ventricular (LV) structure and function when ≥2 contiguous segments are not seen on noncontrast images In difficult-to-image patients presenting for stress echocardiography with reduced image quality -To obtain diagnostic assessment of segmental wall motion and thickening at rest and stress -To increase the proportion of diagnostic studies -To increase reader confidence in interpretation (No Level of Evidence available)

Table 18 References:

1. Dolan MS, Riad K, El-Shafei A, et al. Effect of intravenous contrast for left ventricular opacification and border definition on sensitivity and specificity of dobutamine stress echocardiography compared with coronary angiography in technically difficult patients. Am Heart J 2001;142:908-15.

2. Mulvagh SL, Rakowski H, Vannan MA, et al. American Society of Echocardiography Consensus Statement on the Clinical Applications of Ultrasonic Contrast Agents in Echocardiography. J Am Soc Echocardiogr 2008;21:1179-201.

3. Rainbird AJ, Mulvagh SL, Oh JK, et al. Contrast dobutamine stress echocardiography: clinical practice assessment in 300 consecutive patients. J Am Soc Echocardiogr 2001;14:378-85.

4. Thanigaraj S, Nease RF Jr, Schechtman KB , et al. Use of contrast for image enhancement during stress echocardiography is cost-effective and reduces additional diagnostic testing. Am J Cardiol 2001;87:1430-2.

5. Wei K, Mulvagh SL, Carson L, et al. The safety of Definity and Optison for ultrasound image enhancement: a retrospective analysis of 78,383 adminisitered contrast doses. J Am Soc Echocardiogr 2008;21:1202-1206.

6. Yokoyama N, Schwarz KQ, Steinmetz SD, et al. Prognostic value of contrast stress echocardiography in patients with image quality too limited for traditional noncontrast harmonic echocardiography. J Am Soc Echocardiogr 2004;17:15-20.

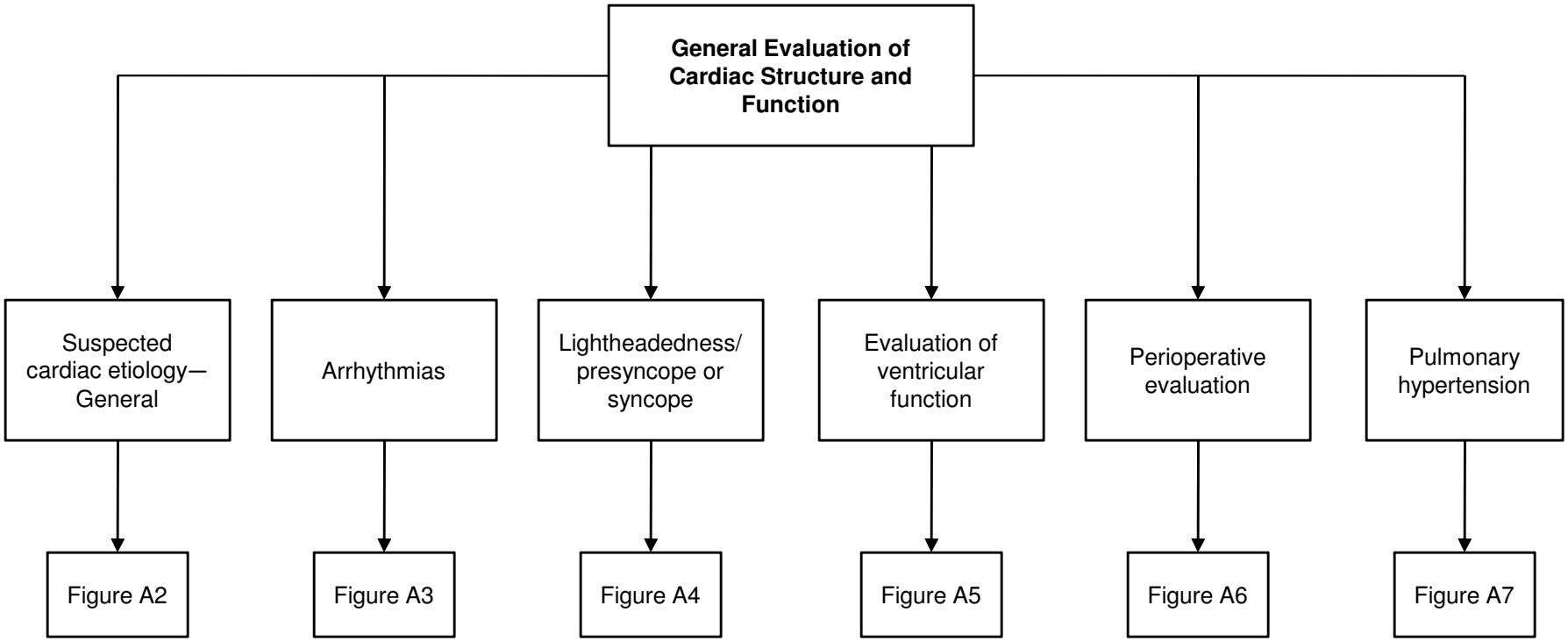

Figure A1. TTE for General Evaluation of Cardiac Structure and Function

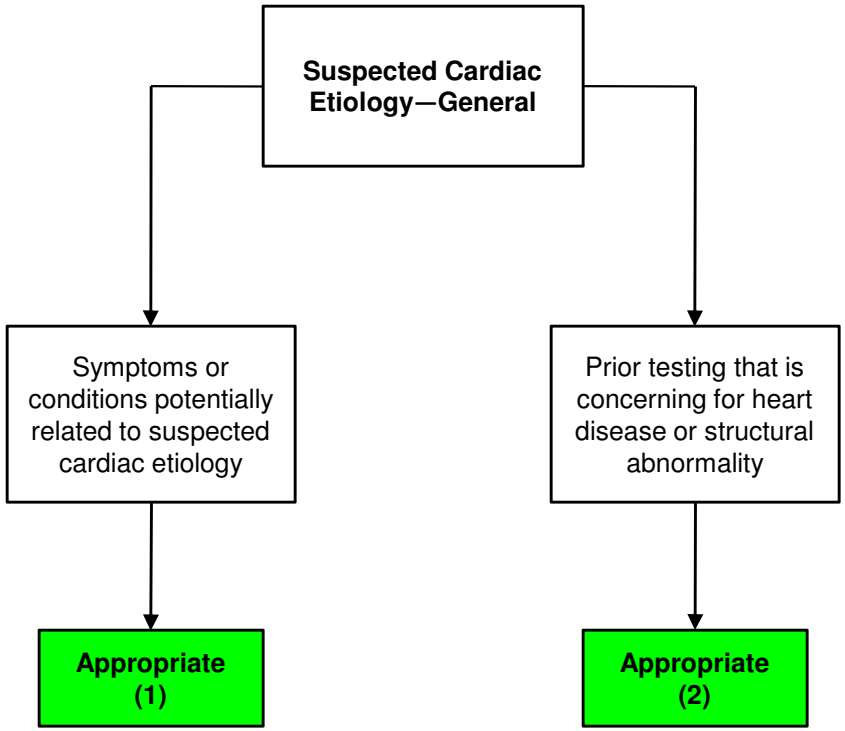

Figure A2. TTE for General Evaluation of Cardiac Structure and Function—Suspected Cardiac Etiology—General

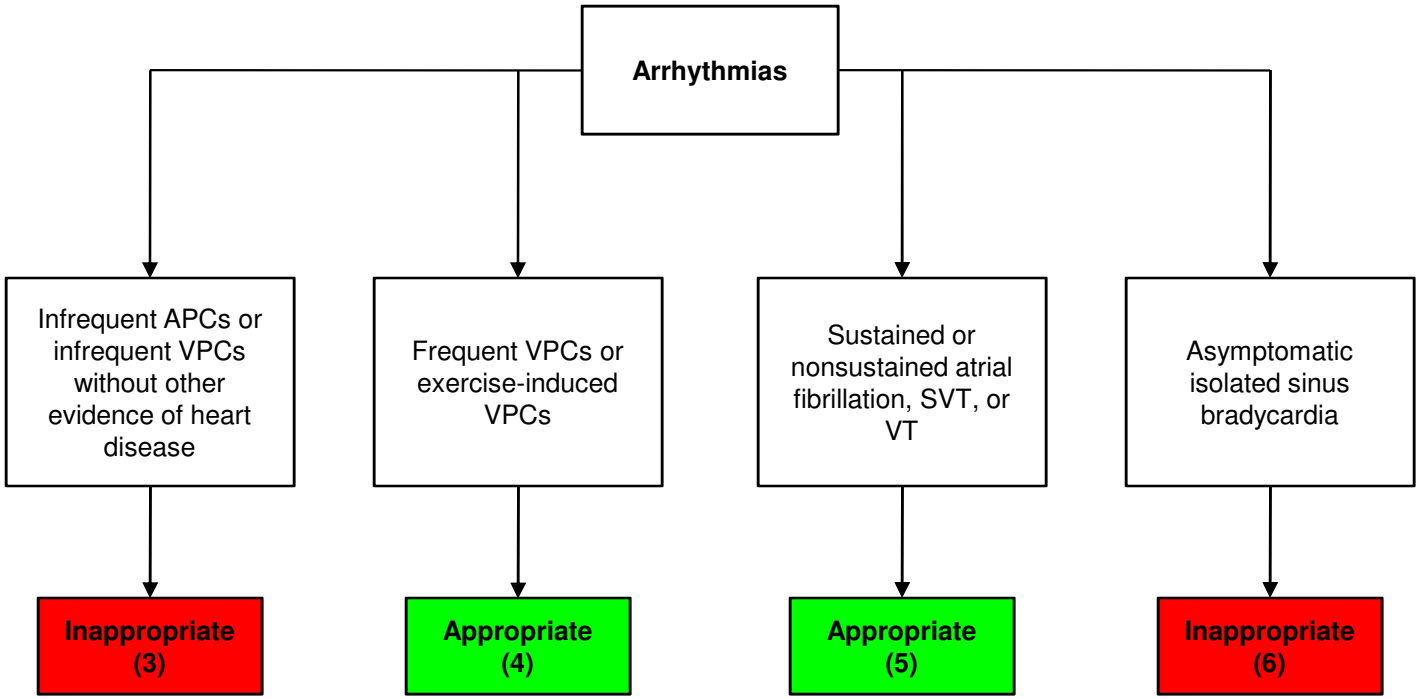

Figure A3. TTE for General Evaluation of Cardiac Structure and Function—Arrhythmias

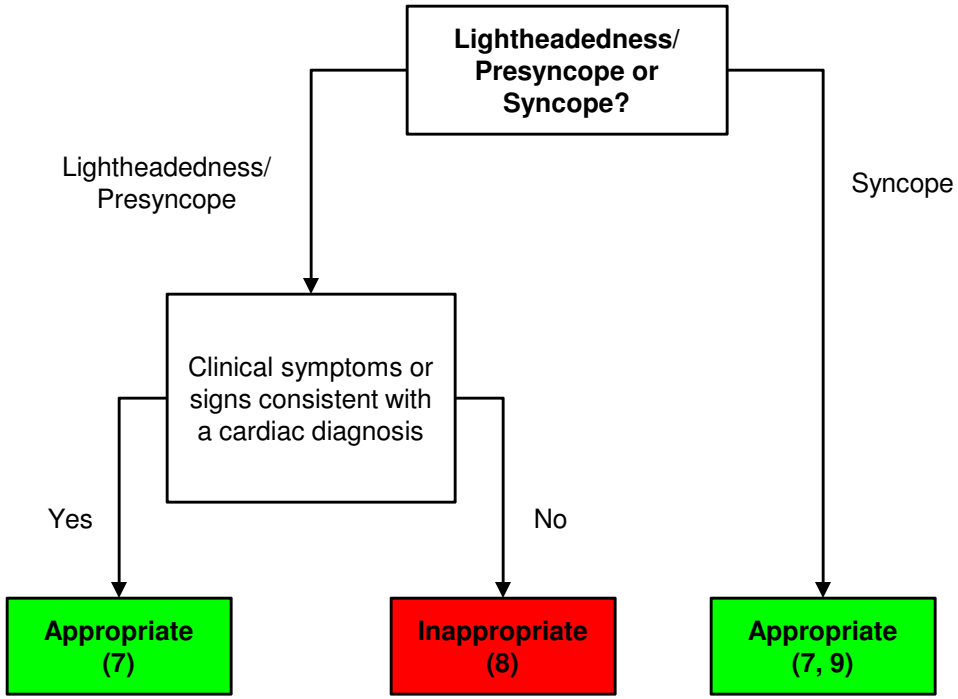

Figure A4. TTE for General Evaluation of Cardiac Structure and Function—Lightheadedness/Presyncope/Syncope

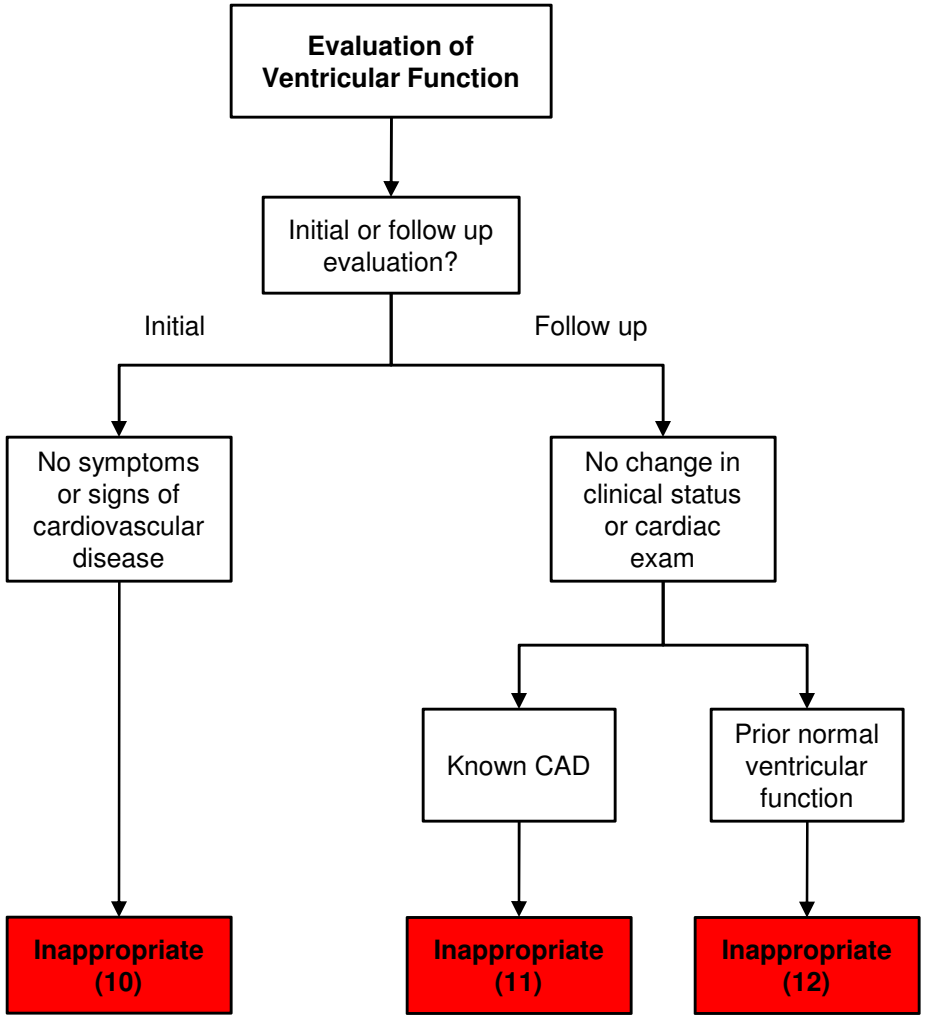

Figure A5. TTE for General Evaluation of Cardiac Structure and Function—Evaluation of Ventricular Function

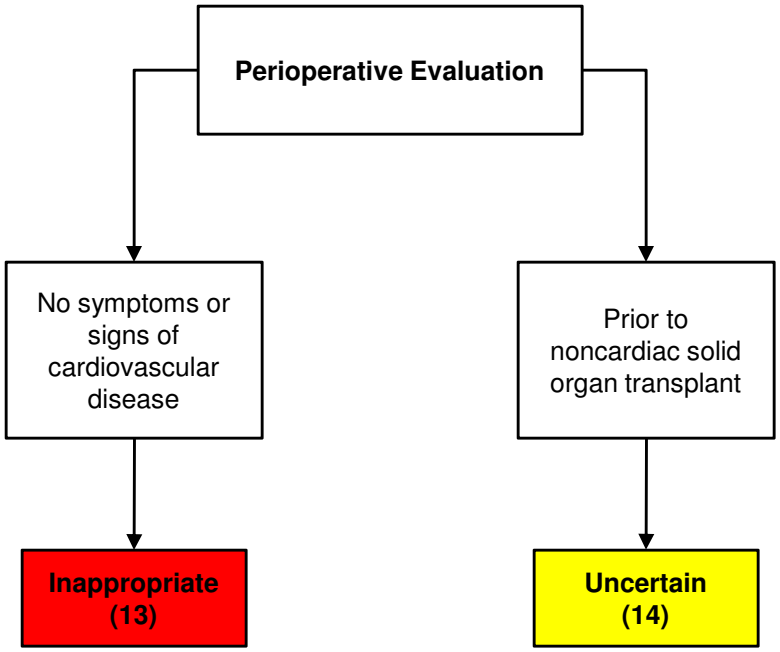

Figure A6. TTE for General Evaluation of Cardiac Structure and Function—Perioperative Evaluation

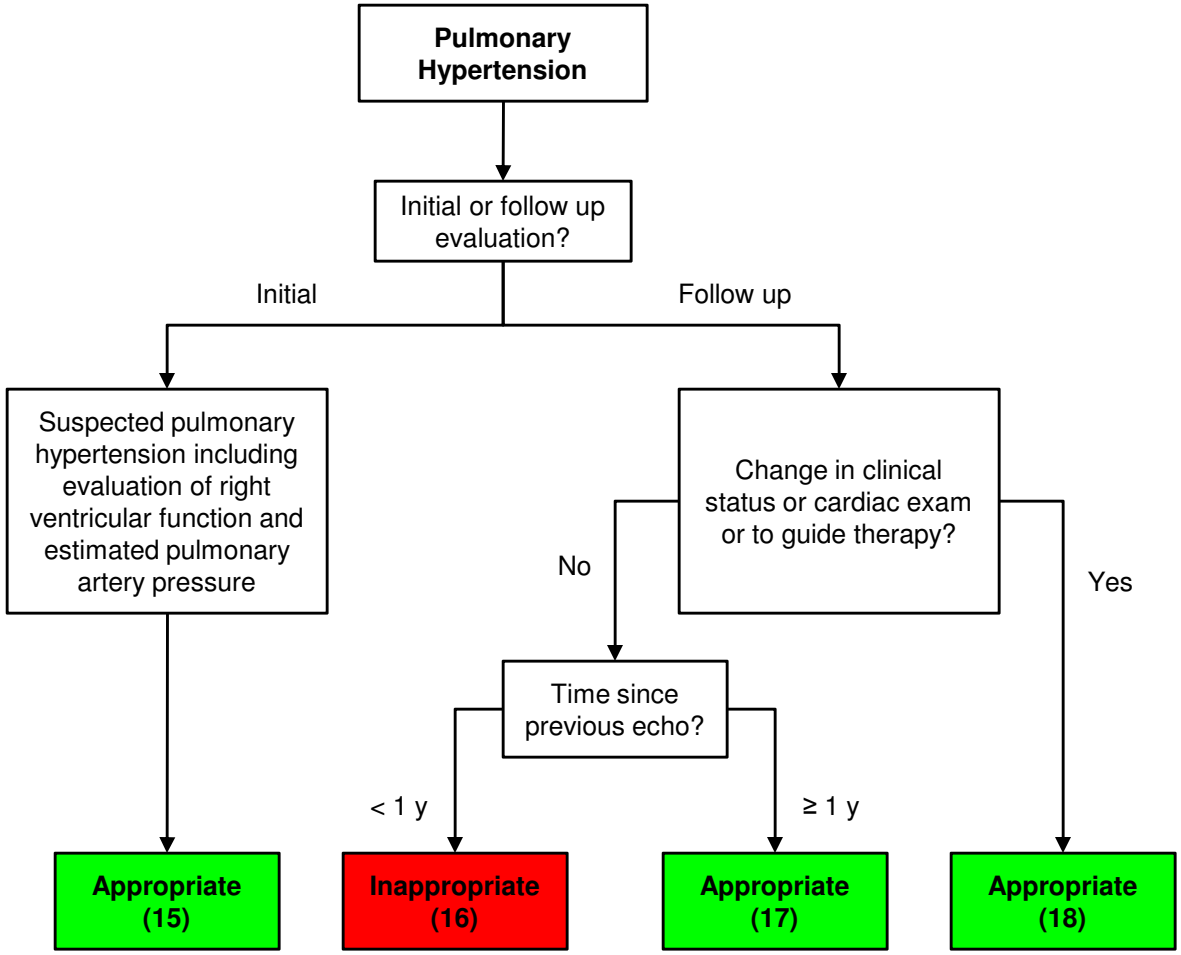

Figure A7. TTE for General Evaluation of Cardiac Structure and Function—Pulmonary Hypertension

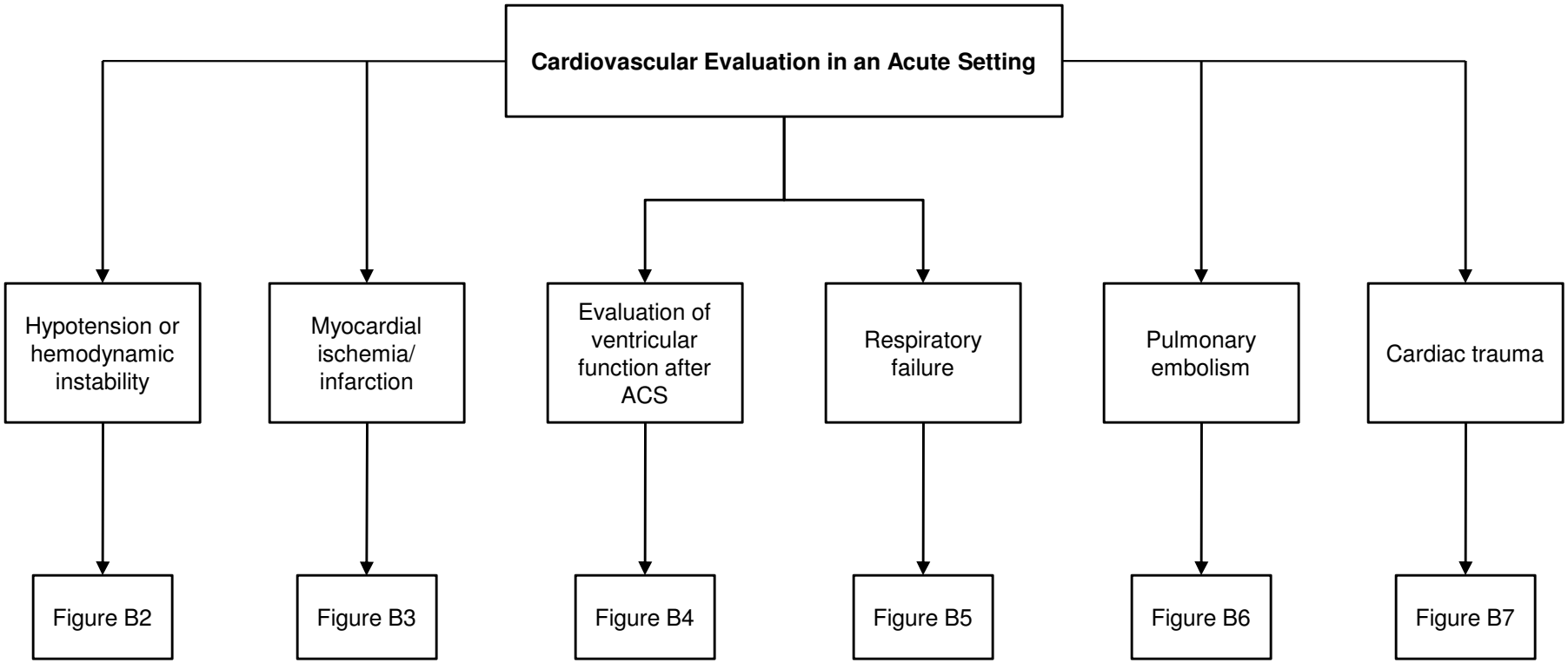

Figure B1. TTE for Cardiovascular Evaluation in an Acute Setting

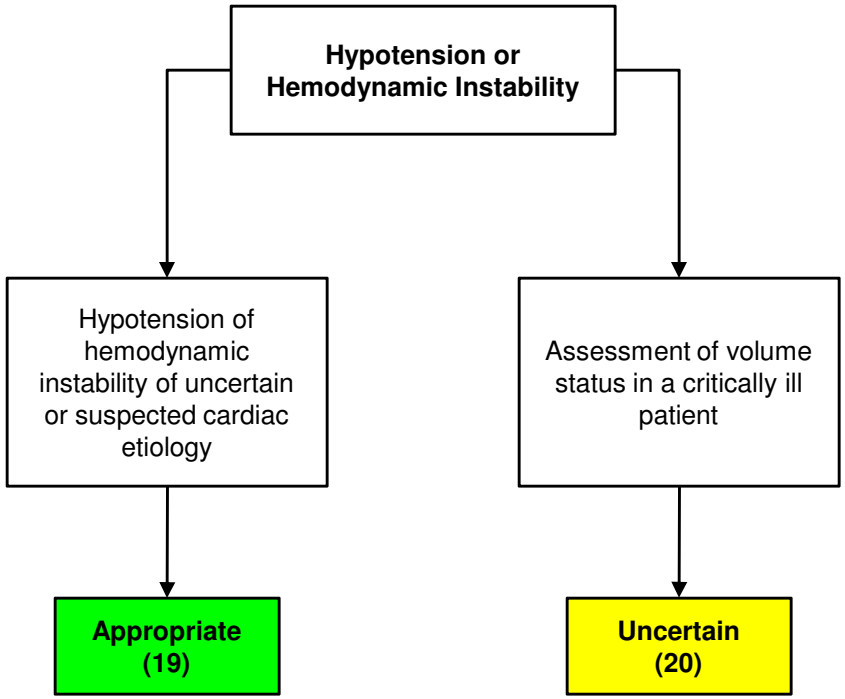

Figure B2. TTE for Cardiovascular Evaluation in an Acute Setting—Hypotension or Hemodynamic Instability

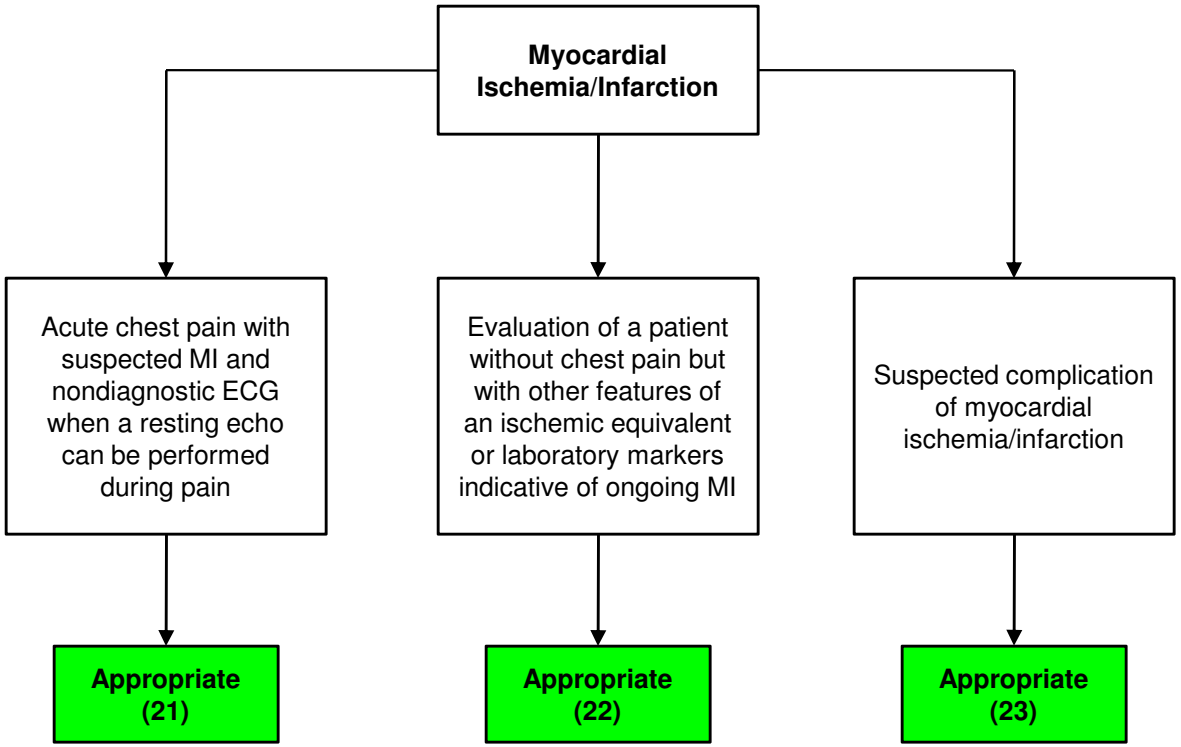

Figure B3. TTE for Cardiovascular Evaluation in an Acute Setting—Myocardial Ischemia/Infarction

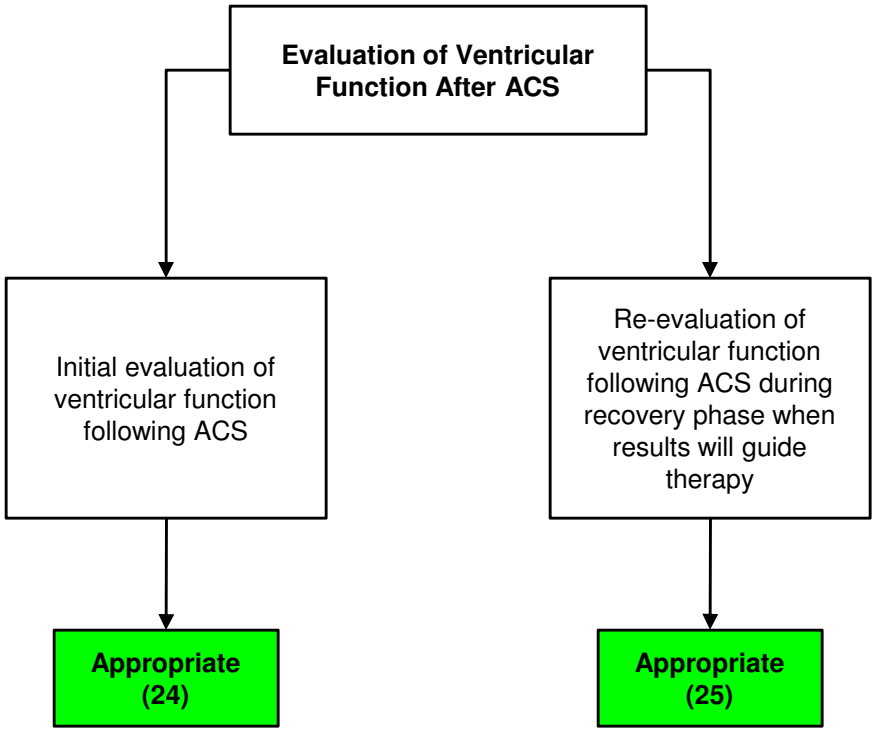

Figure B4. TTE for Cardiovascular Evaluation in an Acute Setting—Evaluation of Ventricular Function After ACS

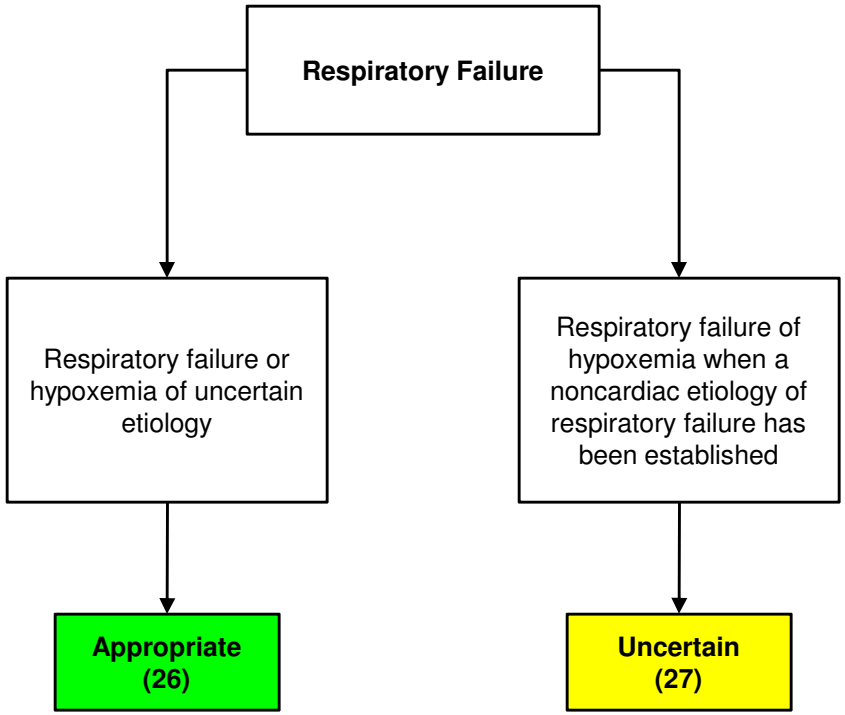

Figure B5. TTE for Cardiovascular Evaluation in an Acute Setting—Respiratory Failure

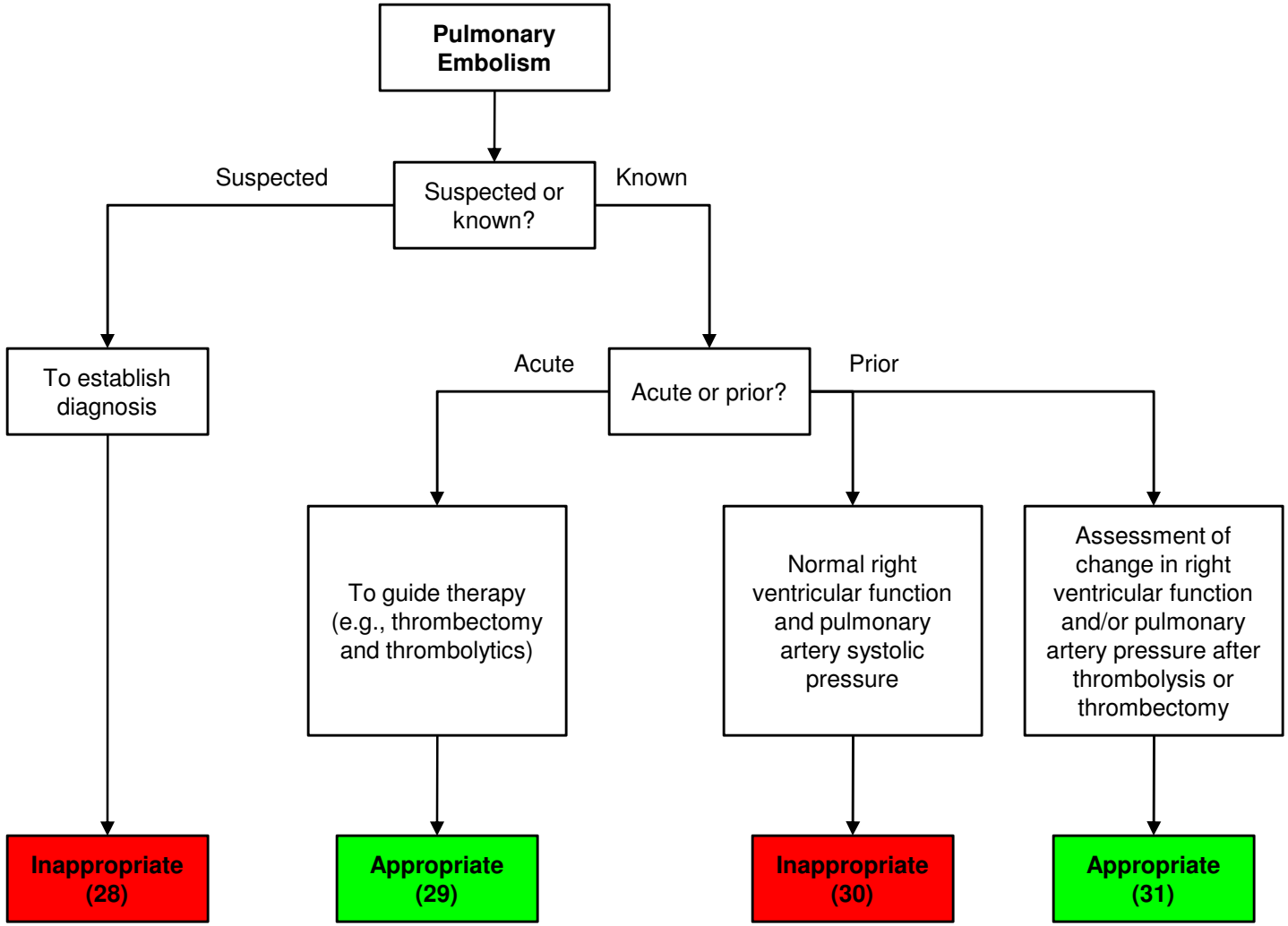

Figure B6. TTE for Cardiovascular Evaluation in an Acute Setting—Pulmonary Embolism

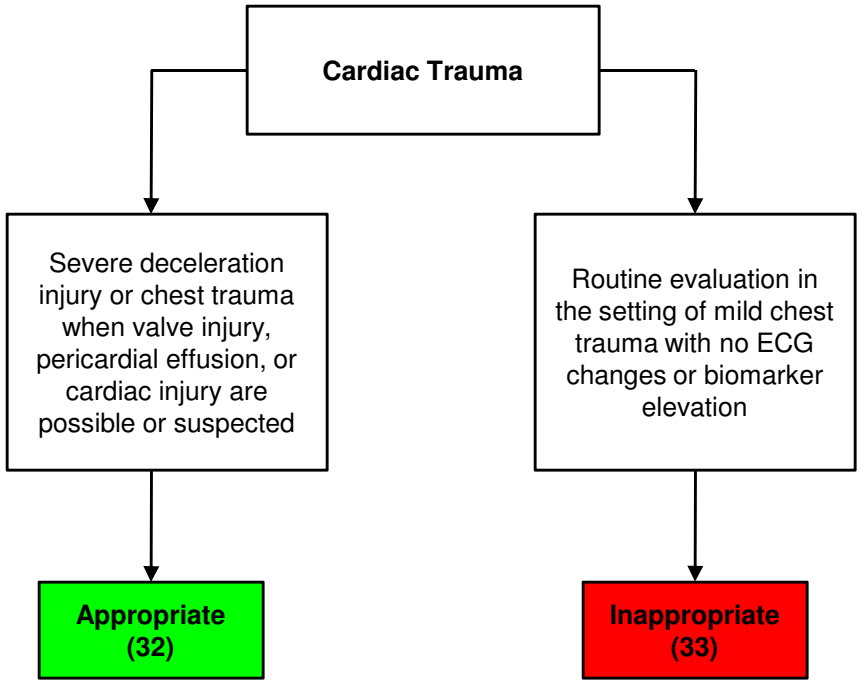

Figure B7. TTE for Cardiovascular Evaluation in an Acute Setting—Cardiac Trauma

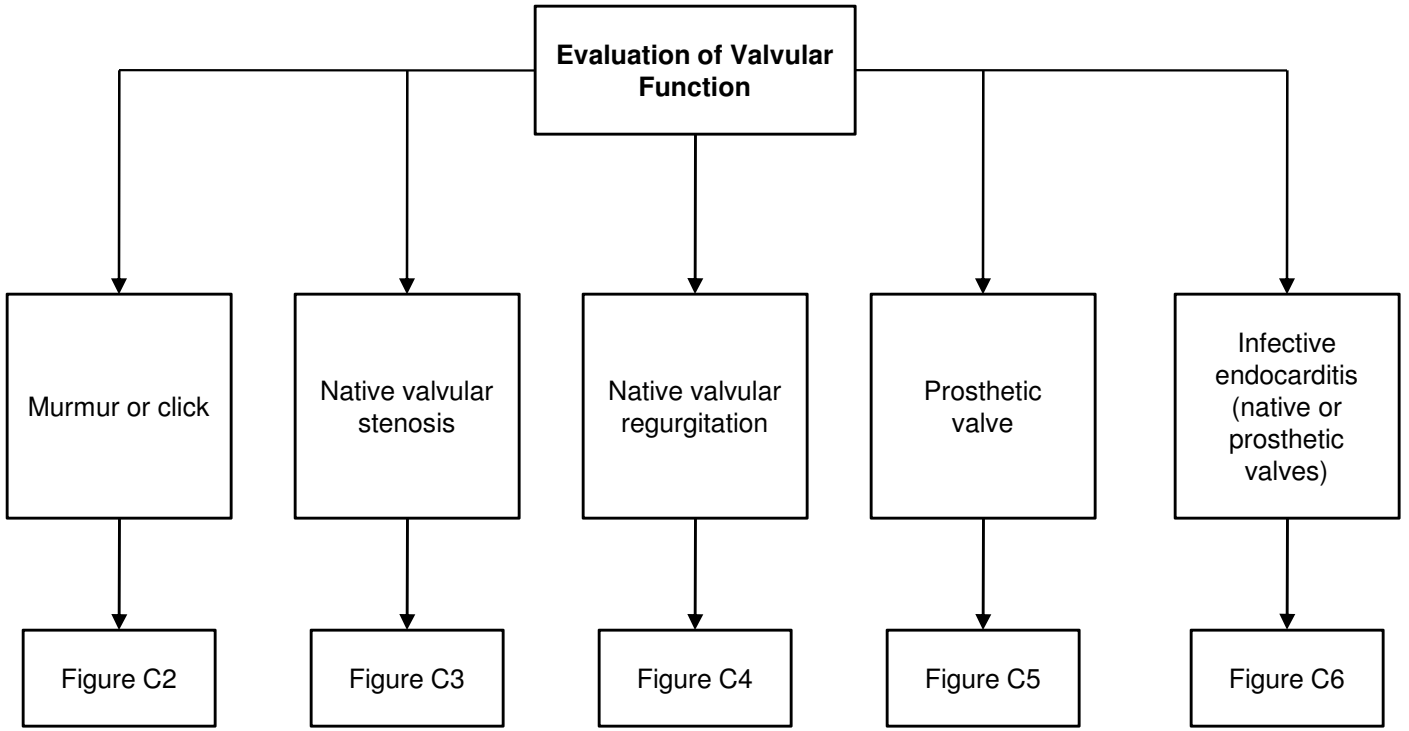

Figure C1. TTE for Evaluation of Valvular Function

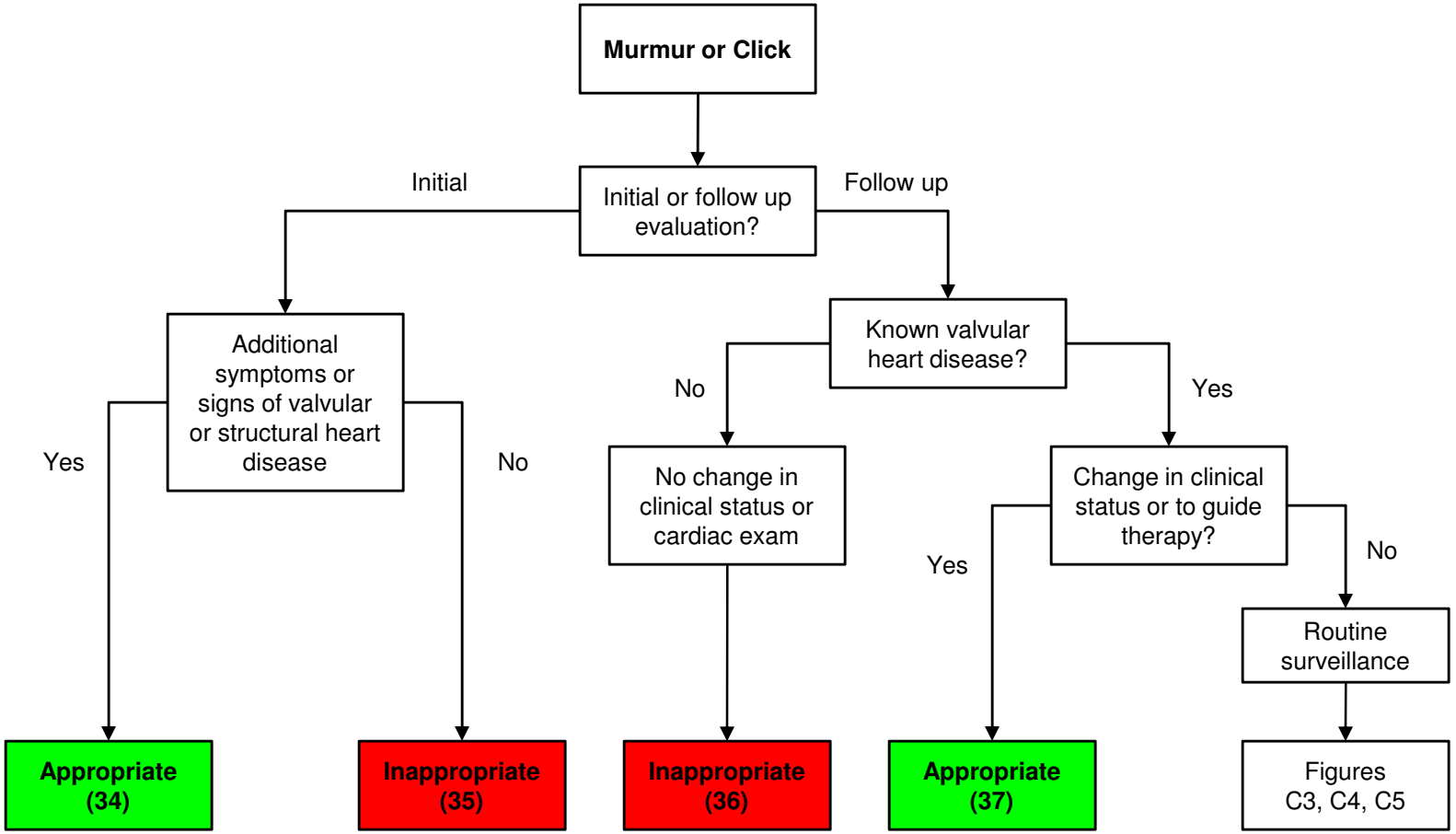

Figure C2. TTE for Evaluation of Valvular Function—Murmur or Click

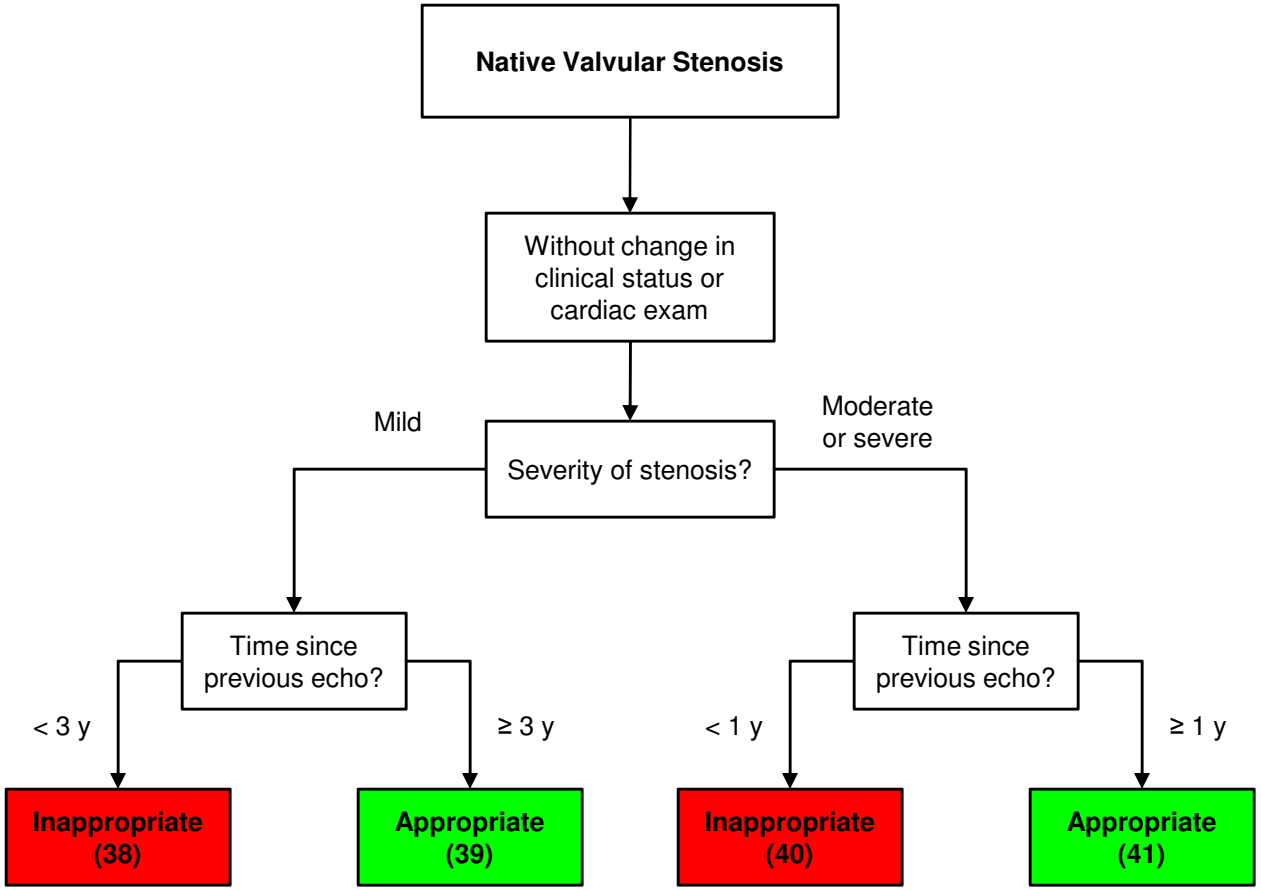

Figure C3. TTE for Evaluation of Valvular Function—Native Valvular Stenosis

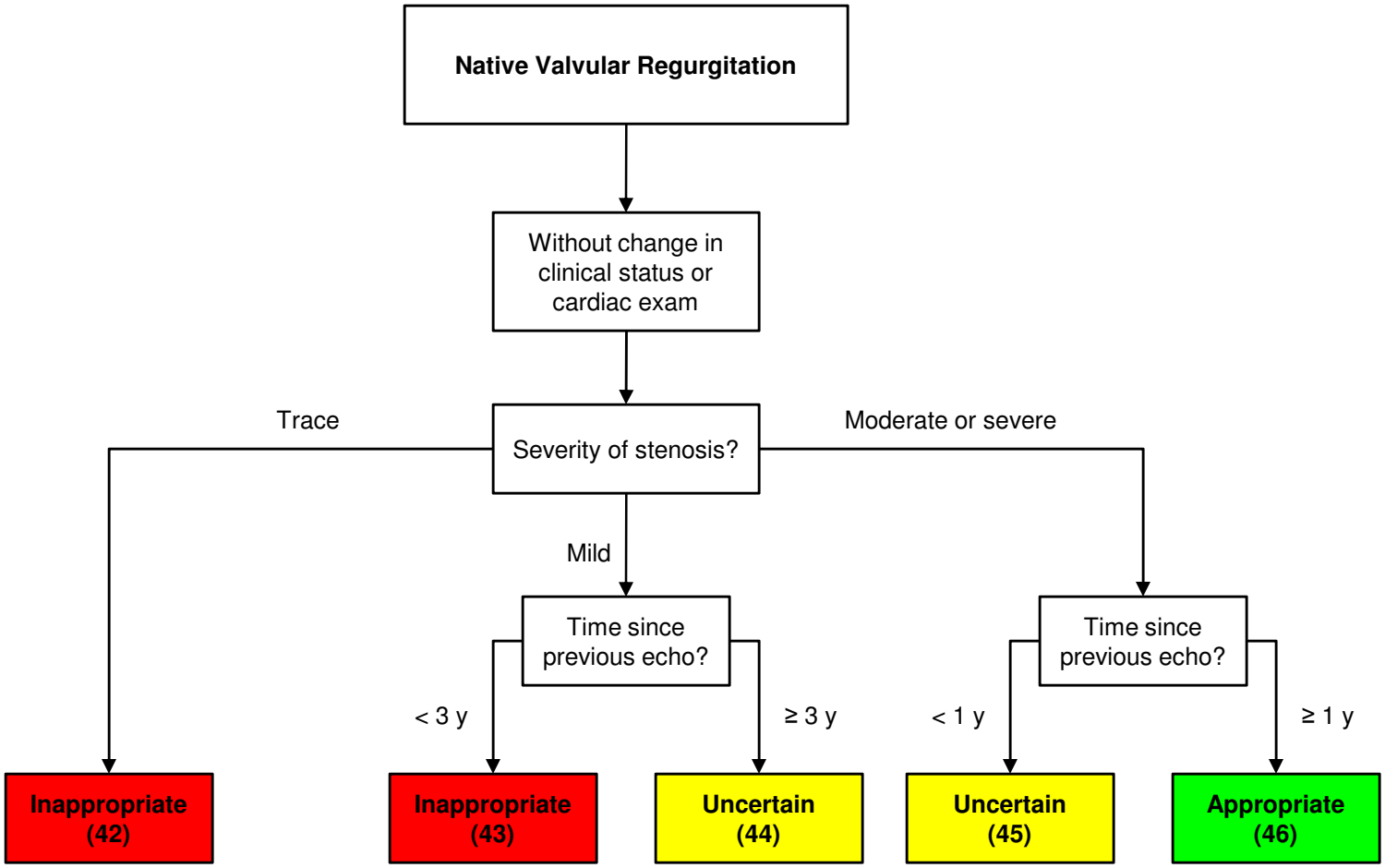

Figure C4. TTE for Evaluation of Valvular Function—Native Valvular Regurgitation

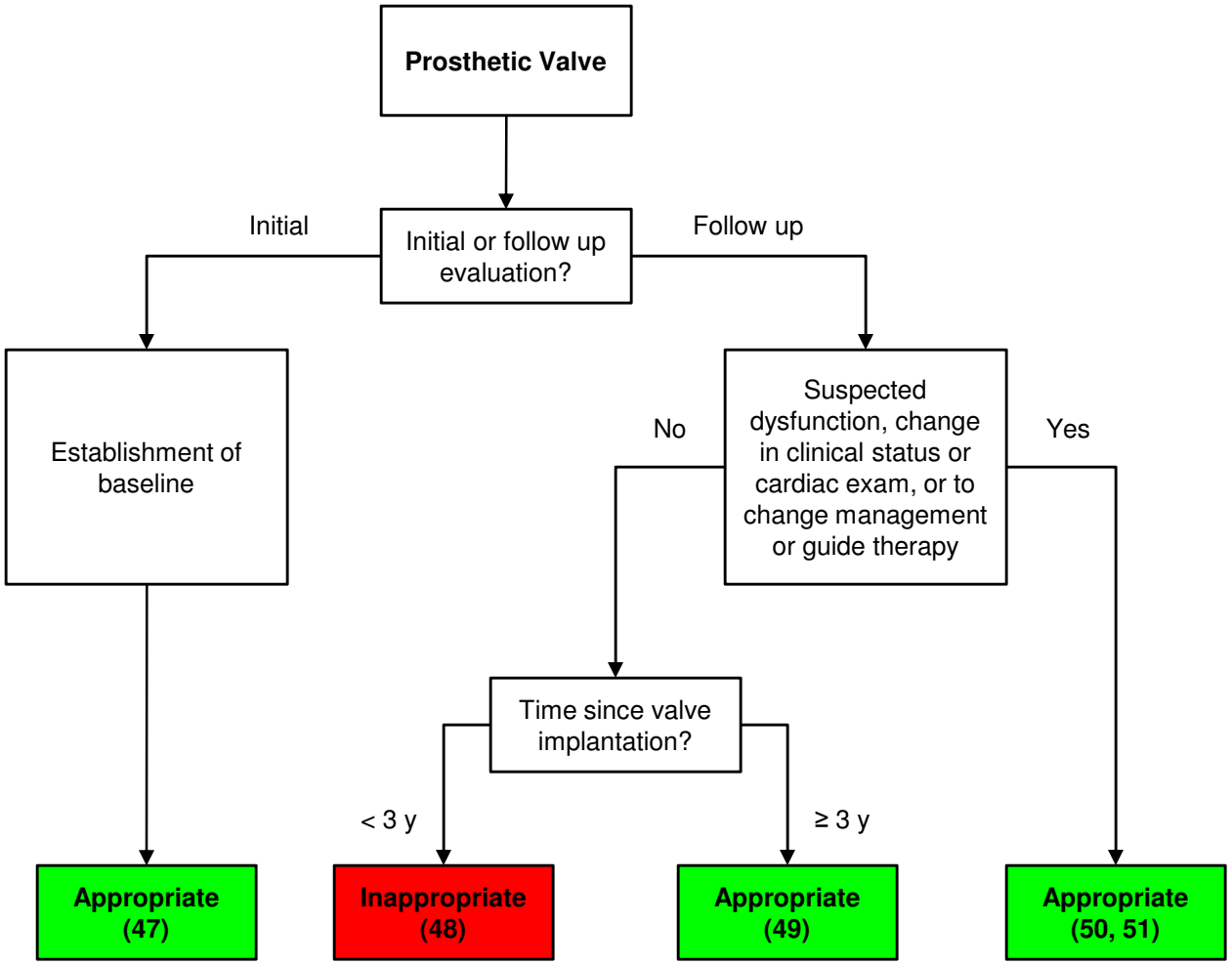

Figure C5. TTE for Evaluation of Valvular Function—Prosthetic Valve

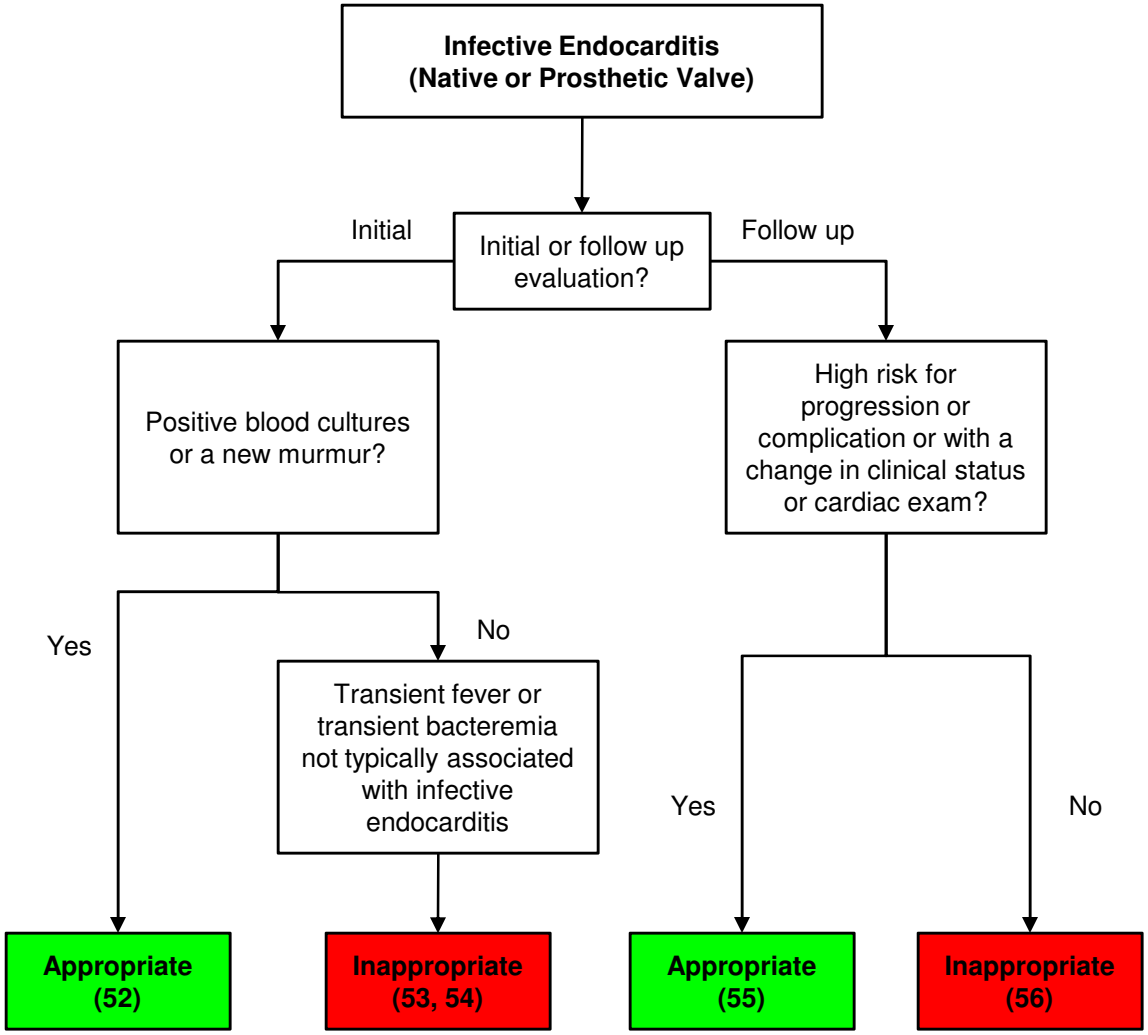

Figure C6. TTE for Evaluation of Valvular Function—Infective Endocarditis (Native or Prosthetic Valve)

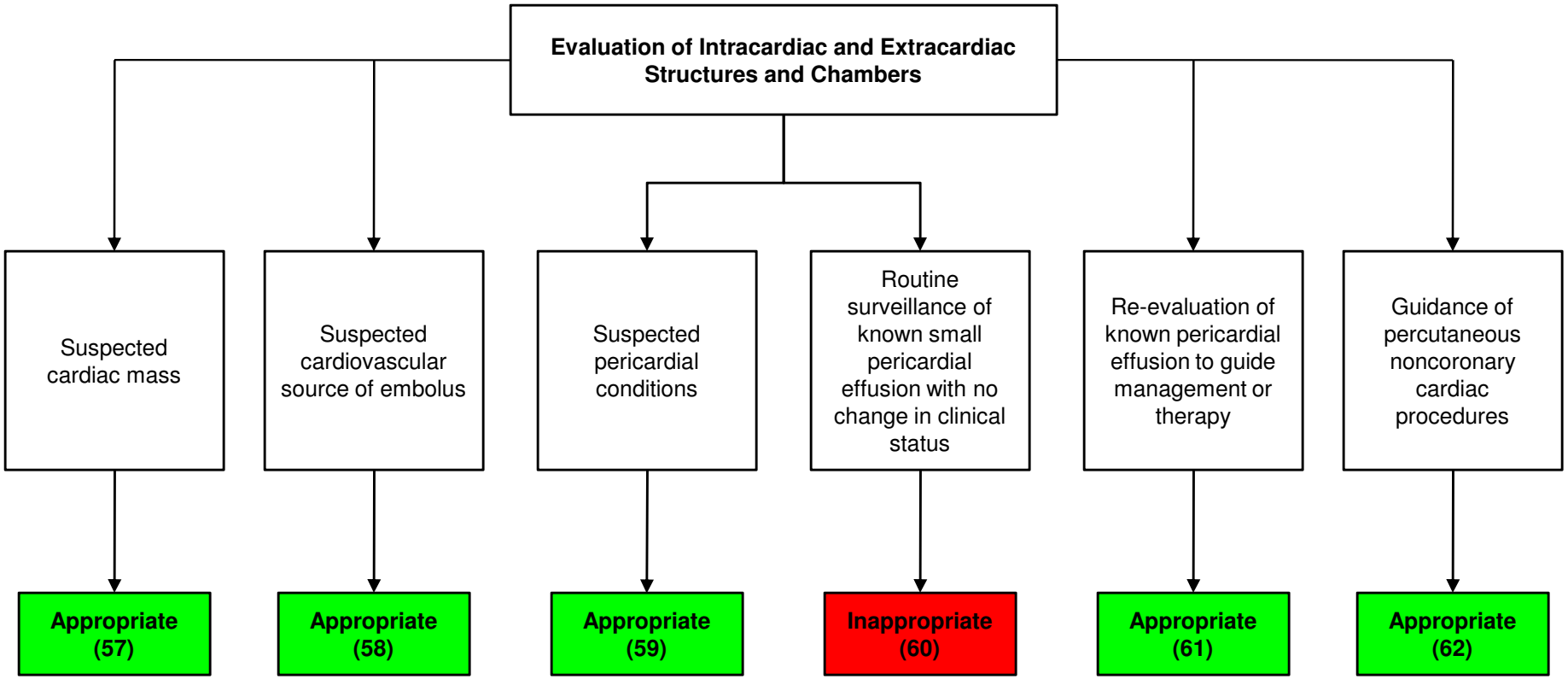

Figure D1. TTE for Evaluation of Intracardiac and Extracardiac Structures and Chambers

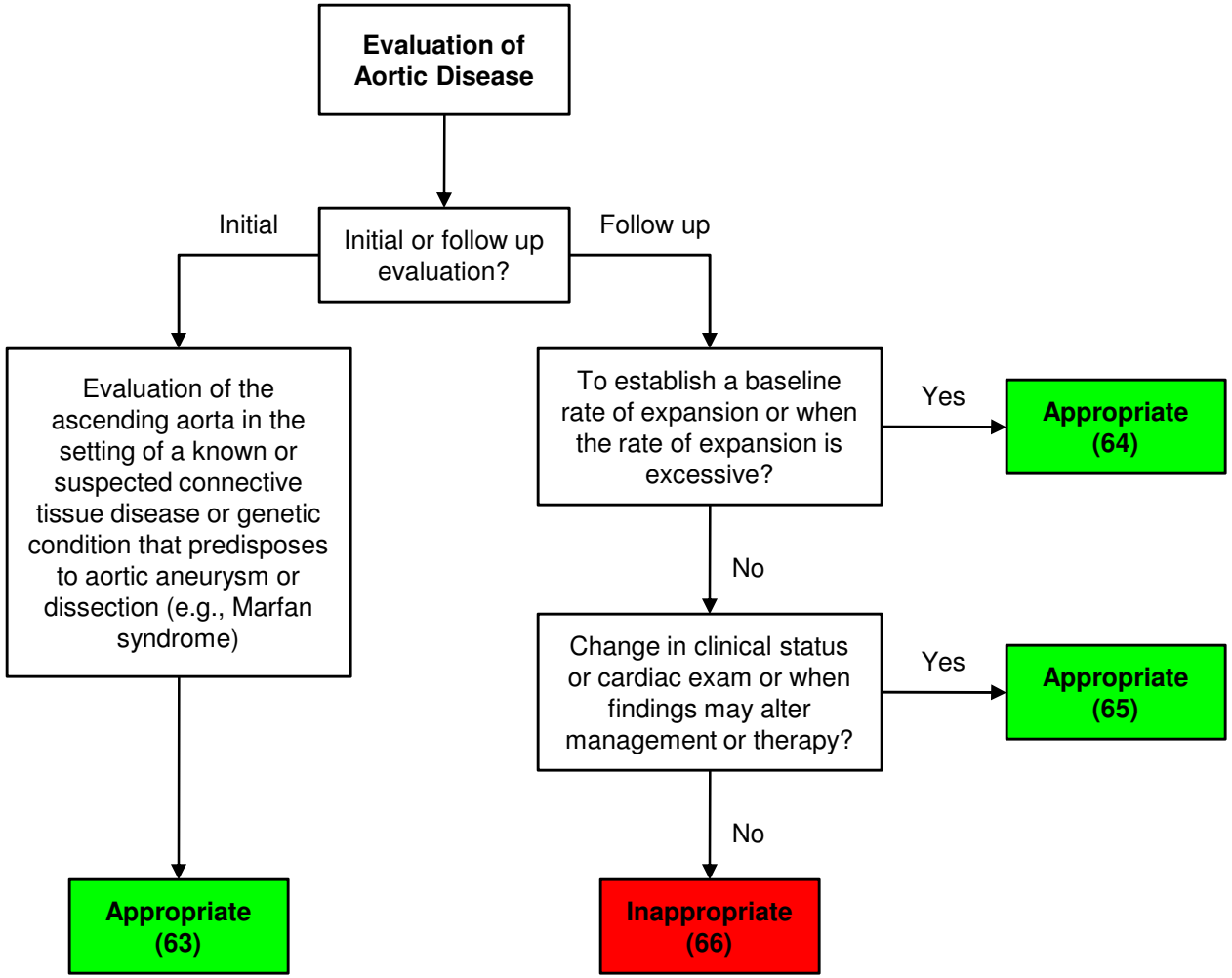

Figure E1. TTE for Evaluation of Aortic Disease

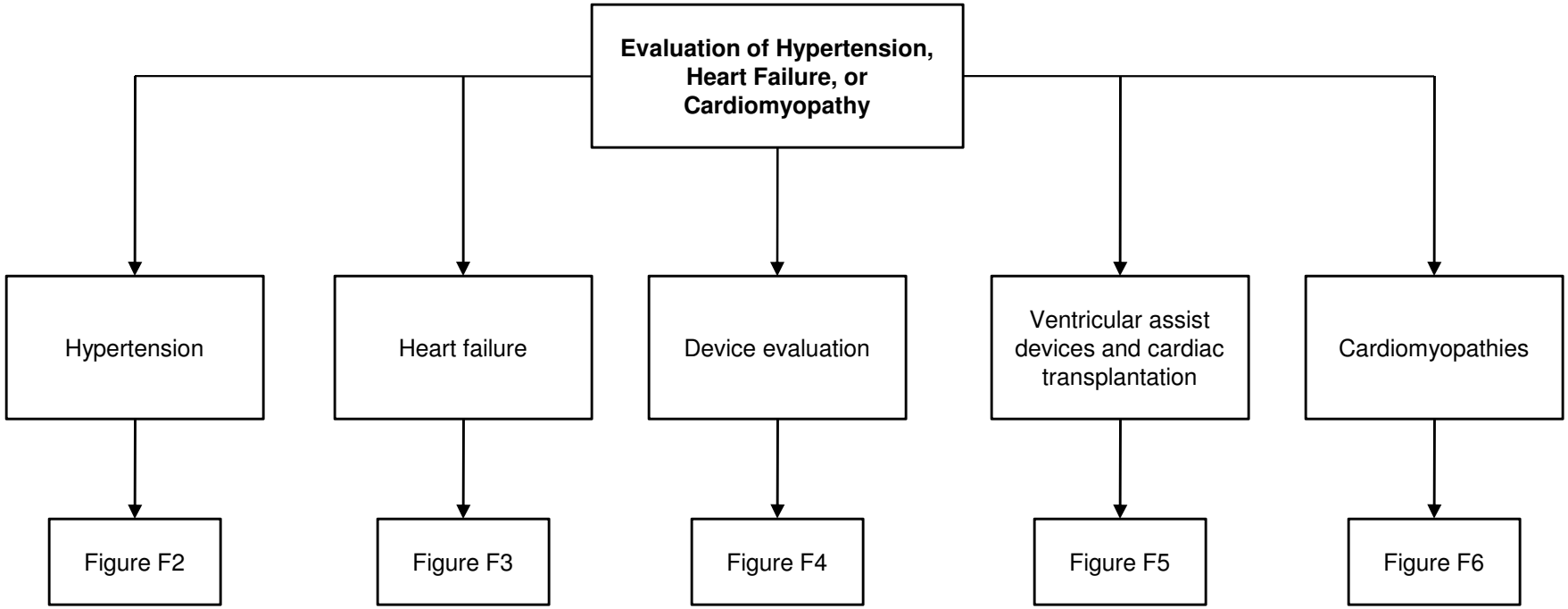

Figure F1. TTE for Evaluation of Hypertension, Heart Failure, or Cardiomyopathy

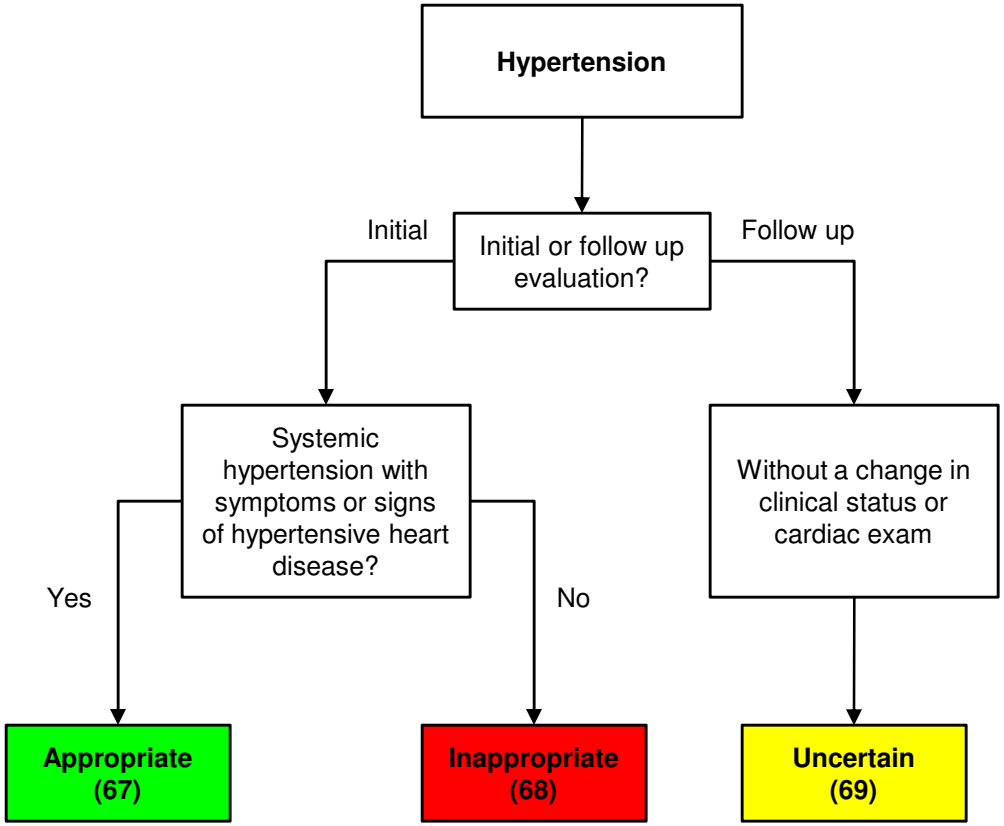

Figure F2. TTE for Evaluation of Hypertension, Heart Failure, or Cardiomyopathy—Hypertension

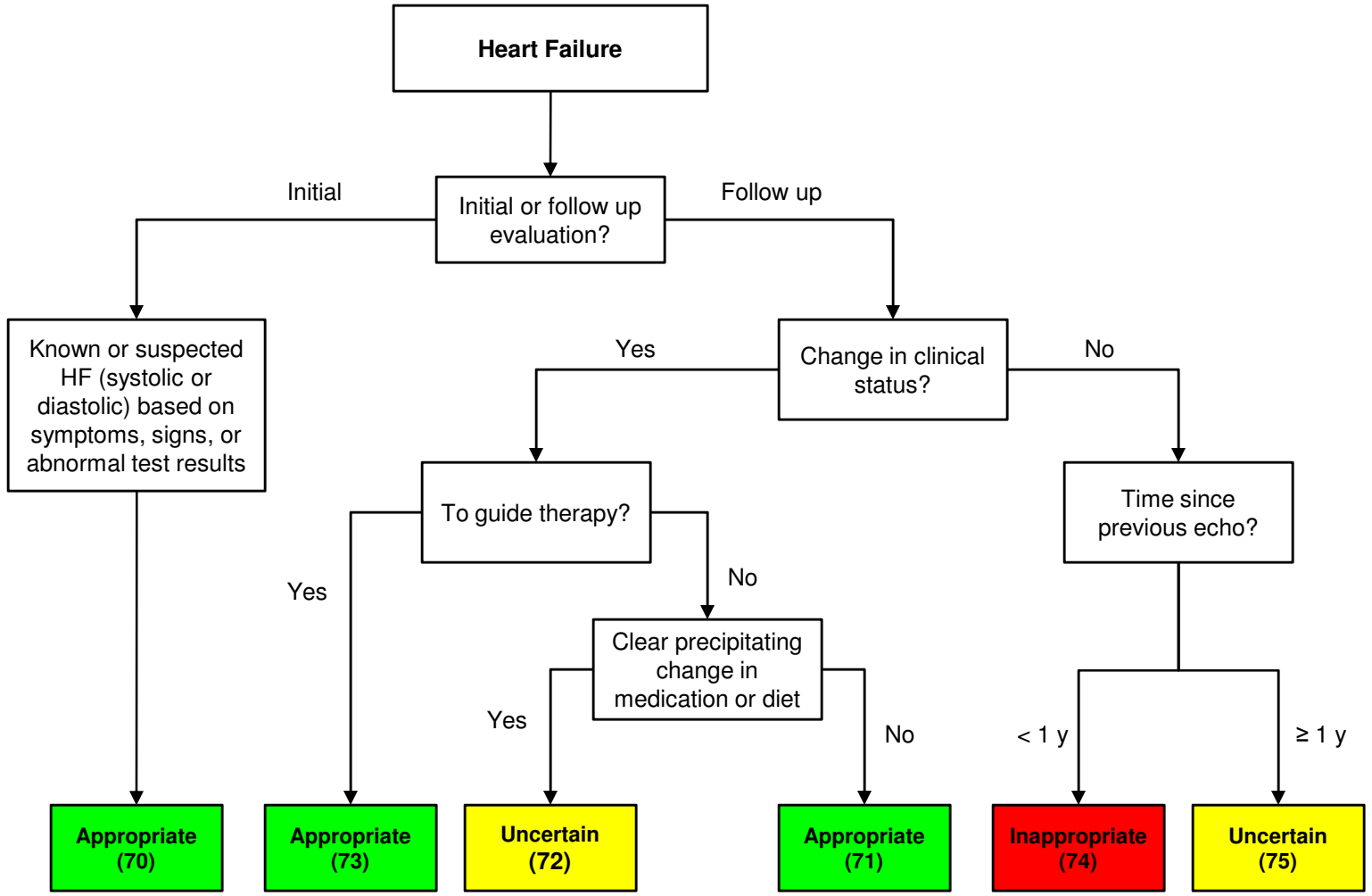

Figure F3. TTE for Evaluation of Hypertension, Heart Failure, or Cardiomyopathy—Heart Failure

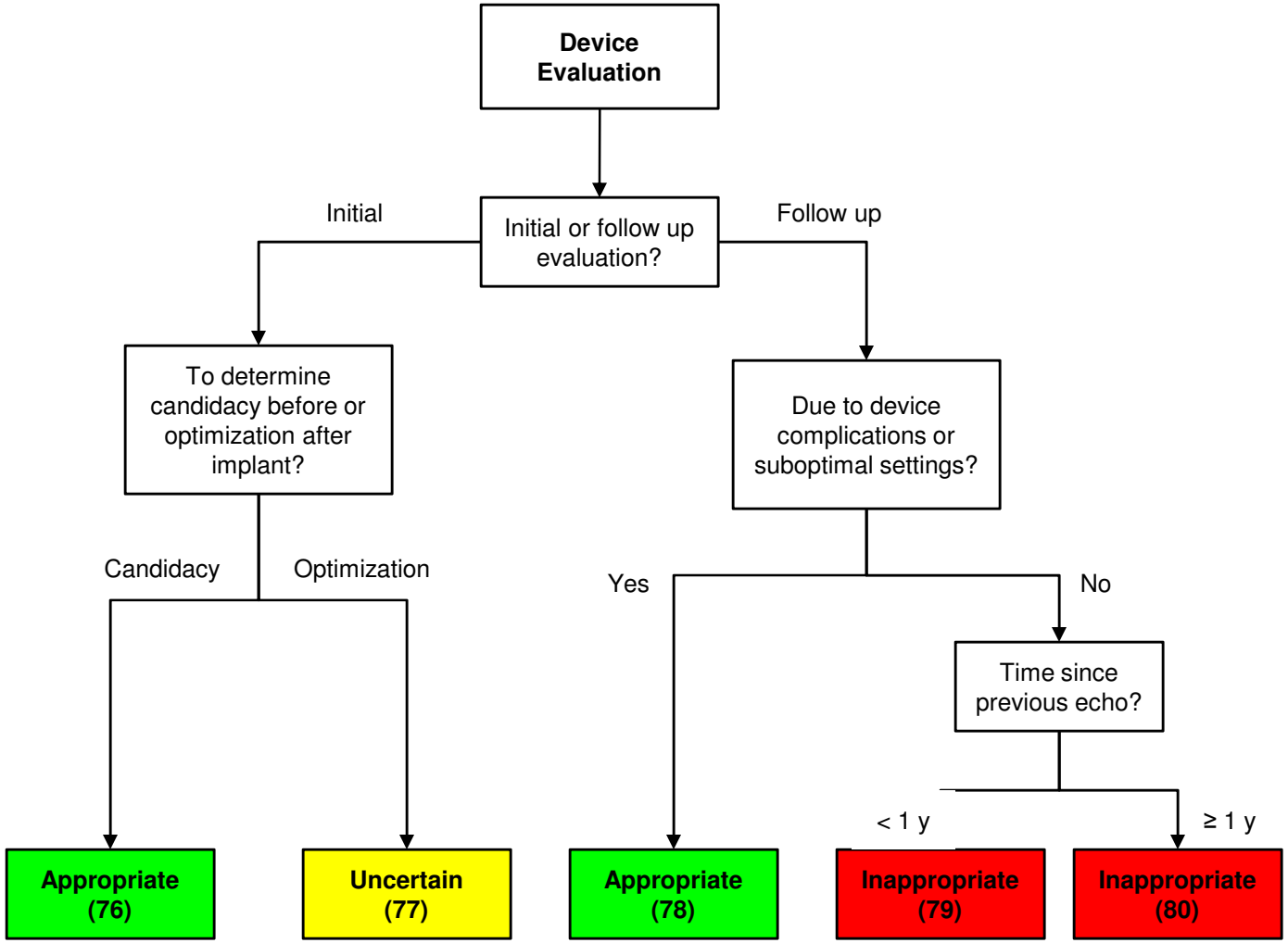

Figure F4. TTE for Evaluation of Hypertension, Heart Failure, or Cardiomyopathy—Device Evaluation

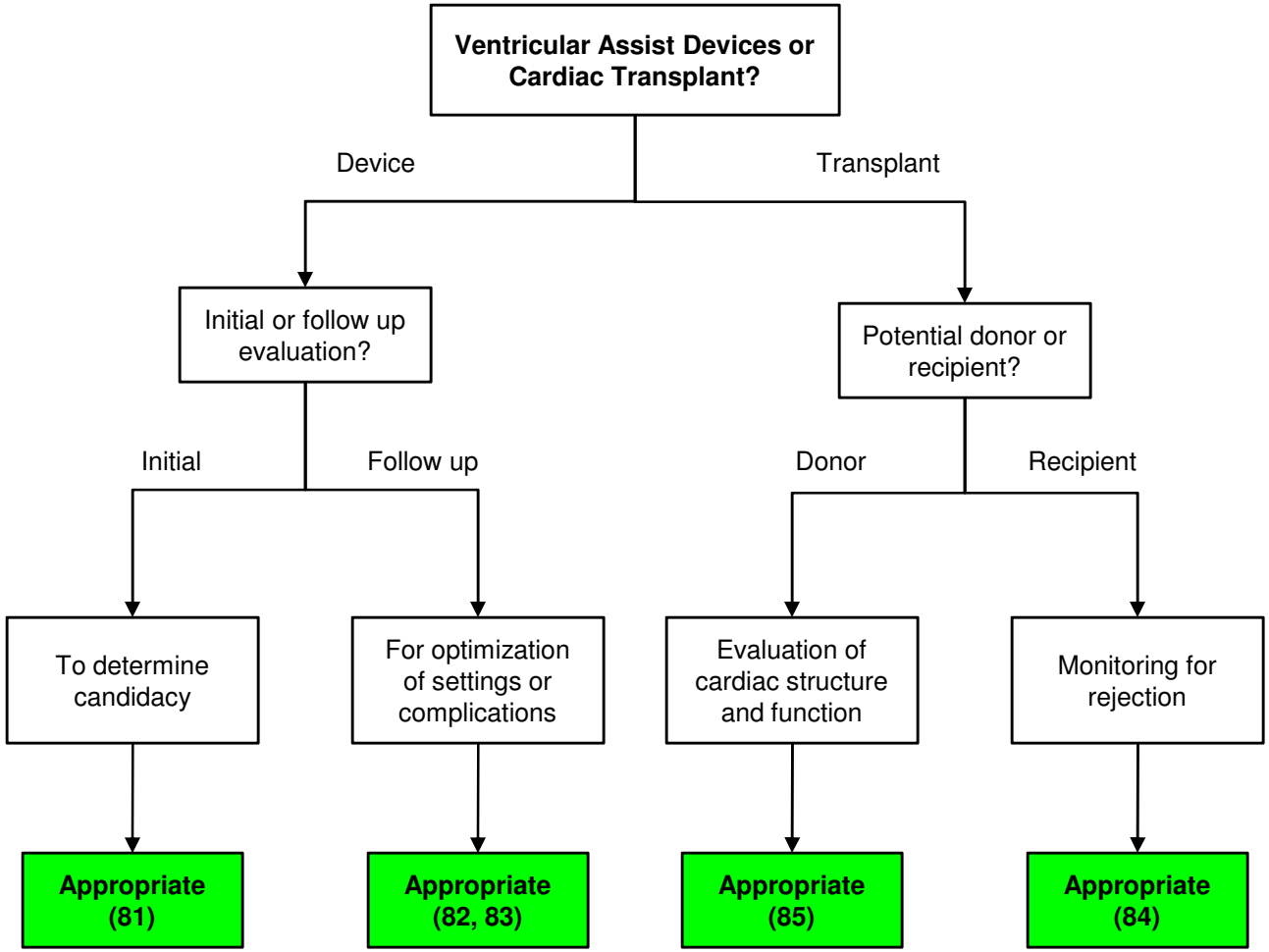

Figure F5. TTE for Evaluation of Hypertension, Heart Failure, or Cardiomyopathy—Ventricular Assist Devices and Cardiac Transplant

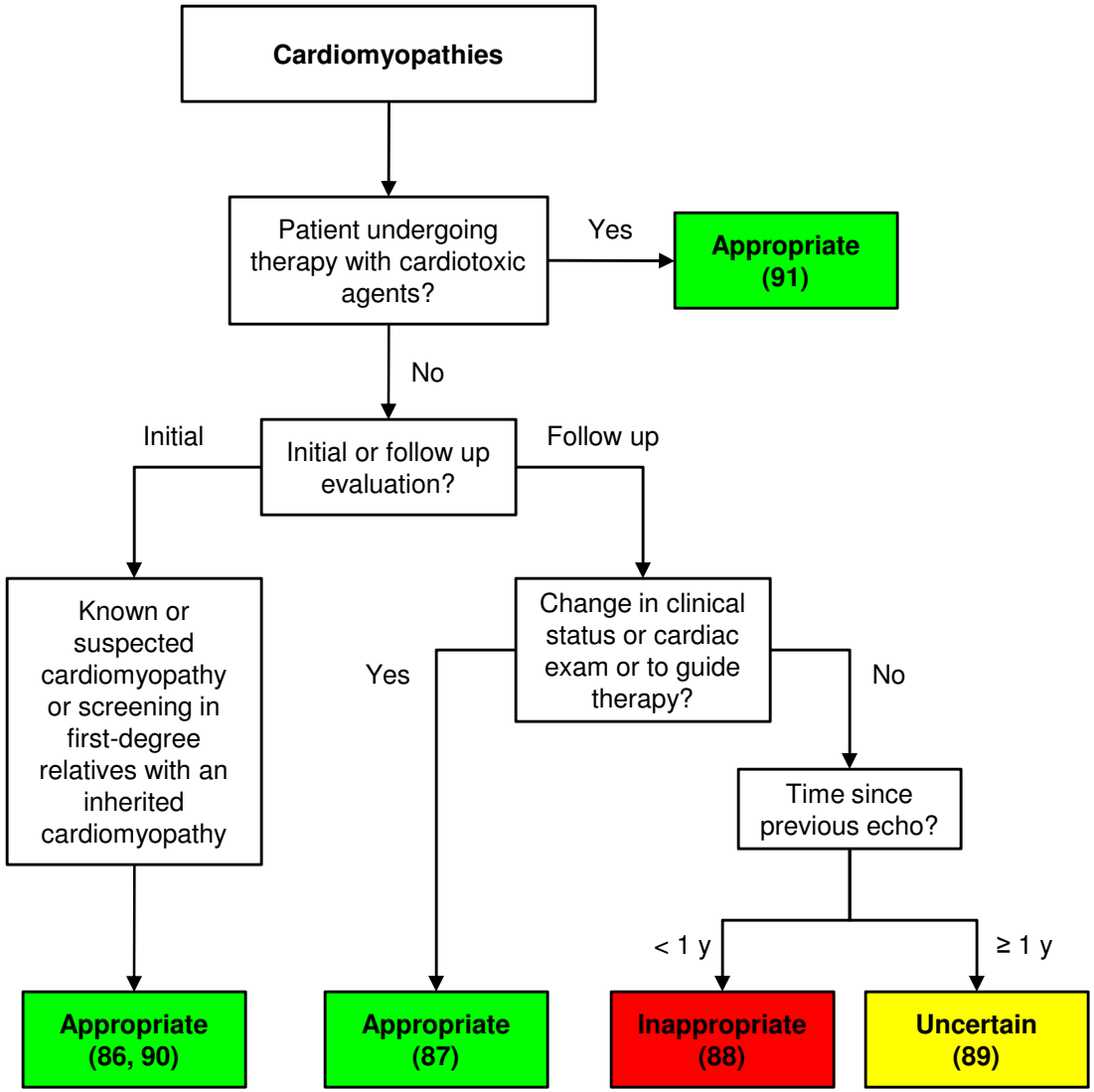

Figure F6. TTE for Evaluation of Hypertension, Heart Failure, or Cardiomyopathy—Cardiomyopathies

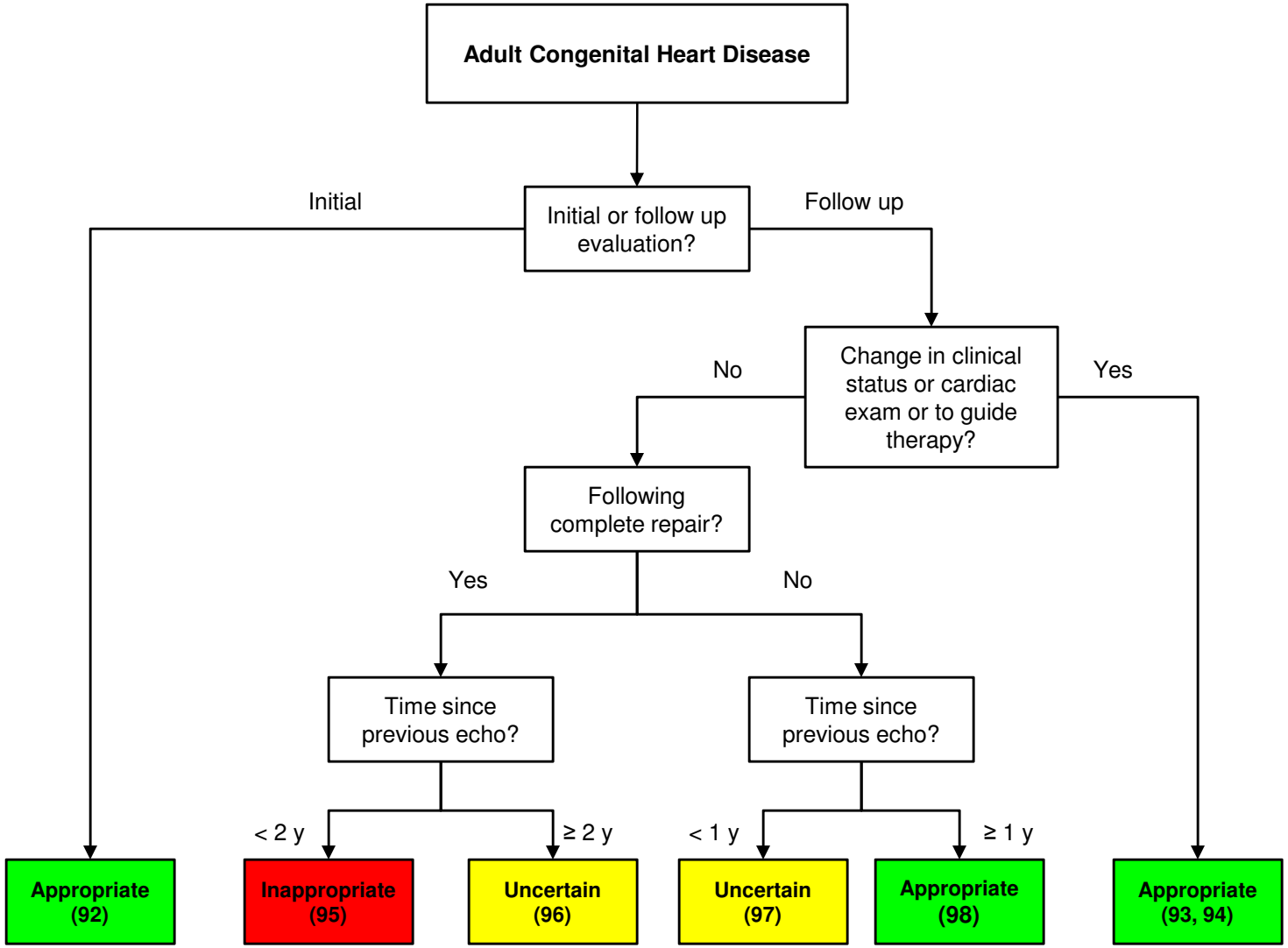

Figure G1. TTE for Adult Congenital Heart Disease

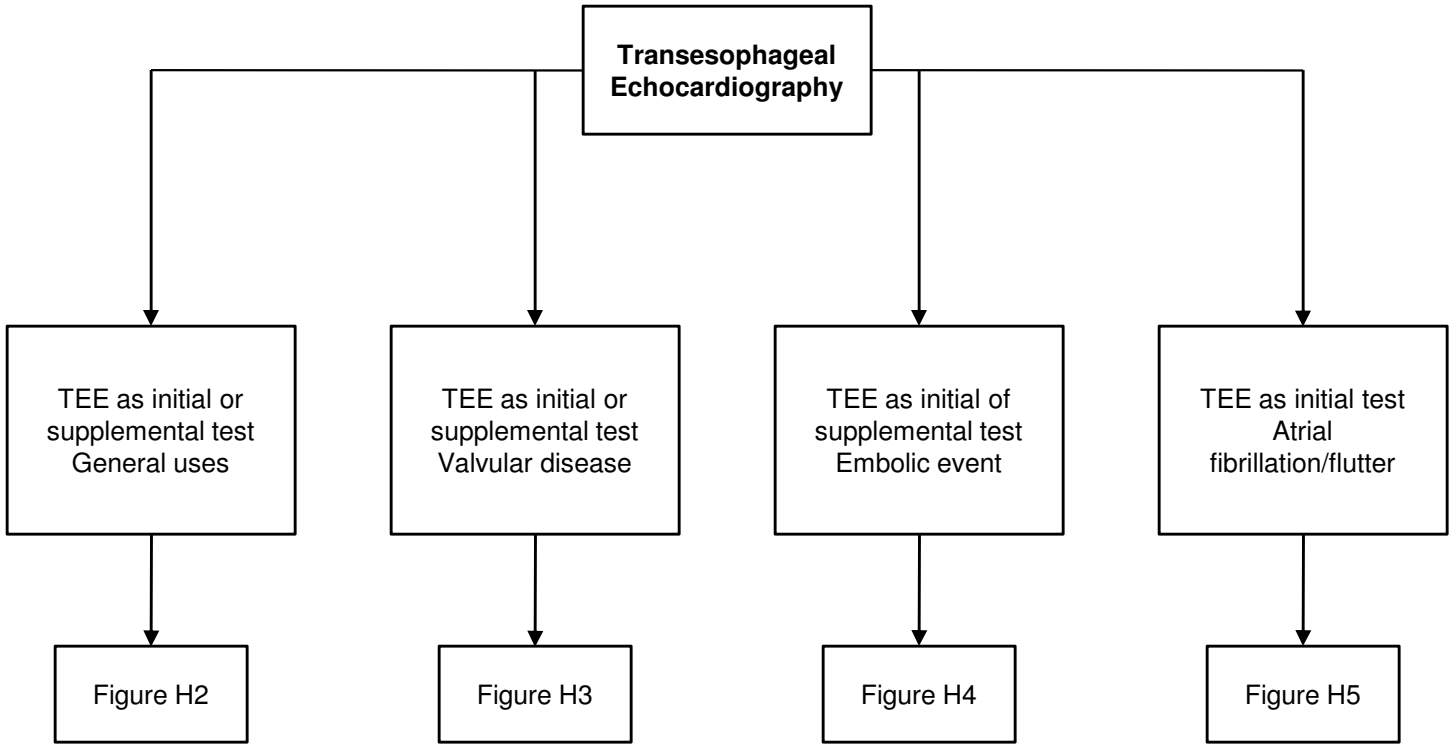

Figure H1. Transesophageal Echocardiography (TEE)

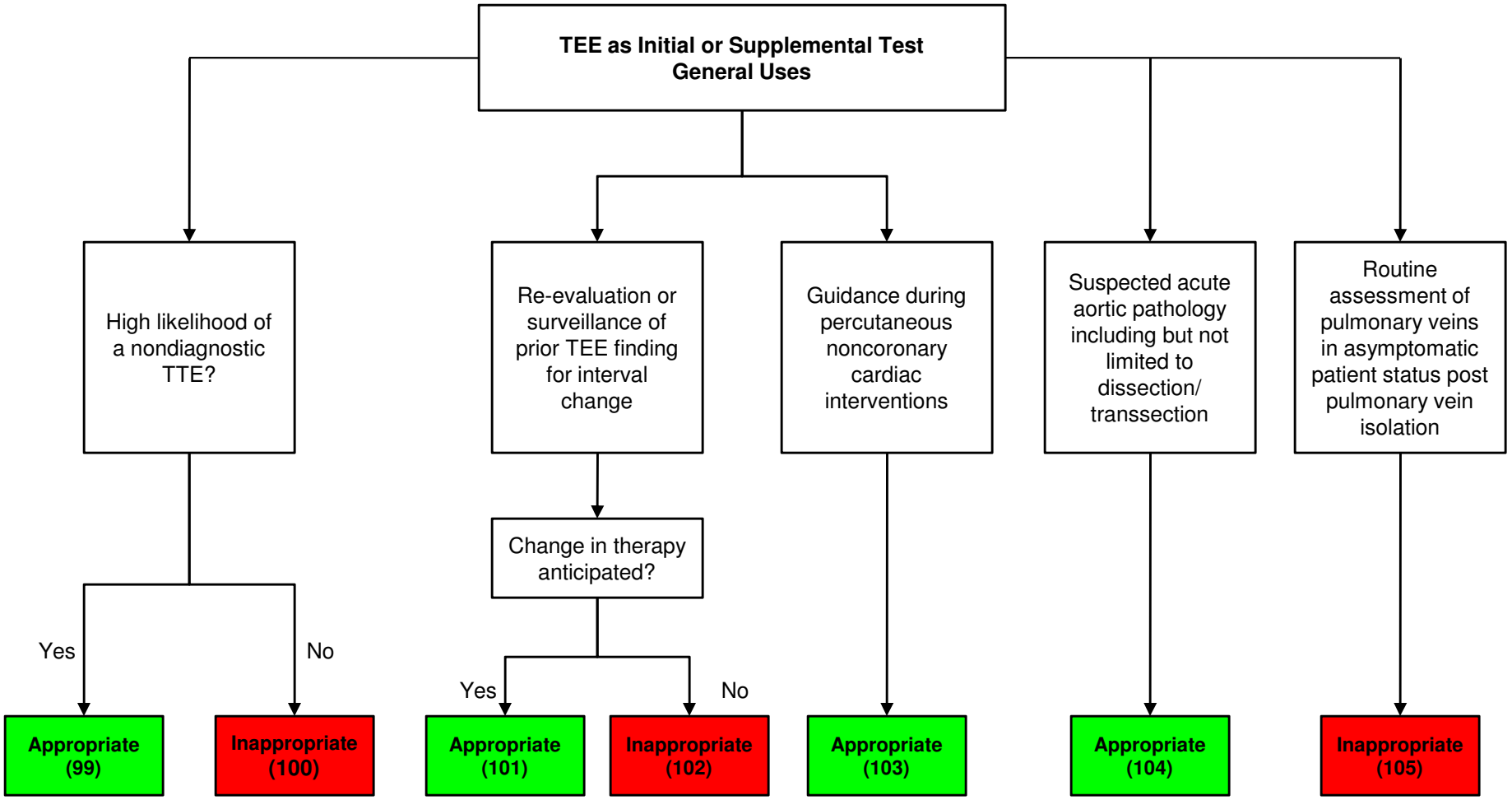

Figure H2. Transesophageal Echocardiography (TEE)—TEE as Initial or Supplemental Test—General Uses

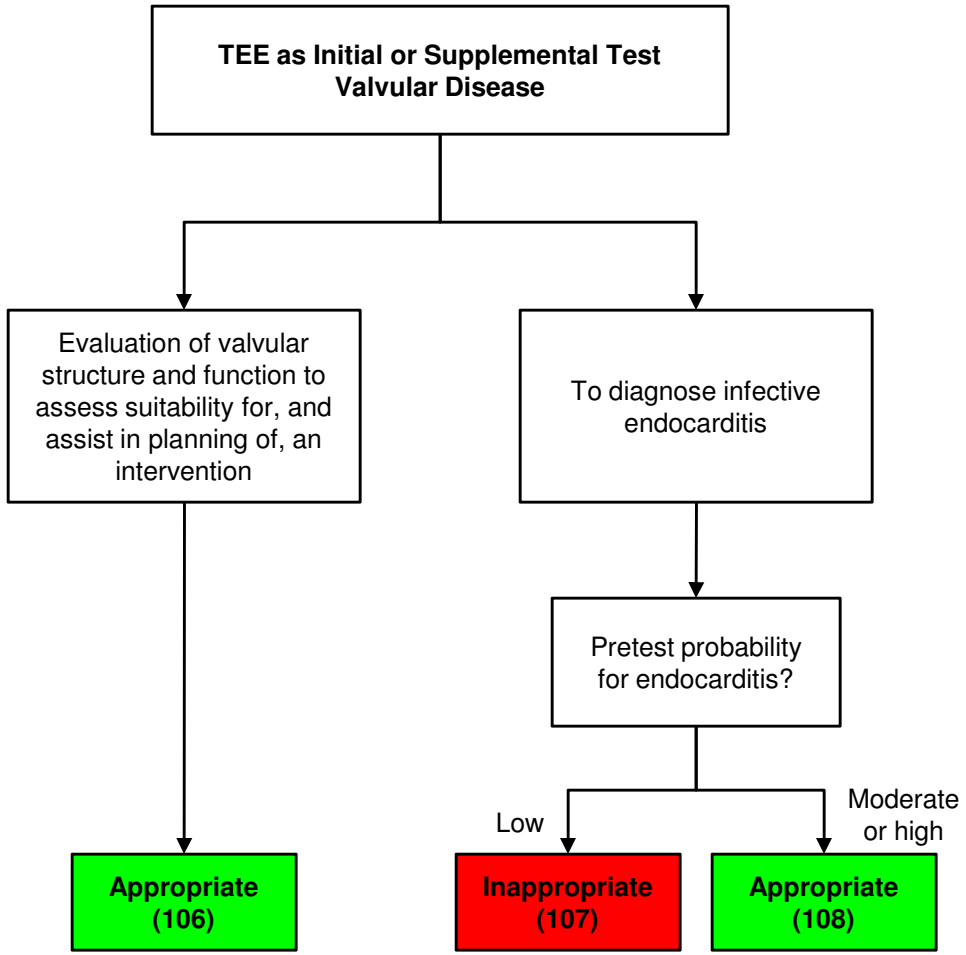

Figure H3. Transesophageal Echocardiography (TEE)—TEE as Initial or Supplemental Test—Valvular Disease

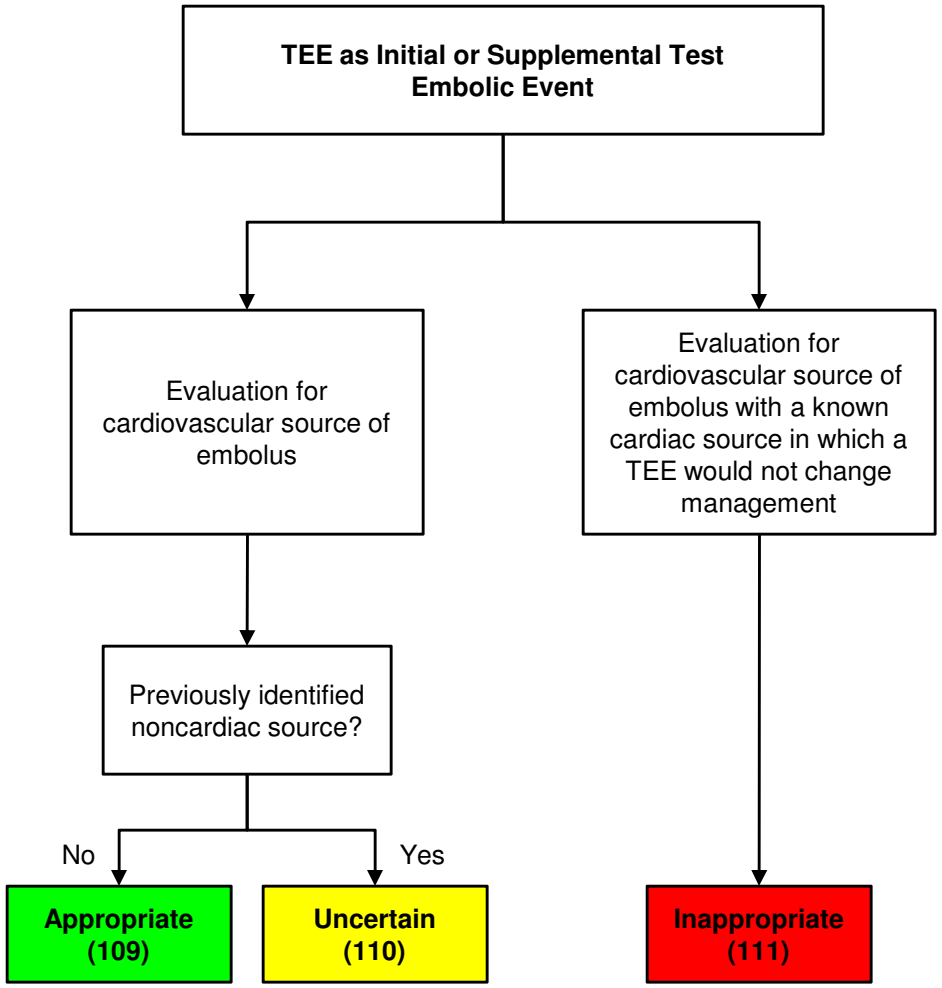

Figure H4. Transesophageal Echocardiography (TEE)—TEE as Initial or Supplemental Test—Embolic Event

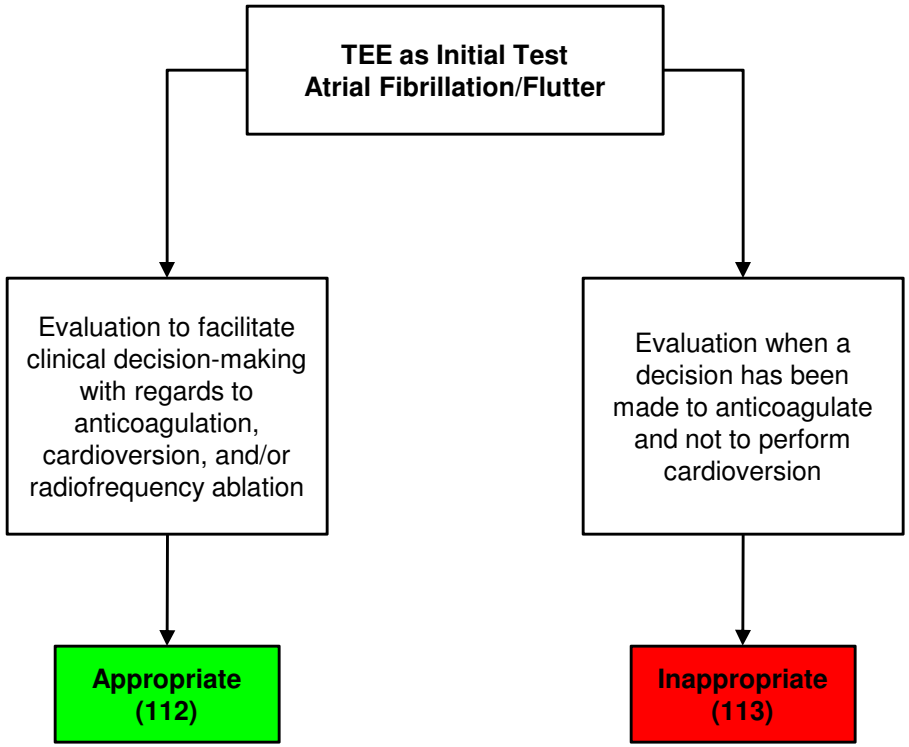

Figure H5. Transesophageal Echocardiography (TEE)—TEE as Initial Test—Atrial Fibrillation/Flutter

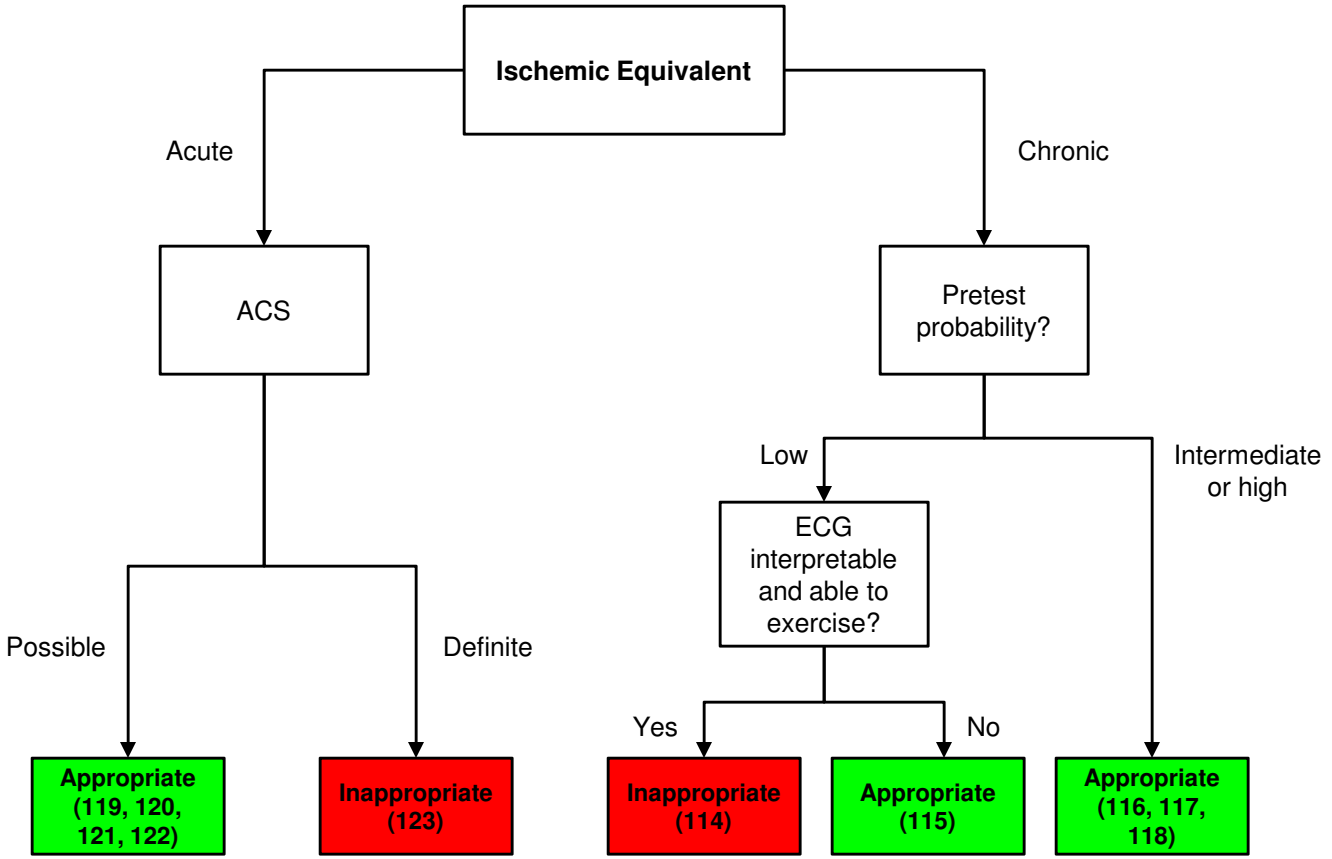

Figure I1. Stress Echocardiography for Detection of CAD/Risk Assessment—Symptomatic or Ischemic Equivalent

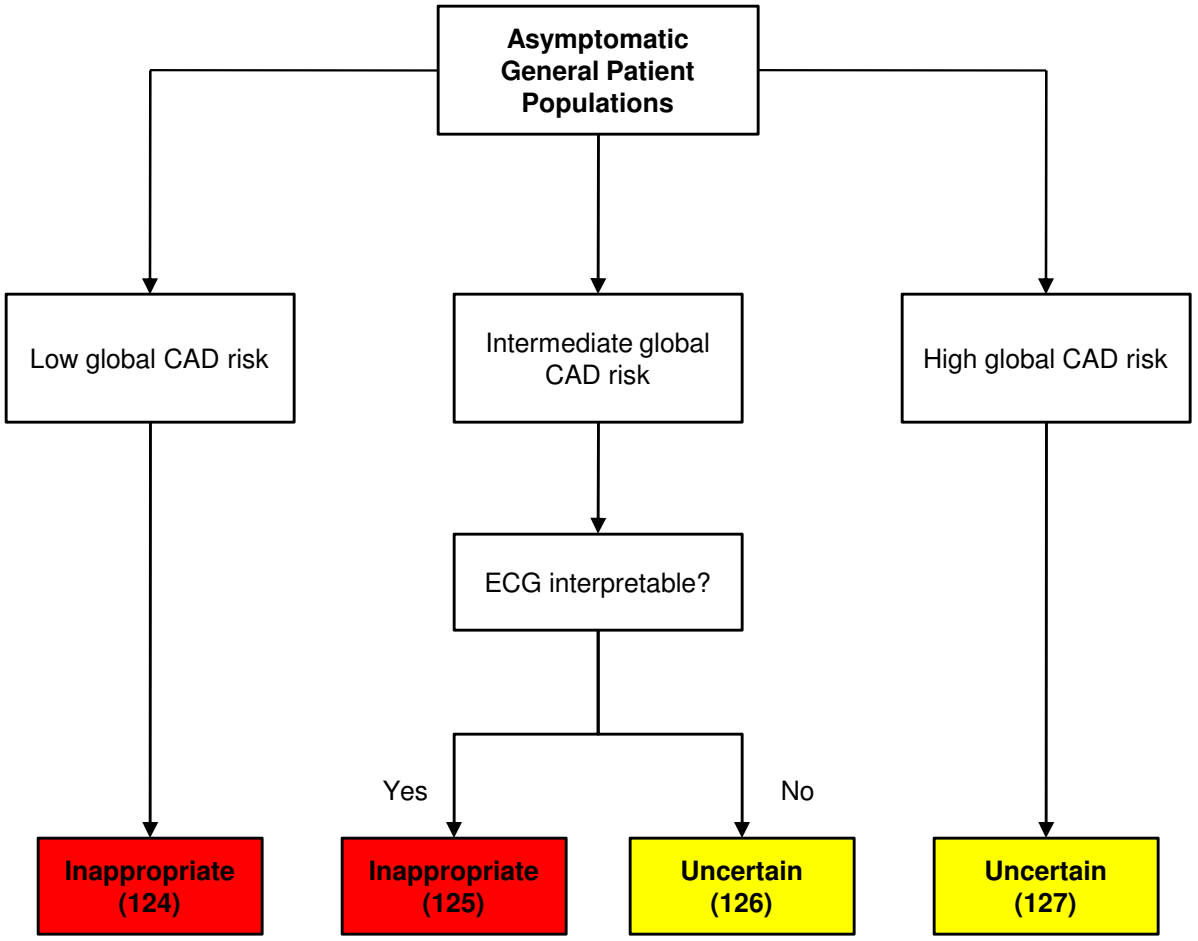

Figure J1. Stress Echocardiography for Detection of CAD/Risk Assessment—Asymptomatic (Without Ischemic Equivalent)

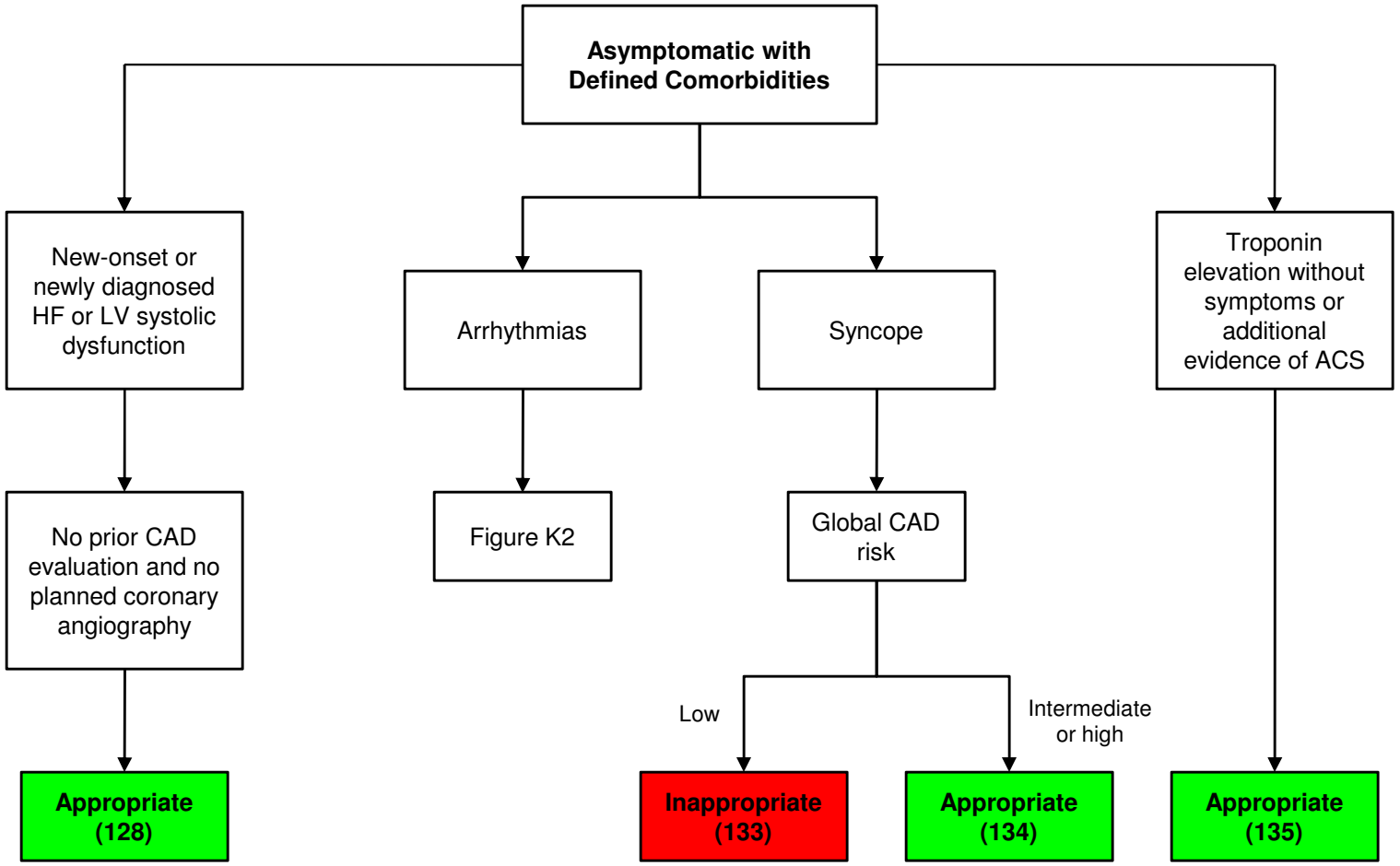

Figure K1. Stress Echocardiography for Detection of CAD/Risk Assessment—Asymptomatic (Without Ischemic Equivalent) in Patient Populations With Defined Comorbidities

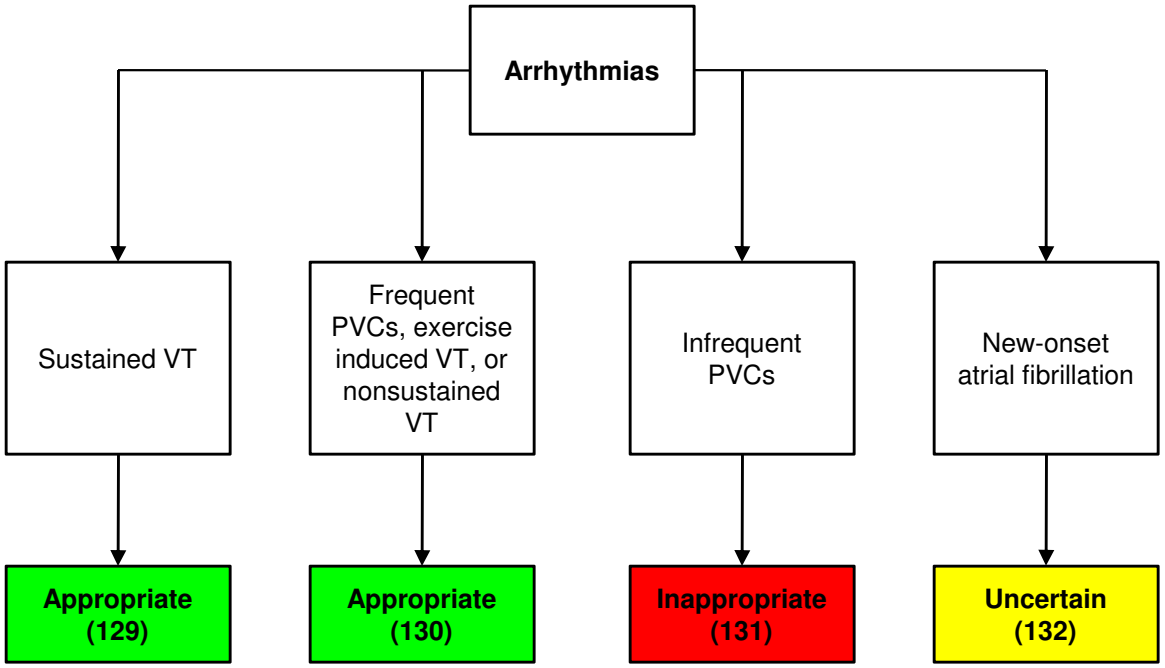

Figure K2. Stress Echocardiography for Detection of CAD/Risk Assessment—Asymptomatic (Without Ischemic Equivalent) in Patient Populations With Defined Comorbidities—Arrhythmias

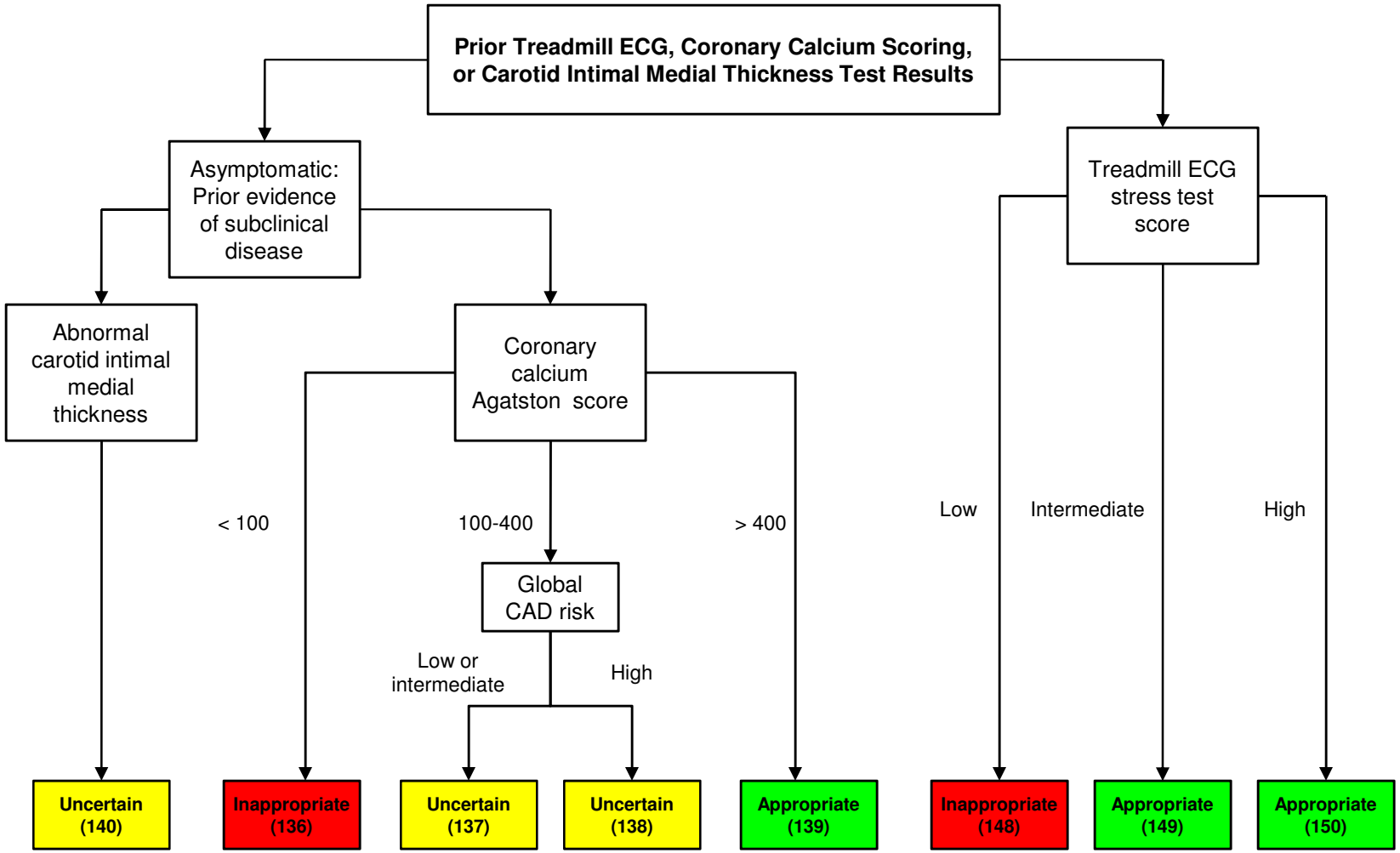

Figure L1. Stress Echocardiography Following Prior Treadmill ECG, Coronary Calcium Scoring, or Carotid Intimal Medial Thickness Test Results

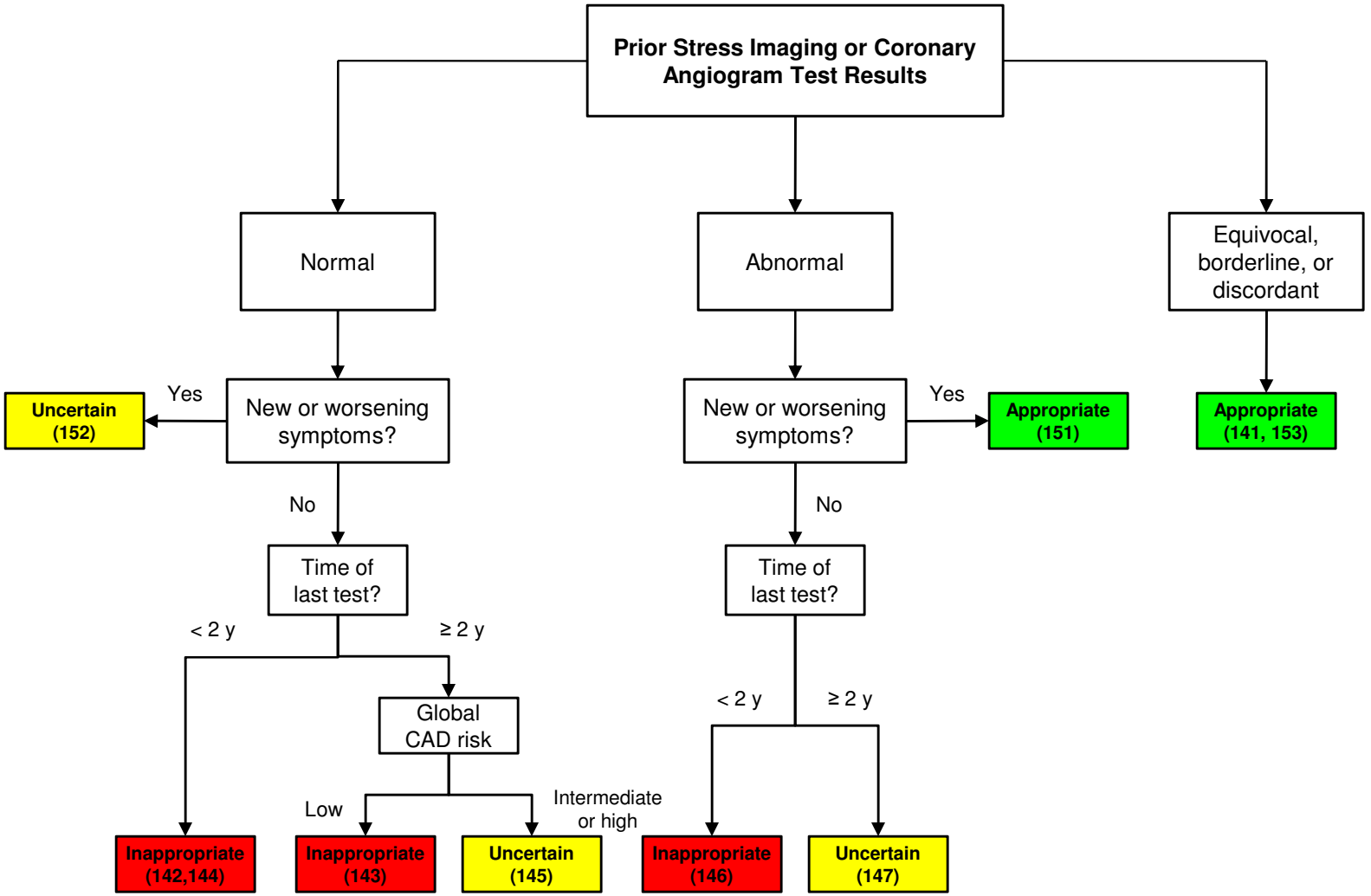

Figure L2. Stress Echocardiography Following Prior Stress Imaging or Coronary Angiogram Test Results

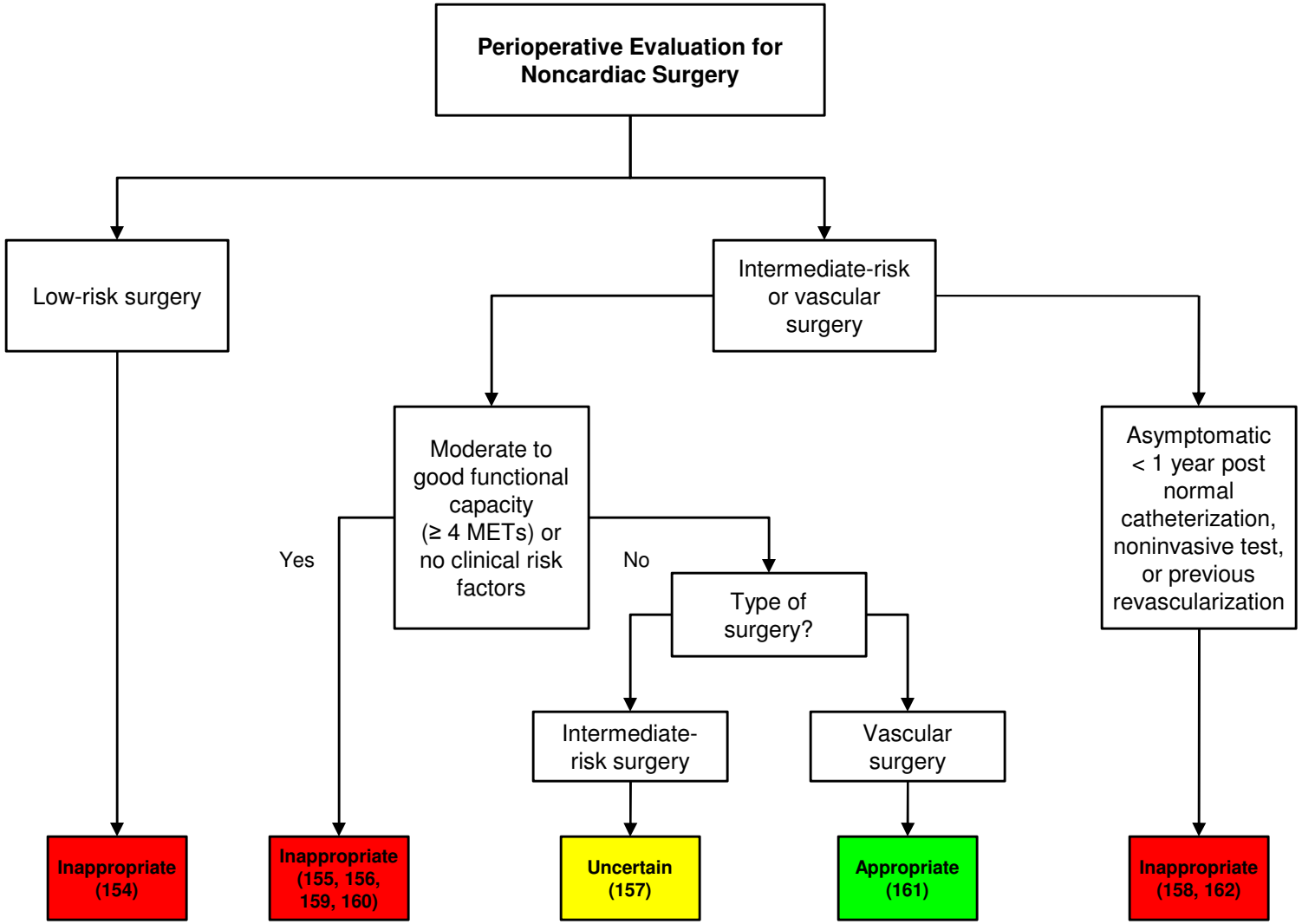

Figure M1. Stress Echocardiography for Risk Assessment—Perioperative Evaluation for Noncardiac Surgery Without Active Cardiac Conditions

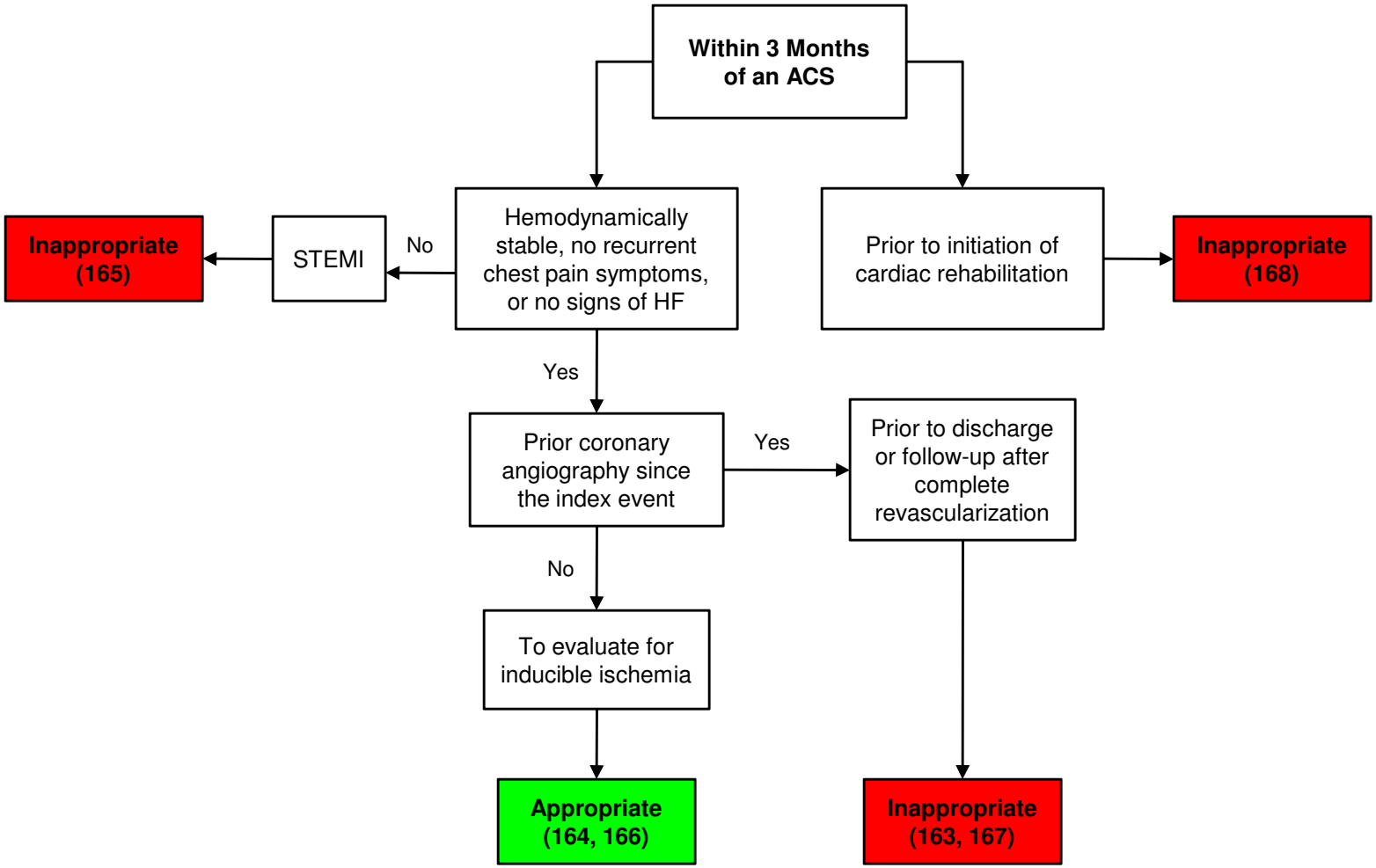

Figure N1. Stress Echocardiography for Risk Assessment—Within 3 months of an Acute Coronary Syndrome (ACS)

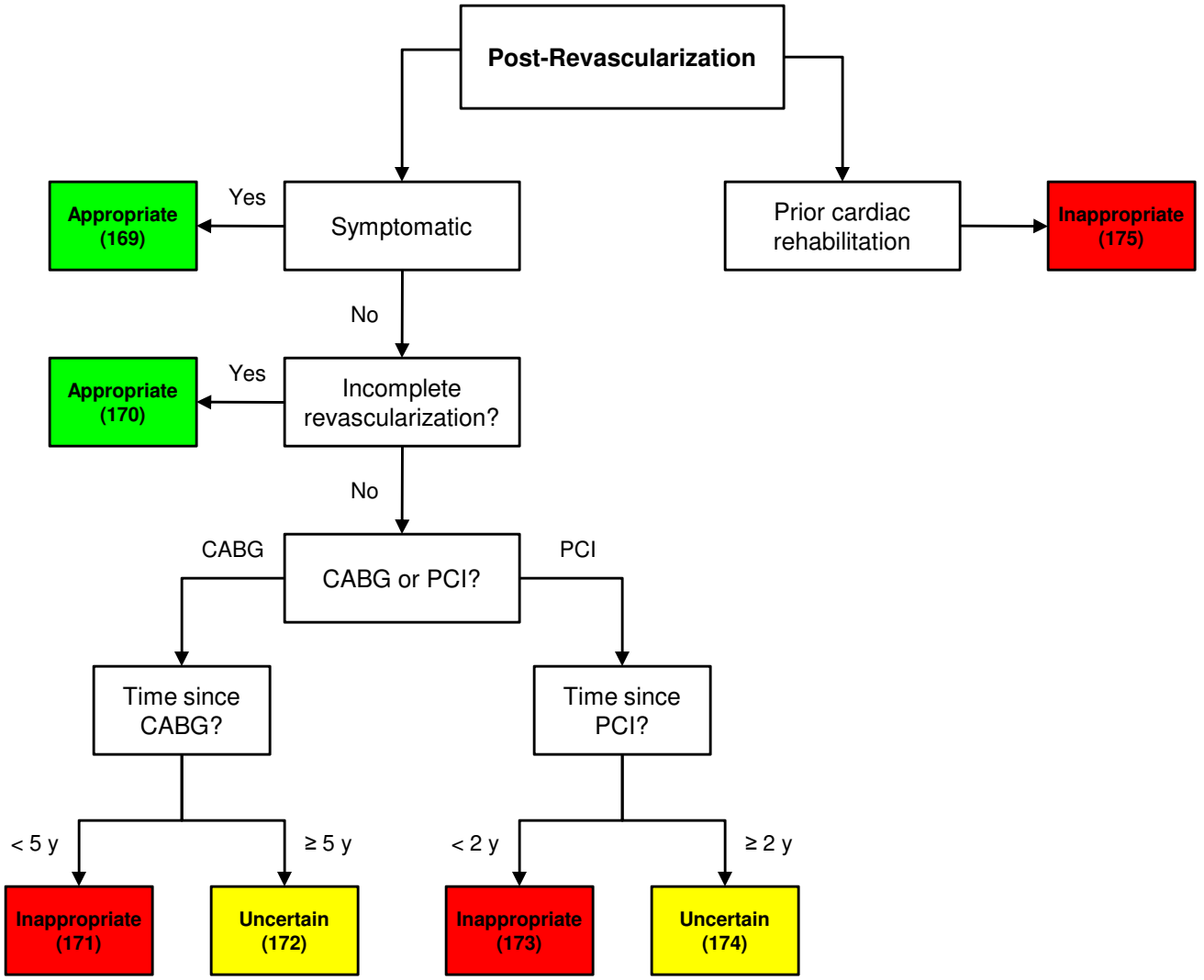

Figure O1. Stress Echocardiography for Risk Assessment—Post-Revascularization (PCI or CABG)

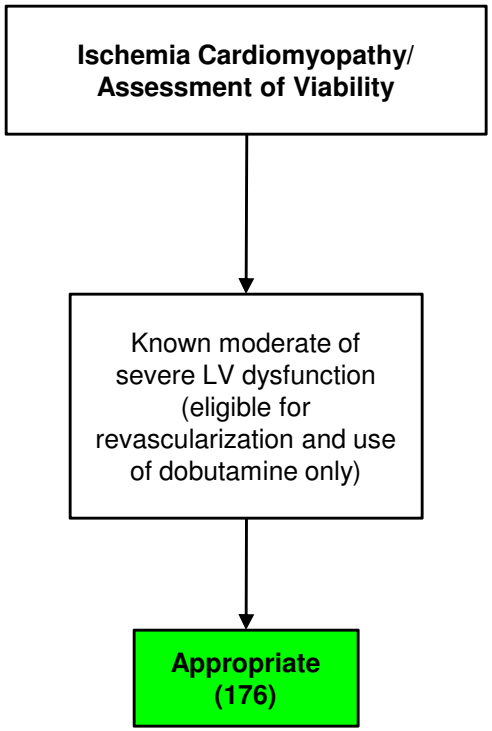

Figure P1. Stress Echocardiography for Assessment of Viability/Ischemia

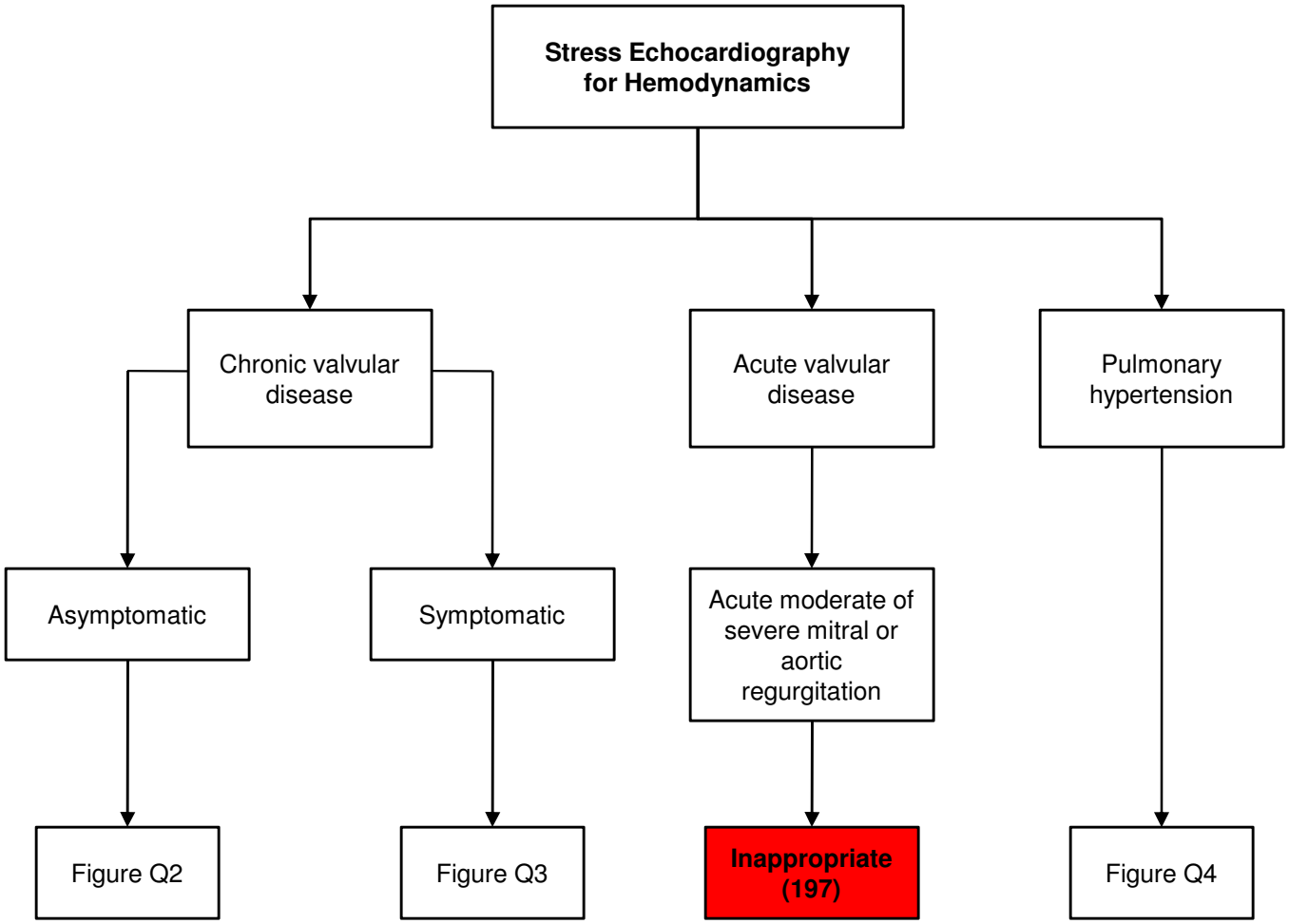

Figure Q1. Stress Echocardiography for Hemodynamics (Includes Doppler During Stress)

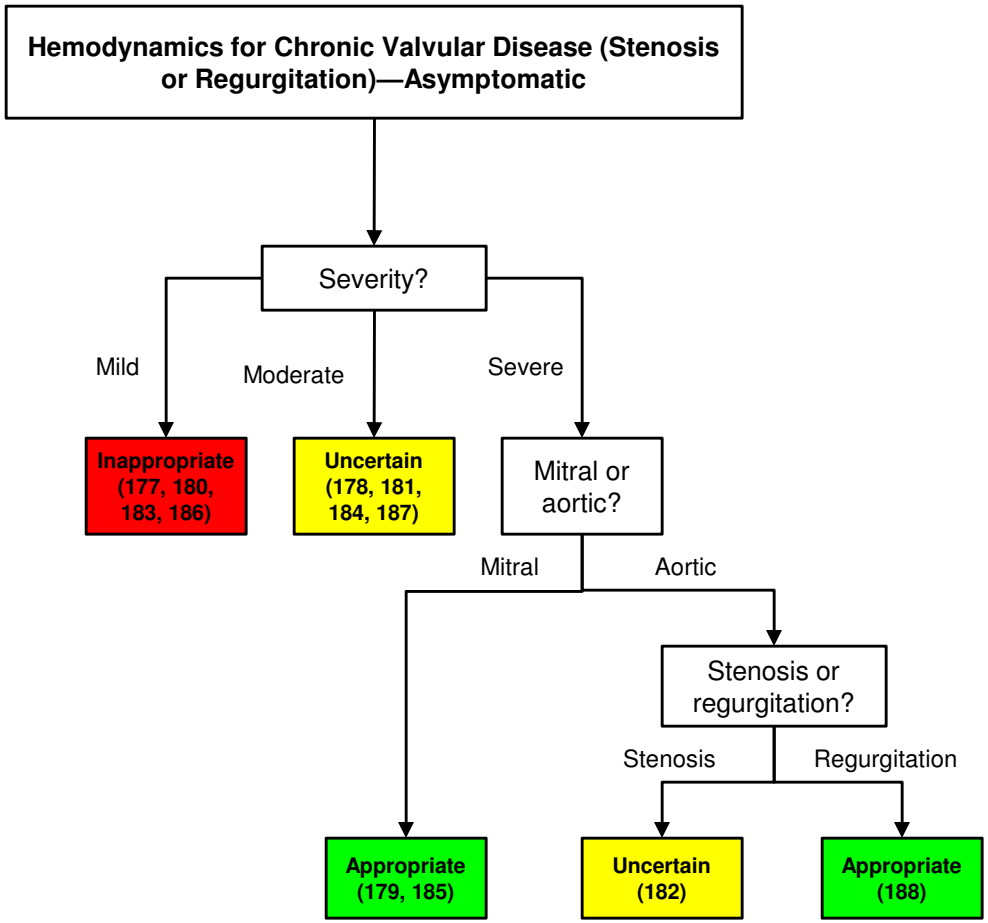

Figure Q2. Stress Echocardiography for Hemodynamics (Includes Doppler During Stress)—Chronic Valvular Disease—Asymptomatic

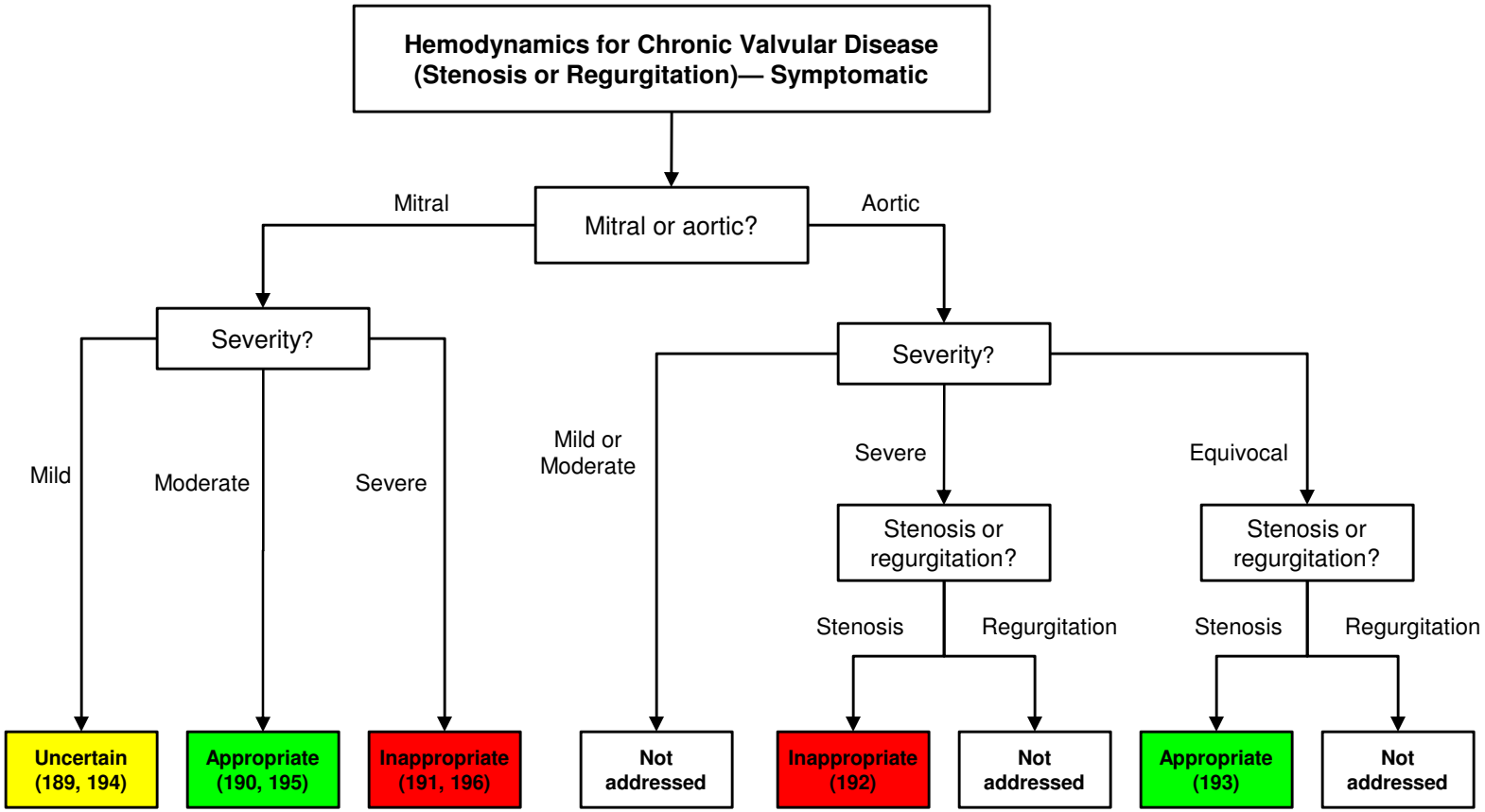

Figure Q3. Stress Echocardiography for Hemodynamics (Includes Doppler During Stress)—Chronic Valvular Disease—Symptomatic

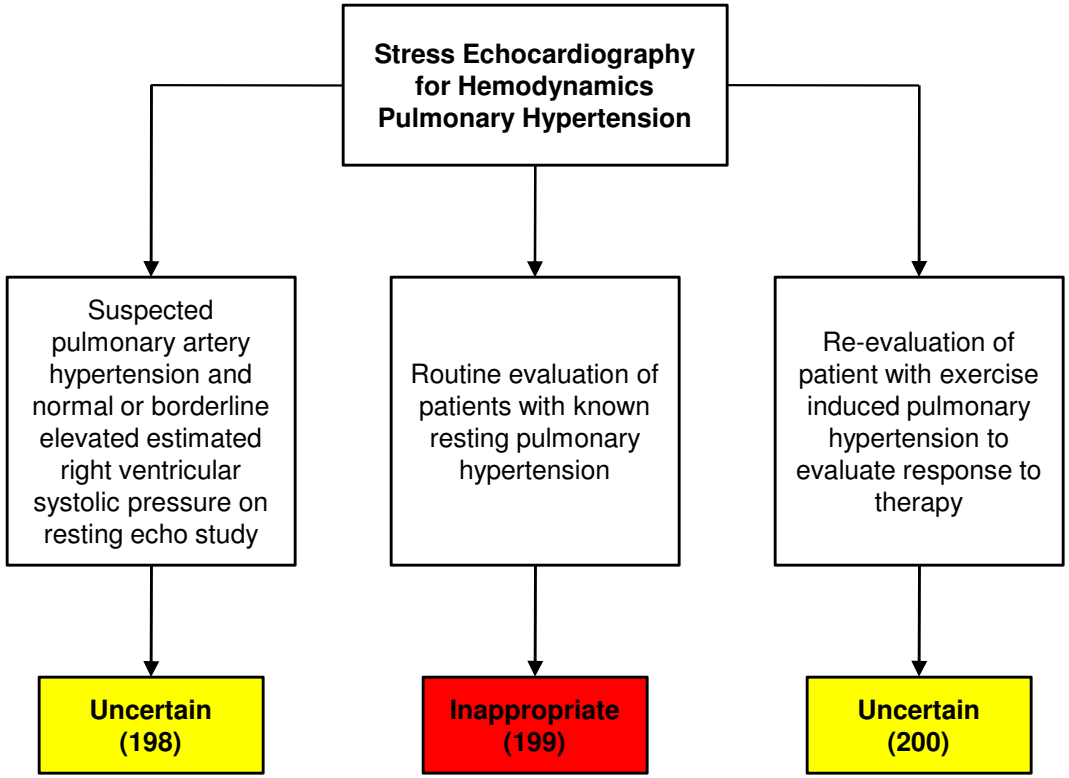

Figure Q4. Stress Echocardiography for Hemodynamics (Includes Doppler During Stress)—Pulmonary Hypertension

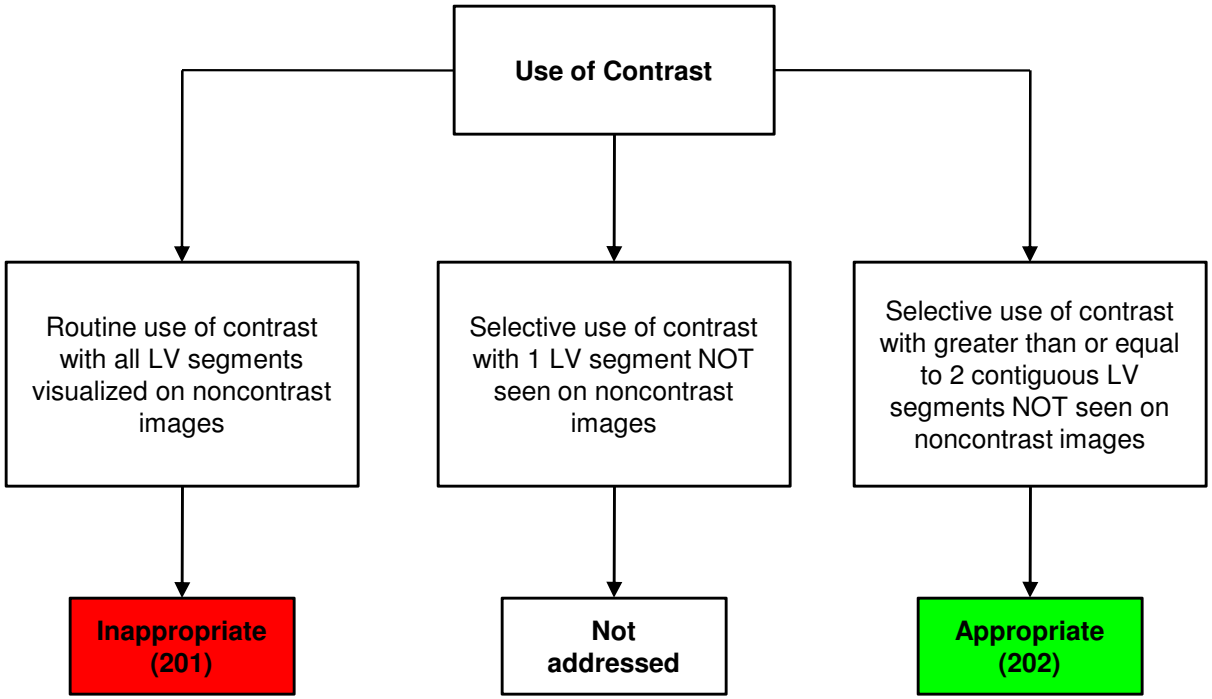

Figure R1. Contrast Use in TTE/TEE or Stress Echocardiography