Nonischemic Myocardial Disease with Clinical Manifestations (Ischemic Cardiomyopathy Already Excluded)

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
1. Follath F. Nonischemic heart failure: epidemiology, pathophysiology, and progression of disease. *J Cardiovasc Pharmacol* 1999; 33 Suppl 3:S31-35.	Review/Other-Dx	N/A	To review the epidemiology, pathophysiology and progression of nonischemic heart failure in patients.	In ambulatory and hospitalized patients with clinically manifest heart failure primary, cardiomyopathy is diagnosed in 2%-15%, while in recent large scale therapeutic trials the proportion of patients with nonischemic heart failure ranged from 18% to 53%. There is epidemiological evidence that, in general, the prognosis of nonischemic heart failure is better than in ischemic heart failure. Therapeutic responses to angiotensin-converting enzyme inhibitors, beta-blockers, amlodipine and amiodarone were also different in some studies. The outcome of nonischemic heart failure is better even in transplant candidates with the most advanced stages of heart failure. They survive longer and respond better to intensified drug regimens than patients with similar clinical severity of ischemic heart failure.	4
2. Cheitlin MD, Armstrong WF, Aurigemma GP, et al. ACC/AHA/ASE 2003 guideline update for the clinical application of echocardiography--summary article: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (ACC/AHA/ASE Committee to Update the 1997 Guidelines for the Clinical Application of Echocardiography). *J Am Coll Cardiol* 2003; 42(5):954-970.	Review/Other-Dx	N/A	To provide guidelines and recommendations for the use of echocardiography in both adult and pediatric patients.	No results stated in abstract.	4

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
3. Ballo P, Guarini G, Simioniuc A, et al. Prognostic value of pulsed tissue Doppler imaging for the assessment of left ventricular systolic function in patients with nonischemic dilated cardiomyopathy. *Echocardiography* 2012; 29(3):291-297.	Observational-Dx	200 consecutive patients	To ascertain whether TDI-derived longitudinal systolic dysfunction may influence the outcome of patients with nonischemic chronic heart failure.	In a time independent analysis, averaged peak systolic mitral annular velocity calculated as the average of septal and lateral systolic mitral annular velocity, resulted to be a significant predictor of outcome in the study population (area under ROC: cardiovascular death, 0.69, P<0.0001; cardiovascular events, 0.64, P=0.0005). In a time-dependent analysis, average systolic mitral annular velocity was associated with both cardiovascular death (HR 0.832, P=0.0019) and cardiovascular events (HR 0.904, P=0.039), independently of other clinical risk factors and echocardiographic parameters of systolic function. Septal systolic mitral annular velocity but not lateral systolic mitral annular velocity was independently associated with the outcome measures.	3
4. Cabell CH, Trichon BH, Velazquez EJ, et al. Importance of echocardiography in patients with severe nonischemic heart failure: the second Prospective Randomized Amlodipine Survival Evaluation (PRAISE-2) echocardiographic study. *Am Heart J* 2004; 147(1):151-157.	Experimental-Dx	93 patients	To identify echocardiographic predictors of survival among patients with NICM and heart failure and to determine if components of the echocardiographic examination add prognostic information to baseline demographic and clinical information.	Seven of 10 routine echocardiographic measures were significantly associated with death. These included mitral regurgitation (HR, 2.31; 95% CI, 1.02, 5.27), LV ejection fraction <20% (HR, 2.59; 95% CI, 1.14, 5.88), restrictive LV filling pattern (HR, 2.37; 95% CI, 1.05, 5.32), and peak D velocity (HR, 1.62; 95% CI, 0.38, 0.87). The only statistically significant clinical predictor of survival was dyspnea at rest. The addition any of several echocardiographic parameters to baseline clinical information significantly improved the ability to predict survival.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
5. Okura H, Fuyuki H, Kubo T, et al. Noninvasive diagnosis of ischemic and nonischemic cardiomyopathy using coronary flow velocity measurements of the left anterior descending coronary artery by transthoracic Doppler echocardiography. *J Am Soc Echocardiogr* 2006; 19(5):552-558.	Observational-Dx	52 consecutive patients	To assess the feasibility and usefulness of coronary flow velocity measurements of the left anterior descending coronary artery by transthoracic Doppler echocardiography to differentiate ICM from NICM in patients.	By coronary angiogram, 13 patients were given the diagnosis of ICM and 31 of NICM. LV end-diastolic and end-systolic volumes and ejection fraction were similar between ICM and NICM. On the other hand, peak diastolic/systolic velocity ratio (1.47 +/- 0.38 vs 2.34 +/- 0.67, P<.0001) and mean diastolic/systolic velocity ratio (1.40 +/- 0.42 vs 2.24 +/- 0.61, P<.0001) were significantly lower in patients with ICM than NICM. Either peak diastolic/systolic velocity ratio <1.8 or mean diastolic/systolic velocity ratio <1.8 had a sensitivity of 77% and a specificity of 77% for detecting the presence of severe left anterior descending coronary artery stenosis and, therefore, the diagnosis of ICM.	3
6. Berman DS, Hachamovitch R, Shaw LJ, et al. Roles of nuclear cardiology, cardiac computed tomography, and cardiac magnetic resonance: assessment of patients with suspected coronary artery disease. *J Nucl Med* 2006; 47(1):74-82.	Review/Other-Dx	N/A	To review the current applications and interactions of noninvasive cardiac imaging approaches for the assessment of patients with suspected coronary artery disease.	Nuclear cardiology, coronary calcium scanning, CTA, and CMR imaging techniques have specific roles in the assessment of patients with suspected coronary disease. Although CT and CMR techniques are currently undergoing rapid technological development and growth, nuclear cardiology techniques will continue to be of great practical value and will often be used in combination with the CCTA or CMR modalities.	4
7. Jain A, Shehata ML, Stuber M, et al. Prevalence of left ventricular regional dysfunction in arrhythmogenic right ventricular dysplasia: a tagged MRI study. *Circ Cardiovasc Imaging* 2010; 3(3):290-297.	Observational-Dx	21 patients with suspected ARVD; 11 healthy controls	To quantify regional LV function in patients with high clinical suspicion for ARVD using tagged MRI.	Of the 21 ARVD subjects, 11 had definite ARVD and 10 had probable ARVD. Compared with control subjects, probable ARVD patients had similar RV ejection fraction (58.9+/-6.2% vs 53.5+/-7.6%, P=0.20), but definite ARVD patients had significantly reduced RV ejection fraction (58.9+/-6.2% vs 45.2+/-6.0%, P=0.001). LV ejection fraction was similar in all 3 groups. Compared with control subjects, peak systolic regional circumferential strain was significantly less negative in 6/16 (37.5%) segments in definite ARVD and 3/16 segments (18.7%) in probable ARVD (all P<0.05).	2

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
8. Bhatti S, Hakeem A, Yousuf MA, Al-Khalidi HR, Mazur W, Shizukuda Y. Diagnostic performance of computed tomography angiography for differentiating ischemic vs nonischemic cardiomyopathy. *J Nucl Cardiol* 2011; 18(3):407-420.	Review/Other-Dx	6 studies with 452 patients	To conduct a meta-analysis of available studies that addresses the use of CTA and if is considered "appropriate" to distinguish ischemic vs nonischemic etiology in patients with cardiomyopathy under the current clinical practice guideline.	The pooled patient population was 62+/-3 years old, with 29% females, 16% diabetics, and 43% with a history of hypertension. Mean ejection fraction was 32%+/-1%. The pooled summary estimate of sensitivity of CTA for diagnosis of ICM was 98% [95% CI; 94% to 99%] and specificity was 97% (CI 94% to 98%), yielding a negative likelihood ratio of 0.06 (CI 0.02 to 0.13) and positive likelihood ratio of 20.85 (CI 12 to 36). There was no significant heterogeneity between studies for these estimates. The ROC analysis showed a robust discriminate diagnostic accuracy of ischemic etiology with an area under curve of 0.99 (P<.00001).	4
9. Abramson SV, Burke JF, Kelly JJ, Jr., et al. Pulmonary hypertension predicts mortality and morbidity in patients with dilated cardiomyopathy. *Ann Intern Med* 1992; 116(11):888-895.	Observational-Dx	108 patients	To ascertain whether pulmonary hypertension, as assessed noninvasively by continuous-wave Doppler of tricuspid regurgitation, can be an important independent factor in the prognosis of patients with ischemic or idiopathic dilated cardiomyopathy.	28 patients had a high velocity of tricuspid regurgitation (<2.5 m/s), and 80 patients had a low velocity (≤2.5 m/s). After 28 months of follow-up, the mortality rate was 57% in patients with a high velocity compared with 17% in patients with a low velocity (difference of 40%, 95% CI, 20% to 60%). Hospitalization for congestive heart failure occurred in 75% and 26% of patients, respectively (difference of 49%, CI, 30% to 68%). 89% of patients with a high velocity either died or were hospitalized compared with only 32% of patients with a low velocity (difference of 57%, CI, 42% to 72%). The peak velocity of tricuspid regurgitation was the only prognostic variable selected using stepwise logistic regression models for the three outcome events. Noninvasive assessment of pulmonary hypertension using continuous-wave Doppler of tricuspid regurgitation can predict morbidity and mortality in patients with ischemic or idiopathic dilated cardiomyopathy.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
10. Dalal D, Nasir K, Bomma C, et al. Arrhythmogenic right ventricular dysplasia: a United States experience. *Circulation* 2005; 112(25):3823-3832.	Review/Other-Dx	100 ARVD patients	To describe the presentation, clinical features, survival, and natural history of ARVD in a large cohort of patients from the United States.	A familial pattern was observed in 32 patients. The most common presenting symptoms were palpitations, syncope, and sudden cardiac death in 27%, 26%, and 23% of patients, respectively. Among those who were diagnosed while living (n=69), the median time between first presentation and diagnosis was 1 (range, 0 to 37) year. During a median follow-up of 6 (IQR, 2 to 13; range, 0 to 37) years, ICD were implanted in 47 patients, 29 of whom received an appropriate ICD discharge, including 3 patients who received the ICD for primary prevention. At follow-up, 66 patients were alive, of whom 44 had an ICD in place, 5 developed signs of heart failure, 2 had a heart transplant, and 18 were on drug therapy. 34 patients died either at presentation (n=23: 21 sudden cardiac death, 2 noncardiac deaths) or during follow-up (n=11: 10 sudden cardiac death, 1 of biventricular heart failure), of whom only 3 were diagnosed while living and 1 had an ICD implanted. On Kaplan-Meier analysis, the median survival in the entire population was 60 years.	4
11. Tandri H, Rutberg J, Bluemke DA, Calkins H. Magnetic resonance imaging of arrhythmogenic right ventricular dysplasia. *J Cardiovasc Electrophysiol* 2002; 13(11):1180.	Review/Other-Dx	N/A	To present how MRI can be a valuable tool in the diagnosis of ARVD as seen from one case.	No results stated in abstract.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
12. Husmann L, Valenta I, Gaemperli O, et al. Feasibility of low-dose coronary CT angiography: first experience with prospective ECG-gating. *Eur Heart J* 2008; 29(2):191-197.	Observational-Dx	41 consecutive patients	To determine the feasibility of prospective electrocardiogram-gating to achieve low-dose CCTA.	Mean effective radiation dose was 2.1 +/- 0.6 mSv (range, 1.1-3.0 mSv). Image quality was inversely related to heart rate (57.3 +/- 6.2, range 39-66 b.p.m.; r = 0.58, P<0.001), vessel attenuation (346 +/- 104, range 110-780 HU; r = 0.56, P<0.001), and body mass index (26.1 +/- 4.0, range 19.1-36.3 kg/m(2); r = 0.45, P<0.001), but not to heart rate variability (1.5 +/- 1.0, range 0.2-5.1 b.p.m.; r = 0.28, P=0.069). Non-diagnostic CCTA image quality was found in 5.0% of coronary segments. However, below a heart rate of 63 b.p.m. (n=28), as determined by ROC, only 1.1% of coronary segments were non-diagnostic compared with 14.8% with heart rate of >63 b.p.m. (P<0.001).	3
13. Heilbron BG, Leipsic J. Submillisievert coronary computed tomography angiography using adaptive statistical iterative reconstruction - a new reality. *Can J Cardiol* 2010; 26(1):35-36.	Review/Other-Dx	N/A	To describe the use of a submillisievert CCTA examination using one case representation.	The ability to perform a diagnostic CCTA with such a low dose challenges the role of coronary calcium scoring and will likely have implications for the future use of this test.	4
14. Achenbach S, Marwan M, Ropers D, et al. Coronary computed tomography angiography with a consistent dose below 1 mSv using prospectively electrocardiogram-triggered high-pitch spiral acquisition. *Eur Heart J* 2010; 31(3):340-346.	Observational-Dx	50 consecutive patients	To evaluate the feasibility and image quality of a new scan mode for CCTA with an effective dose of <1 mSv.	In all 50 patients, imaging was successful. Mean duration of data acquisition was 258 +/- 20 ms. Mean dose-length product was 62 +/- 5 mGy cm, the effective dose was 0.87 +/- 0.07 mSv (0.78-0.99 mSv). Of the 742 coronary artery segments, 94% had an image quality score of 1, 5.0% a score of 2, 0.9% a score of 3, and 4 segments (0.5%) were 'uninterpretable'. In non-obese patients with a low and stable heart rate, prospectively electrocardiogram-triggered high-pitch spiral CCTA provides excellent image quality at a consistent dose below 1.0 mSv.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
15. Tardivon AA, Musset D, Maitre S, et al. Role of CT in chronic pulmonary embolism: comparison with pulmonary angiography. *J Comput Assist Tomogr* 1993; 17(3):345-351.	Observational-Dx	21 consecutive patients	To assess the value of CT in chronic pulmonary embolism by reviewing CT scans and pulmonary angiograms of patients.	CT was better than angiography in assessing proximal clots (3 thrombi not seen by angiography, 3 angiographic false-positives confirmed by surgery). Furthermore, CT was able to analyze pulmonary arteries distal to angiographic amputations. CT was less sensitive than angiography for vascular distortions (38% vs 50%) and stenosis (35% vs 71.8%). Pulmonary infarctions were better detected and characterized by CT than by angiography. Isolated parenchymal ground-glass opacities were seen by CT in 18 patients, especially in those with right cardiomegaly. High resolution CT delineated them better than did standard CT. CT may be a useful adjunct to angiography in the assessment of chronic pulmonary embolism.	3
16. Schwickert HC, Kauczor HU, Piepenburg R, et al. [CT compared with SPECT in chronic recurrent pulmonary embolism: hyperdensities as signs of pulmonary artery hyperperfusion?]. *Rofo* 1995; 162(3):199-203.	Review/Other-Dx	52 patients	To assess the etiology of inhomogeneous lung parenchymal attenuation in patients with chronic pulmonary thromboembolism, presenting as sharply demarcated areas of increased and decreased density on CT.	44 of the 52 patients showed an inhomogeneous pulmonary attenuation on CT. Correlation of hyperdense areas with perfused lung parenchyma was graded as "good" in 26 cases, "moderate" in 14 and "poor" in 4 cases. In 40 of these 44 patients, scintigraphy revealed additional perfusion defects in homogeneously lucent areas on CT. In 6 of 8 patients with entirely homogeneous lung density on CT, SPECT revealed perfusion defects.	4
17. O'Neill JO, McCarthy PM, Brunken RC, et al. PET abnormalities in patients with nonischemic cardiomyopathy. *J Card Fail* 2004; 10(3):244-249.	Observational-Dx	44 patients	To assess the prevalence of regional defects in dilated cardiomyopathy by multiple imaging modalities and to establish the relationship between QRS width and these defects.	Of 44 patients studied, PET imaging revealed scar in 91% of patients, with a mean of 25 +/- 18% of the left ventricle involved, predominantly in the distribution of the left anterior descending artery. Regional wall motion abnormalities occurred in 51% of patients who underwent echocardiography and 59% of patients who underwent nuclear scintigraphy (with only 70% concordance). QRS duration on the surface electrocardiogram correlated positively with the degree of scarring (r=.52, P=.0007).	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
18. Shaw LJ, Raggi P, Schisterman E, Berman DS, Callister TQ. Prognostic value of cardiac risk factors and coronary artery calcium screening for all-cause mortality. *Radiology* 2003; 228(3):826-833.	Observational-Dx	10,377 asymptomatic patients	To develop risk-adjusted multivariable models that included risk factors and coronary calcium scores determined with electron-beam CT in asymptomatic patients for the prediction of all-cause mortality.	During a mean follow-up of 5.0 years +/- 0.0086 (standard error of the mean), the death rate was 2.4%. In a risk-adjusted model (model chi2 = 388.2, P<.001), coronary calcium was an independent predictor of mortality (P<.001). Risk-adjusted relative risk values for coronary calcium were 1.64, 1.74, 2.54, and 4.03 for scores of 11-100, 101-400, 401-1,000, and <1,000, respectively (P<.001 for all values), as compared with that for a score of 10 or less. 5-year risk-adjusted survival was 99.0% for a calcium score of 10 or less and 95.0% for a score of <1,000 (P<.001). With a ROC curve, the concordance index increased from 0.72 for cardiac risk factors alone to 0.78 (P<.001) when the calcium score was added to a multivariable model for prediction of death.	3
19. Jiji RS, Kramer CM. Cardiovascular magnetic resonance: applications in daily practice. *Cardiol Rev* 2011; 19(5):246-254.	Review/Other-Dx	N/A	To review the applications of CMR.	CMR is a versatile tool to guide diagnosis and treatment of a wide range of cardiovascular diseases. The cornerstone of current CMR practice remains the assessment of viability, ventricular function, and myocardial tissue characterization. As the importance of information gleaned from CMR is increasingly recognized, CMR will become increasingly invaluable to patient care.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
20. Karamitsos TD, Francis JM, Myerson S, Selvanayagam JB, Neubauer S. The role of cardiovascular magnetic resonance imaging in heart failure. *J Am Coll Cardiol* 2009; 54(15):1407-1424.	Review/Other-Dx	N/A	To review the advantages of CMR for patients with heart failure and its important role in key areas.	Noninvasive imaging plays a central role in the diagnosis of heart failure, assessment of prognosis, and monitoring of therapy. CMR offers a comprehensive assessment of heart failure patients and is now the gold standard imaging technique to assess myocardial anatomy, regional and global function, and viability. Furthermore, it allows assessment of perfusion and acute tissue injury (edema and necrosis), whereas in nonischemic heart failure, fibrosis, infiltration, and iron overload can be detected. The information derived from CMR often reveals the underlying etiology of heart failure, and its high measurement accuracy makes it an ideal technique for monitoring disease progression and the effects of treatment. Evidence on the prognostic value of CMR-derived parameters in heart failure is rapidly emerging.	4
21. Kumar A, Patton DJ, Friedrich MG. The emerging clinical role of cardiovascular magnetic resonance imaging. *Can J Cardiol* 2010; 26(6):313-322.	Review/Other-Dx	N/A	A review to discuss the emerging role of CMR imaging in clinical cardiology.	CMR imaging's high accuracy of flow measurements, freedom to deliberately choose an imaging plane and the lack of ionizing radiation make it the imaging modality of choice for CHD in children and adults. CMR imaging is used for the assessment of regional and global ventricular function, and to answer questions regarding anatomy. State-of-the-art CMR sequences allow for a wide range of tissue characterization approaches, including the identification and quantification of nonviable, edematous, inflamed, infiltrated or hypoperfused myocardium.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
22. Kim YJ, Kim RJ. The role of cardiac MR in new-onset heart failure. *Curr Cardiol Rep* 2011; 13(3):185-193.	Review/Other-Dx	N/A	To review the utility of CMR for patient risk stratification, and its potential role in important management decisions such as for cardiac resynchronization therapy and defibrillator placement.	In patients with heart failure, CMR allows a multifaceted approach to cardiac evaluation by enabling an assessment of morphology, function, perfusion, viability, tissue characterization, and blood flow during a single comprehensive examination. Given its accuracy and reproducibility, many believe CMR is the reference standard for the noninvasive assessment of ventricular volumes, mass, and function, and offers an ideal means for the serial assessment of disease progression or treatment response in individual patients. Delayed-enhancement CMR provides a direct assessment of myopathic processes. This permits a fundamentally different approach than that traditionally taken to ascertaining the etiology of cardiomyopathy, which is vital in patients with NICM and incidental coronary artery disease and patients with mixed, ischemic and NICM.	4
23. Karamitsos TD, Francis JM, Neubauer S. The current and emerging role of cardiovascular magnetic resonance in the diagnosis of nonischemic cardiomyopathies. *Prog Cardiovasc Dis* 2011; 54(3):253-265.	Review/Other-Dx	N/A	To review the main CMR features of common nonischemic cardiomyopathies, with particular focus on the specific advantages of this imaging modality.	Imaging plays a crucial role in the diagnosis, management, and prognosis assessment of patients with nonischemic cardiomyopathies. Over the past decade, the role of CMR imaging in clinical practice has been rapidly expanding. The technique's unsurpassed accuracy in defining cardiac morphology and function and ability to provide tissue characterization make it particularly well suited for the study of patients with nonischemic cardiomyopathies. In this review article, we provide an overview of the main CMR features of nonischemic cardiomyopathies, highlighting the diagnostic and prognostic utility of the technique in this heterogenous group of diseases.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
24. Kim DH, Choi SI, Chang HJ, Choi DJ, Lim C, Park JH. Delayed hyperenhancement by contrast-enhanced magnetic resonance imaging: Clinical application for various cardiac diseases. *J Comput Assist Tomogr* 2006; 30(2):226-232.	Review/Other-Dx	N/A	To review the clinical application of delayed hyperenhancement is demonstrated for various cardiac diseases such as myocardial infarction, including RV infarction; microvascular obstruction; and NICM such as dilated cardiomyopathy and myocarditis.	The clinical applications of contrast-enhanced MRI for defining viability are evolving as a result of the advantage of the technique's excellent spatial resolution. The value of delayed hyperenhancement imaging is for the accurate identification of the infarcted myocardium with resolution that allows determination of the transmural extent of myocardial injury. In addition, nonischemic patterns of myocardial injury such as dilated or hypertrophic cardiomyopathy have been reported in other disease states. Delayed hyperenhancement may have an additional role in guiding the management of or determining the prognosis for diseases such as myocarditis.	4
25. Gottlieb I, Macedo R, Bluemke DA, Lima JA. Magnetic resonance imaging in the evaluation of non-ischemic cardiomyopathies: current applications and future perspectives. *Heart Fail Rev* 2006; 11(4):313-323.	Review/Other-Dx	N/A	To review the applications of MRI in the evaluation of non-ischemic cardiomyopathies and provide future perspectives.	Delayed myocardial enhancement MRI has been developed and is currently being used for a growing number of clinical applications. On delayed enhancement MRI, scarring or fibrosis appears as an area of high signal intensity, and the pattern by which this enhancement occurs in the myocardium allows distinction of many different pathologies. In NICM, the delayed enhancement usually does not occur in a coronary artery distribution and is often midwall rather than subendocardial or transmural. It could also guide myocardial biopsy to an affected area, increasing its yield. CMR has now a definitive role in clinical practice, and its capability to non-invasively provide high resolution images of the heart with good tissue characterization is redefining the understanding of the conditions that can adversely affect the myocardium.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
26. Bluemke DA. MRI of nonischemic cardiomyopathy. *AJR* 2010; 195(4):935-940.	Review/Other-Dx	N/A	To present current clinical and research issues in MRI evaluation of NICM, a diverse set of diseases, many of which have a genetic basis.	Cardiac cine MRI along with delayed myocardial enhancement MRI and other MRI techniques can provide information beyond echocardiography for tissue characterization. MRI is increasingly being used for evaluation of genetically positive, phenotypically negative patients as well as for risk stratification.	4
27. Caliskan K, Szili-Torok T, Theuns DA, et al. Indications and outcome of implantable cardioverter-defibrillators for primary and secondary prophylaxis in patients with noncompaction cardiomyopathy. *J Cardiovasc Electrophysiol* 2011; 22(8):898-904.	Observational-Dx	77 patients	To investigate ICD indications and outcomes in noncompaction cardiomyopathy patients.	ICD was implanted in 44 (57%) patients with noncompaction cardiomyopathy according to the current ICD guidelines for nonischemic cardiomyopathies: in 12 for secondary prevention (7 × ventricular fibrillation, 5 × sustained ventricular tachycardia) and in 32 patients for primary prevention (heart failure/severe LV dysfunction). During a mean follow-up of 33 +/- 24 months, 8 patients presented with appropriate ICD shocks due to sustained ventricular tachycardia after median 6.1 [1-16] months. This included 4 of 32 (13%) patients in the primary prevention group and 4 of 12 (33%) in the secondary prevention group (P=0.04). 9 patients presented with inappropriate ICD therapy: 6 (19%) in the primary and 3 (25%) in the secondary prevention group, at a median follow-up of 4 (2-23) months.	3

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
28. Bello D, Shah DJ, Farah GM, et al. Gadolinium cardiovascular magnetic resonance predicts reversible myocardial dysfunction and remodeling in patients with heart failure undergoing beta-blocker therapy. *Circulation* 2003; 108(16):1945-1953.	Observational-Dx	45 patients	To obtain high-resolution spatial maps of myocardial scarring and viability in these patients at baseline and, with the addition of cine CMR, to precisely assess changes in LV function and remodeling after 6 months of b-blocker therapy.	Gadolinium CMR demonstrated scarring in 30/45 patients (67%). Scarring was found in 100% of patients with ICE (28/28) but in only 12% with NICM (2/17). In the 35 patients who were maintained on beta-blockers and had a second study, there was an inverse relation between the extent of scarring at baseline and the likelihood of contractile improvement 6 months later (P<0.001). For instance, contractility improved in 56% (674/1207) of regions with no scarring but in only 3% with >75% scarring (8/232). Multivariate analysis showed that the amount of dysfunctional but viable myocardium by CMR was an independent predictor of the change in ejection fraction (P=0.01), mean wall motion score (P=0.0007), LV end-diastolic volume index (P=0.007), and LV end-systolic volume index (P≤0.0001).	3
29. Masci PG, Barison A, Aquaro GD, et al. Myocardial delayed enhancement in paucisymptomatic nonischemic dilated cardiomyopathy. *Int J Cardiol* 2012; 157(1):43-47.	Observational-Dx	125 patients	To investigate the prognostic role of myocardial fibrosis by delayed enhancement CMR in NICM patients with no or mild symptoms of heart failure.	50 (40%) patients showed myocardial delayed enhancement, representing 12 +/- 7% of LV mass. During a median follow-up of 14.2months, 16 (32%) patients with delayed enhancement experienced a composite event vs only 6 (8%) patients without delayed enhancement (Kaplan-Meier survival curve, P=0.001). After correction for age, CMR-derived LV and RV volumes, echocardiographic measurements of LV diastolic function and Doppler-estimated systolic pulmonary artery pressure, the presence of DE remained a strong and independent predictor of cardiac death or heart failure hospitalization (HR: 5.32, 95% CIs: 1.60 to 17.63, P=0.006).	2

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
30. Wu KC, Weiss RG, Thiemann DR, et al. Late gadolinium enhancement by cardiovascular magnetic resonance heralds an adverse prognosis in nonischemic cardiomyopathy. *J Am Coll Cardiol* 2008; 51(25):2414-2421.	Observational-Dx	65 patients	To examine whether the presence and extent of late gadolinium enhancement by CMR predict adverse outcomes in NICM patients.	A total of 42% (n=27) of patients had CMR late gadolinium enhancement, averaging 10 +/- 13% of LV mass. During a 17-month median follow-up, 44% (n=12) of patients with late gadolinium enhancement had an index composite outcome event vs only 8% (n=3) of those without late gadolinium enhancement (P<0.001 for Kaplan-Meier survival curves). After adjustment for LV volume index and functional class, patients with late gadolinium enhancement had an 8-fold higher risk of experiencing the primary outcome (HR 8.2, 95% CI; 2.2 to 30.9; P=0.002).	3
31. Marcus FI, McKenna WJ, Sherrill D, et al. Diagnosis of arrhythmogenic right ventricular cardiomyopathy/dysplasia: proposed modification of the Task Force Criteria. *Eur Heart J* 2010; 31(7):806-814.	Review/Other-Dx	N/A	To review the clinical diagnosis of ARVD/D.	Revision of the diagnostic criteria provides guidance on the role of emerging diagnostic modalities and advances in the genetics of ARVD/D. The criteria have been modified to incorporate new knowledge and technology to improve diagnostic sensitivity, but with the important requisite of maintaining diagnostic specificity. The approach of classifying structural, histological, electrocardiographic, arrhythmic, and genetic features of the disease as major and minor criteria has been maintained. In this modification of the Task Force criteria, quantitative criteria are proposed and abnormalities are defined on the basis of comparison with normal subject data.	4

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Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
32. Dalal D, Tandri H, Judge DP, et al. Morphologic variants of familial arrhythmogenic right ventricular dysplasia/cardiomyopathy a genetics-magnetic resonance imaging correlation study. *J Am Coll Cardiol* 2009; 53(15):1289-1299.	Observational-Dx	38 patients	To determine the extent of LV involvement in individuals predisposed to developing ARVD/C, and to investigate novel morphologic variants of ARVD/C.	25 individuals had mutations in PKP2, DSP, and/or DSG2 genes. RV abnormalities were associated with the presence of mutation(s) and with disease severity determined by criteria (minor = 1; major = 2) points for ARVD/C diagnosis. The only LV abnormality detected, the presence of intramyocardial fat, was present in 4 individuals. Each of these individuals was a mutation carrier, whereas 1 had no previously described ARVD/C-related abnormality. On detailed CMR, a focal "crinkling" of the RV outflow tract and subtricuspid regions ("accordion sign") was observed in 60% of the mutation carriers and none of the noncarriers (P<0.001). The sign was present in 0%, 37%, 71%, and 75% of individuals who met 1, 2, 3, and 4+ criteria points, respectively (P<0.01).	2
33. Prakasa KR, Wang J, Tandri H, et al. Utility of tissue Doppler and strain echocardiography in arrhythmogenic right ventricular dysplasia/cardiomyopathy. *Am J Cardiol* 2007; 100(3):507-512.	Observational-Dx	30 patients with ARVD; 30 healthy controls	To assess RV function in patients with ARVD using TDI and strain echocardiography, identify the cut-off values for different TDI and strain echocardiography parameters to diagnose RV dysfunction in ARVD, identify the most sensitive and specific TDI and strain echocardiography parameters to diagnose ARVD, and to establish the reproducibility of TDI and strain echocardiography measurements in the ARVD population.	Peak systolic velocity, early diastolic velocity, displacement, strain rate, strain, outflow tract diameter, and fractional RV area change were measured in all subjects. Peak RV systolic velocity (6.4 +/- 2.2 vs 9 +/- 1.6 cm/s, P<0.0001), early diastolic velocity (-6.7 +/- 2.7 vs -9.4 +/- 2 cm/s, P<0.0001), displacement (13.7 +/- 5.8 vs 18.7 +/- 3.5 mm, P<0.0003), strain rate (-1 +/- 0.7 vs -2 +/- 1 s(-1), P=0.002), and strain (-10 +/- 6% vs -28 +/- 11%, P=0.001) were significantly lower in patients with ARVD compared with controls, respectively. Sensitivity and specificity, respectively, were 67% and 89% for systolic velocity, 77% and 71% for displacement, 73% and 87% for strain, 50% and 96% for strain rate, 53% and 93% for outflow tract diameter, and 47% and 83% for fractional area change. RV systolic velocity and displacement were significantly lower than in controls, even in the subset of patients with ARVD with apparently normal right ventricles by conventional echocardiography. Inter- and intraobserver agreement was high.	3

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
34. Bomma C, Dalal D, Tandri H, et al. Evolving role of multidetector computed tomography in evaluation of arrhythmogenic right ventricular dysplasia/cardiomyopathy. *Am J Cardiol* 2007; 100(1):99-105.	Observational-Dx	31 patients	To report one center's experience with MDCT in the evaluation of patients suspected to have ARVD/C.	31 patients (19 men; mean age 41 +/- 12 years) referred for evaluation of known or suspected ARVD/C had a complete reevaluation including contrast-enhanced cardiac MDCT at the center. Two patients underwent both CMR and MDCT. 17/31 patients met Task Force criteria for ARVD/C and were confirmed to have ARVD/C. MDCT images were analyzed for qualitative and quantitative characteristic findings of ARVD/C. Increased RV trabeculation ($P<0.001$), RV intramyocardial fat ($P<0.001$), and scalloping ($P<0.001$) were significantly associated with the final diagnosis of ARVD/C. RV volumes, RV inlet dimensions, and RV outflow tract surface area were increased in patients with ARVD/C compared with patients who did not meet the criteria. RV and LV functional analysis was performed in 2 patients.	3
35. Deyell MW, Andrade JG, McManus BM, Leipsic J. The other side of arrhythmogenic right ventricular cardiomyopathy. *Can J Cardiol* 2011; 27(2):263 e213-266.	Review/Other-Dx	3 cases	To present 3 cases of patients with ARVD who presented with LV involvement as manifested by nonischemic pattern of delayed enhancement in the left ventricle.	No results stated in abstract.	4
36. Stather D, Ford S, Kisilevsky R. Sarcoid, amyloid, and acute myocardial failure. *Mod Pathol* 1998; 11(9):901-904.	Review/Other-Dx	1 case	To report a case of one patient who died in acute myocardial failure after cardiac catheterization.	No results stated in abstract.	4

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
37. Syed J, Myers R. Sarcoid heart disease. *Can J Cardiol* 2004; 20(1):89-93.	Review/Other-Dx	N/A	To review the literature on sarcoid heart disease and present an approach to its diagnosis, prognosis and therapy.	Clinical disease often includes heart block, dilated cardiomyopathy and ventricular arrhythmias. Patients with sarcoidosis are at increased risk of sudden death. Because the yield of endomyocardial biopsy for definitive diagnosis is low, the diagnosis is often made with a combination of electrocardiography, Holter monitoring, echocardiography, myocardial perfusion imaging and, most recently, MRI. For symptomatic patients, medical therapy may include a trial of steroids and immunosuppressive therapy. Monoclonal antibodies against tumor necrosis factor may be employed in refractory cases. Heart block warrants a permanent pacemaker, while ventricular tachyarrhythmias are typically amiodarone-unresponsive, requiring implantation of an ICD.	4
38. Ohira H, Tsujino I, Sato T, et al. Early detection of cardiac sarcoid lesions with (18)F-fluoro-2-deoxyglucose positron emission tomography. *Intern Med* 2011; 50(11):1207-1209.	Review/Other-Dx	1 case	To present a case of one patient with pulmonary sarcoidosis who had focal FDG uptake in the heart on fasting FDG-PET.	No results stated in abstract.	4
39. Patel MR, Cawley PJ, Heitner JF, et al. Detection of myocardial damage in patients with sarcoidosis. *Circulation* 2009; 120(20):1969-1977.	Observational-Dx	81 patients	To compare delayed-enhancement CMR with standard clinical evaluation for the identification of cardiac involvement. Patients were recruited for a parallel and masked comparison of cardiac involvement between (1) delayed-enhancement CMR, and (2) standard clinical evaluation with the use of consensus criteria (modified Japanese Ministry of Health [JMH] guidelines).	Delayed-enhancement CMR identified cardiac involvement in 21 patients (26%) and JMH criteria in 10 (12%, 8 overlapping), a 2-fold higher rate for delayed-enhancement CMR (P=0.005). All patients with myocardial damage on delayed-enhancement CMR had coronary disease excluded by x-ray angiography. Pathology evaluation in 15 patients (19%) identified 4 with cardiac sarcoidosis; all 4were positive by delayed-enhancement CMR, whereas 2 were JMH positive. On follow-up, 8 had adverse events, including 5 cardiac deaths. Patients with myocardial damage on delayed-enhancement CMR had a 9-fold higher rate of adverse events and an 11.5-fold higher rate of cardiac death than patients without damage.	2

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
40. Smedema JP, Snoep G, van Kroonenburgh MP, et al. The additional value of gadolinium-enhanced MRI to standard assessment for cardiac involvement in patients with pulmonary sarcoidosis. *Chest* 2005; 128(3):1629-1637.	Observational-Dx	55 patients	To determine whether gadolinium-enhanced CMR was of additional diagnostic value to standard assessment in patients with sarcoidosis who underwent evaluation for cardiac involvement.	Of the 55 evaluated patients, standard evaluation diagnosed cardiac involvement in 13 patients while CMR diagnosed myocardial scarring (mean +/- SD, 2.5 +/- 1.9 segments) [all 6 patients] and impaired systolic left ventricular function (1 patient) in an additional 6 patients. The extent of delayed enhancement correlated with disease duration ($P<0.05$), ventricular dimensions and function ($P<0.001$), severity of mitral regurgitation ($P<0.05$), and the presence of ventricular tachycardias ($P<0.001$). Patients in whom cardiac involvement was diagnosed only with CMR had less myocardial scarring and functional impairment ($P<0.05$) compared to patients with a diagnosis made by standard assessment.	2
41. Smedema JP, Snoep G, van Kroonenburgh MP, et al. Evaluation of the accuracy of gadolinium-enhanced cardiovascular magnetic resonance in the diagnosis of cardiac sarcoidosis. *J Am Coll Cardiol* 2005; 45(10):1683-1690.	Observational-Dx	58 patients	To analyze the accuracy of gadolinium-enhanced CMR for the diagnosis of cardiac sarcoidosis.	The diagnosis of cardiac sarcoidosis was made in 12/58 patients (21%); CMR revealed late gadolinium enhancement, mostly involving basal and lateral segments (73%), in 19 patients. In 8 of the 19 patients, scintigraphy was normal, while patchy late gadolinium enhancement was present. The sensitivity and specificity of CMR were 100% (95% CI, 78% to 100%) and 78% (95% CI, 64% to 89%), and the positive and negative predictive values were 55% and 100%, respectively, with an overall accuracy of 83%.	2

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
42. Bargout R, Kelly RF. Sarcoid heart disease: clinical course and treatment. *Int J Cardiol* 2004; 97(2):173-182.	Review/Other-Dx	N/A	To review the clinical course and treatment of sarcoidosis.	Sarcoidosis is a rare granulomatous disease of unknown etiology that can affect any organ. Cardiac involvement, although uncommon, has a wide spectrum of clinical manifestations and is potentially fatal. Although there is no agreement upon a strategy for the diagnosis (which is difficult to make based on clinical information alone), the introduction of newer technology is promising and may be useful both for the early diagnosis of cardiac involvement and for the evaluation of response to therapy. Early treatment is crucial in improving symptoms and prognosis. ICD implantation and cardiac transplantation may offer improvements in management, as steroid therapy and pacemaker implantation has led to improved outcomes over the past three decades.	4
43. Falk RH, Dubrey SW. Amyloid heart disease. *Prog Cardiovasc Dis* 2010; 52(4):347-361.	Review/Other-Dx	N/A	To review the common types of cardiac amyloidosis and address their diagnosis and treatment.	The systemic amyloidoses are an uncommon group of disorders characterized by the extracellular deposition of amyloid in one or more organs. Cardiac deposition, leading to an infiltrative/restrictive cardiomyopathy, is a common feature of amyloidosis. It may be the presenting feature of the disease or may be discovered while investigating a patient presenting with non-cardiac amyloidosis. In this article we review the features of cardiac amyloidosis and its varied manifestations. The need for a high index of suspicion and the critical importance of precise biochemical typing of the amyloid deposits is stressed in light of recent advances in therapy which can, when appropriately used, significantly improve prognosis.	4

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
44. Nicolosi GL, Pavan D, Lestuzzi C, Burelli C, Zardo F, Zanuttini D. Prospective identification of patients with amyloid heart disease by two-dimensional echocardiography. *Circulation* 1984; 70(3):432-437.	Review/Other-Dx	2,078 consecutive echocardiograms	To determine whether changes in myocardial wall echogenicity that suggest amyloid disease could be prospectively identified by a qualitative analysis of 2D echocardiographic images.	2,078 consecutive echocardiograms obtained over a 14 month period were prospectively analyzed. The myocardial walls of 30 patients showed multiple, discrete, small highly refractive echoes; amyloid disease was not known or suspected in any of them. It was recommended that all 30 patients undergo gingival biopsy to confirm the diagnosis and biopsy was performed in 15 patients. The recommendation for biopsy was made only on the basis of 2D echocardiographic images and was independent of findings regarding thickness of the walls or the dimensions of the cardiac chambers. Results of biopsy were positive in 11 patients and negative in four.	4
45. Maceira AM, Joshi J, Prasad SK, et al. Cardiovascular magnetic resonance in cardiac amyloidosis. *Circulation* 2005; 111(2):186-193.	Observational-Dx	29 patients	To assess if CMR would show abnormalities in cardiac amyloidosis of diagnostic value.	Subendocardial T1 in amyloid patients was shorter than in controls (at 4 minutes: 427+/-73 vs 579+/-75 ms; $P<0.01$), was shorter than subepicardium T1 for the first 8 minutes ($P\leq0.01$), and was correlated with markers of increased myocardial amyloid load, as follows: LV mass (r=-0.51, P=0.013); wall thickness (r=-0.54 to -0.63, $P<0.04$); interatrial septal thickness (r=-0.52, P=0.001); and diastolic function (r=-0.42, P=0.025). Global subendocardial late gadolinium enhancement was found in 20 amyloid patients (69%); these patients had greater LV mass (126+/-30 vs 93+/-25 g/m2; P=0.009) than unenhanced patients. Histological quantification showed substantial interstitial expansion with amyloid (30.5%) but only minor fibrosis (1.3%). Amyloid was dominantly subendocardial (42%) compared with midwall (29%) and subepicardium (18%). There was 97% concordance in diagnosis of cardiac amyloid by combining the presence of late gadolinium enhancement and an optimized T1 threshold (191 ms at 4 minutes) between myocardium and blood.	3

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
46. Regueiro A, Garcia-Alvarez A, Sitges M, et al. Myocardial involvement in Chagas disease: Insights from cardiac magnetic resonance. *Int J Cardiol* 2013; 165(1):107-112.	Observational-Dx	67 patients	To describe CMR findings in patients with Chagas' disease living in a non-endemic area focusing on differentiation from other cardiomyopathies and relation with clinical status.	The presence of wall motion abnormalities and delayed enhancement by CMR was more frequent in the inferolateral and apical segments. Delayed enhancement distribution in the myocardial wall was heterogeneous (subendocardial 26.8%, midwall 14.0%, subepicardial 22.6%, and transmural 36.0% of total segments with delayed enhancement) and related to larger cardiac chambers and worse systolic function.	3
47. Kremastinos DT, Farmakis D. Iron overload cardiomyopathy in clinical practice. *Circulation* 2011; 124(20):2253-2263.	Review/Other-Tx	N/A	To describe the forms, pathophysiology, and phenotypic expression of iron overload cardiomyopathy, focusing on ventricular geometry and function and describe the early diastolic abnormalities that lead ultimately to heart muscle dysfunction and heart failure. The clinical implications of the condition are also discussed.	Iron overload, resulting mostly from transfusion-dependent anemias and primary hemochromatosis, is a more frequently encountered condition than generally is believed. The management of iron overload with proper iron chelation therapy guided by CMR T2* relaxometry is the key for the prevention and treatment of iron overload cardiomyopathy, in addition to other disease-specific modalities and the conventional heart failure therapy.	4
48. Pennell DJ. T2* magnetic resonance: iron and gold. *JACC Cardiovasc Imaging* 2008; 1(5):579-581.	Review/Other-Dx	N/A	Editorial comment on the role of T2* MR.	No results stated.	4
49. Anderson LJ, Holden S, Davis B, et al. Cardiovascular T2-star (T2*) magnetic resonance for the early diagnosis of myocardial iron overload. *Eur Heart J* 2001; 22(23):2171-2179.	Observational-Dx	106 patients	To develop and validate a noninvasive method for measuring myocardial iron in order to allow diagnosis and treatment before overt cardiomyopathy and failure develops.	There was a significant, curvilinear, inverse correlation between iron concentration by biopsy and liver T2* ($r=0.93$, $P<0.0001$). Inter-study cardiac reproducibility was 5.0%. As myocardial iron increased, there was a progressive decline in ejection fraction ($r=0.61$, $P<0.001$). All patients with ventricular dysfunction had a myocardial T2* of <20 ms. There was no significant correlation between myocardial T2* and the conventional parameters of iron status, serum ferritin and liver iron. Multivariate analysis of clinical parameters to predict the requirement for cardiac medication identified myocardial T2* as the most significant variable (odds ratio 0.79, $P<0.002$).	3

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
50. Tanner MA, Galanello R, Dessi C, et al. A randomized, placebo-controlled, double-blind trial of the effect of combined therapy with deferoxamine and deferiprone on myocardial iron in thalassemia major using cardiovascular magnetic resonance. *Circulation* 2007; 115(14):1876-1884.	Experimental-Tx	65 patients randomized to receive either deferoxamine plus deferiprone (combined group; n=32) or deferoxamine plus placebo (deferoxamine group; n=33)	Randomized, placebo-controlled, double-blind trial to test the hypothesis that the combined therapy of deferoxamine and deferiprone would result in greater reduction in cardiac iron loading than deferoxamine alone, using myocardial T2* as the primary end point.	There were significant improvements in the combined treatment group compared with the deferoxamine group in myocardial T2* (ratio of change in geometric means 1.50 vs 1.24; P=0.02), absolute LV ejection fraction (2.6% vs 0.6%; P=0.05), and absolute endothelial function (8.8% vs 3.3%; P=0.02). There was also a significantly greater improvement in serum ferritin in the combined group (-976 vs -233 microg/L; P<0.001).	1
51. Westwood MA, Wonke B, Maceira AM, et al. Left ventricular diastolic function compared with T2* cardiovascular magnetic resonance for early detection of myocardial iron overload in thalassemia major. *J Magn Reson Imaging* 2005; 22(2):229-233.	Observational-Dx	67 patients and 22 controls	To compare LV diastolic function with myocardial iron levels in beta thalassemia major patients, using CMR.	Myocardial iron loading was found in 46 thalassemia major patients (69%), in whom the early peak filling rate correlated poorly with T2* (r = -0.20, P=0.19). The atrial peak filling rate (r = 0.49, P<0.001) and early peak filling rate/atrial peak filling rate ratio (r = -0.62, P<0.001) correlated better with T2*. The sensitivity of the diastolic parameters for detecting myocardial iron loading ranged from 4% (EPFR and APFR) to 17% (early peak filling rate/atrial peak filling rate ratio).	3
52. Nagueh SF, Bierig SM, Budoff MJ, et al. American Society of Echocardiography clinical recommendations for multimodality cardiovascular imaging of patients with hypertrophic cardiomyopathy: Endorsed by the American Society of Nuclear Cardiology, Society for Cardiovascular Magnetic Resonance, and Society of Cardiovascular Computed Tomography. *J Am Soc Echocardiogr* 2011; 24(5):473-498.	Review/Other-Dx	N/A	To review the strengths and applications of the current imaging modalities and provide recommendation guidelines for using these techniques to optimize the management of patients with hypertrophic cardiomyopathy.	No results stated in abstract.	4

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
53. Syed IS, Ommen SR, Breen JF, Tajik AJ. Hypertrophic cardiomyopathy: identification of morphological subtypes by echocardiography and cardiac magnetic resonance imaging. *JACC Cardiovasc Imaging* 2008; 1(3):377-379.	Review/Other-Dx	N/A	To present a short review of hypertrophic cardiomyopathy.	Hypertrophic cardiomyopathy is characterized by marked genotypic, phenotypic, and clinical heterogeneity. Ventricular septal hypertrophy is the most common form of hypertrophy with mid-ventricular and apical forms of hypertrophy being far less common. The pattern of ventricular septal hypertrophy is variable and can broadly be divided into the following morphological subtypes: reverse curvature, sigmoid, and neutral.	4
54. Puntmann VO, Jahnke C, Gebker R, et al. Usefulness of magnetic resonance imaging to distinguish hypertensive and hypertrophic cardiomyopathy. *Am J Cardiol* 2010; 106(7):1016-1022.	Observational-Dx	119 subjects (39 with hypertension, 43 with nonobstructive hypertrophic cardiomyopathy, 37 control subjects)	To investigate whether apparently different pathophysiologic pathways in the development of LV hypertrophy might be reflected in the phenotypical differences, discernable by means of multiparametric CMR.	Compared to controls, both hypertrophic groups had significantly greater maximal wall thickness and LV mass index (P<0.01). The patients with hypertension had reduced ejection fraction, increased heart cavities, and increased LV wall stress (P<0.01). The hypertrophic cardiomyopathy group had supernormal ejection fraction and reduced LV wall stress (P<0.01). The hypertension group had reduced anteroseptal systolic strains (P<0.02), and the hypertrophic cardiomyopathy group displayed a marked decrease in longitudinal systolic strain (P<0.01). In the hypertrophic cardiomyopathy group, an inverse relation was seen between a globally increased late gadolinium enhancement score and the ejection fraction (r = -0.5, P=0.01), and between regional late gadolinium enhancement scores and regional systolic strain in the inferoseptal segments. Increased LV wall stress was identified as the hallmark of hypertension (odds ratio 1.2, P=0.002), while hypertrophic cardiomyopathy was best characterized by reduced total longitudinal strain (odds ratio 1.3, P=0.002).	3

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
55. van Dalen BM, Caliskan K, Soliman OI, et al. Diagnostic value of rigid body rotation in noncompaction cardiomyopathy. *J Am Soc Echocardiogr* 2011; 24(5):548-555.	Observational-Dx	15 patients with dilated cardiomyopathy, 52 healthy subjects, and 52 patients with prominent trabeculations	To explore the diagnostic value of rigid body rotation in a large group of patients with prominent trabeculations.	The majority of normal subjects had LV rotation pattern 1A (98%), whereas the 18 subjects with hypertrabeculation not fulfilling diagnostic criteria for noncompaction cardiomyopathy predominantly had pattern 1B (71%), and the 34 patients with noncompaction cardiomyopathy predominantly had pattern 2 (88%). None of the patients with dilated cardiomyopathy showed rigid body rotation. Sensitivity and specificity of rigid body rotation for differentiating noncompaction cardiomyopathy from "hypertrabeculation" were 88% and 78%, respectively.	3
56. Mavrogeni S, Dimitroulas T, Kitas GD. Multimodality imaging and the emerging role of cardiac magnetic resonance in autoimmune myocarditis. *Autoimmun Rev* 2012; 12(2):305-312.	Review/Other-Dx	N/A	To summarize the current state of knowledge regarding the non-invasive imaging assessment of autoimmune myocarditis, mainly focusing on the role of multimodality imaging in the detection, treatment guidance and follow up of patients with autoimmune diseases.	Early diagnosis is of great significance because of the likelihood of progression to severe and potentially fatal complications. The clinical presentation of the disease is silent leading to delayed diagnosis when dilated cardiomyopathy or heart failure has already advanced. Therefore, a major issue is whether the diagnosis of myocarditis will continue to require invasive procedures such as endomyocardial biopsy or can be achieved with non-invasive methods. CMR in particular, has emerged as an important technique in the evaluation of myocarditis using three types of images: T2-weighted (T2-W), early T1-weighted images taken after 1min, and delayed enhanced images taken 15min after the injection of contrast agent. If 2/3 of the imaging sequences are positive, myocardial inflammation can be predicted or ruled out with a diagnostic accuracy of 78%.	4
57. Danti M, Sbarbati S, Alsadi N, et al. Cardiac magnetic resonance imaging: diagnostic value and utility in the follow-up of patients with acute myocarditis mimicking myocardial infarction. *Radiol Med* 2009; 114(2):229-238.	Review/Other-Dx	23 consecutive patients	To evaluate the efficacy of MRI in the differential diagnosis between active myocarditis and myocardial infarction in patients with clinical symptoms mimicking acute myocardial infarction.	CMR with injection of contrast material showed late subepicardial and intramyocardial enhancement in all patients. Subendocardial late enhancement, a typical pattern of myocardial infarction, was never seen. In addition, in agreement with the literature, there was prevalent involvement of the lateral segments of the LV wall.	4

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
58. Crean A, Greenwood JP, Plein S. Contribution of noninvasive imaging to the diagnosis and follow-up of Takotsubo cardiomyopathy. *JACC Cardiovasc Imaging* 2009; 2(4):519-521.	Review/Other-Dx	N/A	To review imaging of Takotsubo cardiomyopathy.	The defining hallmark of Takotsubo cardiomyopathy is the complete recovery of function that occurs within days to weeks of the original clinical presentation. Cardiologists need to be aware of the specific diagnostic features of the condition and the contribution that imaging may make to its recognition and management.	4
59. Andersson H, Atharovski KA, Christensen TE, et al. How to distinguish takotsubo cardiomyopathy from acute myocardial infarction using multimodal cardiac imaging. *Int J Cardiol.* 2012;159(1):73-74.	Review/Other-Dx	1 patient	Case report to demonstrate how multimodal cardiac imaging can be used to to distinguish takotsubo cardiomyopathy from acute myocardial infarction.	The present case indicates that multimodal cardiac imaging examinations might be of benefit in distinguishing between TC and AMI.	4
60. Kanjanauthai S, Ananthasubramaniam K. Integral role of cardiovascular magnetic resonance imaging in the diagnostic workup of suspected takotsubo cardiomyopathy: Avoiding misdiagnosis. *Cardiol J* 2007; 14(6):592-594.	Review/Other-Dx	N/A	To report a case initially diagnosed as Takotsubo cardiomyopathy, in which CMR imaging demonstrated that myocardial infarction, was in fact the true diagnosis.	CMR should be an integral part of the diagnostic workup of suspected Takotsubo cardiomyopathy.	4
61. Nagy AC, Cserep Z, Tolnay E, Nagykalnai T, Forster T. Early diagnosis of chemotherapy-induced cardiomyopathy: a prospective tissue Doppler imaging study. *Pathol Oncol Res* 2008; 14(1):69-77.	Observational-Dx	40 women	To compare the applicability of the conventional echocardiography and a novel method, TDI in detection of late or subclinical cardiotoxicity following anthracycline chemotherapy in long-term follow-up.	After 1 year, diastolic LV function was impaired in 39 patients (97.5%), and 29 (72.5%) of these showed clear changes by means of the traditional E/A ratio and TDI. However, in 10 patients (25%) the diastolic dysfunction could only be detected with TDI. At the end of the study diastolic dysfunction was detected in each patient, but in 13 patients (32.5%) the relaxation disorder could be revealed only with TDI. Detectable myocardial damage occurred in the study group as a result of anthracycline therapy. TDI is a more precise and useful examination method than the traditional ones (E/A ratio or deceleration time) to demonstrate isolated diastolic dysfunction.	3

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
62. Stanton C, Bruce C, Connolly H, et al. Isolated left ventricular noncompaction syndrome. *Am J Cardiol* 2009; 104(8):1135-1138.	Observational-Dx	30 patients	To define the clinical characteristics and outcomes in patients diagnosed with isolated LVNC at a single center using specific diagnostic criteria.	30 patients with confirmed isolated LVNC were included in analyses (mean age at diagnosis 39 +/- 19.5 years, 60% men). Three patients with isolated LVNC died during follow-up (mean 2.5 +/- 1.2 years) compared to 5 dilated cardiomyopathic and 1 community controls. No mortality difference was observed among these groups (P=0.42 and 0.054, respectively). No isolated LVNC deaths were observed in patients with normal LV ejection fraction. New-onset AF was diagnosed in 2 patients with isolated LVNC, and none was observed in dilated cardiomyopathic controls. Stroke occurred in 2 dilated cardiomyopathic controls and none was observed in patients with isolated LVNC. ICDs were implanted in 11 patients with isolated LVNC. No appropriate therapies were identified during follow-up, but 2 patients underwent inappropriate therapies related to atrial fibrillation. Mortality in patients with isolated LVNC is similar to that in dilated cardiomyopathic patients.	4
63. Guntheroth WG. Left ventricular noncompaction cardiomyopathy. *J Am Soc Echocardiogr* 2012; 25(7):806.	Review/Other-Dx	N/A	A letter to the editor on the characteristics of LVNC echocardiographic findings in fetuses that illustrate the pathophysiology.	No results stated in abstract.	4
64. Caliskan K, de Visser RN, van Geuns RJ, Ten Cate FJ, Serruys PW. Left ventricular angiogram in a patient with noncompaction cardiomyopathy. *EuroIntervention* 2007; 2(4):533-534.	Review/Other-Dx	N/A	To review a case finding of a patient with LVNC.	No results stated in abstract.	4

EVIDENCE TABLE

Reference	Study Type	Patients/ Events	Study Objective (Purpose of Study)	Study Results	Study Quality
65. Paterick TE, Gerber TC, Pradhan SR, Lindor NM, Tajik AJ. Left ventricular noncompaction cardiomyopathy: what do we know? *Rev Cardiovasc Med* 2010; 11(2):92-99.	Review/Other-Dx	N/A	To review LVNC including the symptoms, diagnosis, prognosis, and treatment.	Estimates of the frequency and incidence of LVNC are limited because of the controversy over whether LVNC is a discrete disease entity. There is considerable overlap with dilated cardiomyopathy, apical hypertrophy, and hypertrophic cardiomyopathy. Symptoms, diagnosis, and prognosis are variable because of the heterogeneous nature of these diseases, making treatment often empirical and mimicking the treatment of other cardiomyopathies. However, there are management issues that should be addressed in each patient with LVNC, including genetic testing and family screening, the need for ICD placement, the role of anticoagulation in prevention of thromboembolic complications, and prescriptions/restrictions for implementation of physical activity.	4

Evidence Table Key

Study Quality Category Definitions

- *Category 1* The study is well-designed and accounts for common biases.
- *Category 2* The study is moderately well-designed and accounts for most common biases.
- *Category 3* There are important study design limitations.
- *Category 4* The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:
  a) the study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description);
  b) the study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence;
  c) the study is an expert opinion or consensus document.

Dx = Diagnostic

Tx = Treatment.

Abbreviations Key

ARVD = Arrhythmogenic right ventricular dysplasia

ARVD/C = Arrhythmogenic right ventricular dysplasia/cardiomyopathy

ARVD/D = Arrhythmogenic right ventricular dysplasia/dysplasia

CCTA = Coronary computed tomography angiography

CI = Confidence interval

CMR = Cardiovascular magnetic resonance

CT = Computed tomography

CTA = Computed tomography angiography

FDG-PET = Fluorine-18-2-fluoro-2-deoxy-D-glucose-positron emission tomography

HR = Hazard ratio

ICD = Implantable cardioverter-defibrillators

ICM = Ischemic cardiomyopathy

LV = Left ventricular

LVNC = Left ventricular noncompaction cardiomyopathy

MDCT = Multidetector computed tomography

MRI = Magnetic resonance imaging

NICM = Nonischemic cardiomyopathy

ROC = Receiver-operator characteristic

RV = Right ventricular

SPECT = Single-photon emission tomography

TDI = Tissue Doppler imaging