When Should I Order An Echo?

A Primer for General Practitioners

The role of echocardiography as a diagnostic, therapeutic and management-guiding tool is becoming increasingly relevant in cardiology and general practice. This article discusses the appropriate application of this form of testing.

By Richard Bon, MD; and Kenneth Gin, MD, FRCPC

A comprehensive history and thorough physical examination have traditionally been the cornerstones upon which the diagnosis and management of cardiovascular disease are based. While these fundamentals of medicine will never be replaced in the assessment and treatment of patients, technology has provided physicians with additional tools to aid in the pursuit of optimal patient care. Since its inception, echocardiography has become an invaluable addition to the diagnostic and therapeutic

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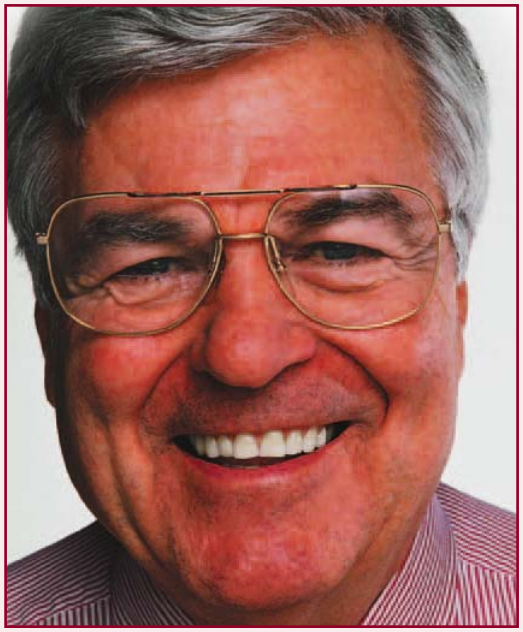
Case



Michael, a 68-year-old man, presents for his initial visit to your office for a life insurance assessment. He has no known cardiac history, however, you elicit a history of infrequent "skipped beats" and one prolonged episode of self-terminating irregular palpitations while he was vacationing in Mexico one year ago. He denies any history of chest pain or dyspnea at rest, however, he has noticed a decrease in exercise tolerance over the past six months, which he attributes merely to deconditioning. He has a history of "borderline" hypertension, which currently is not being treated medically. He has no known history of diabetes or hypercholesterolemia, he quit smoking 30 years ago, and has no family history of coronary artery disease. He currently takes no medications.

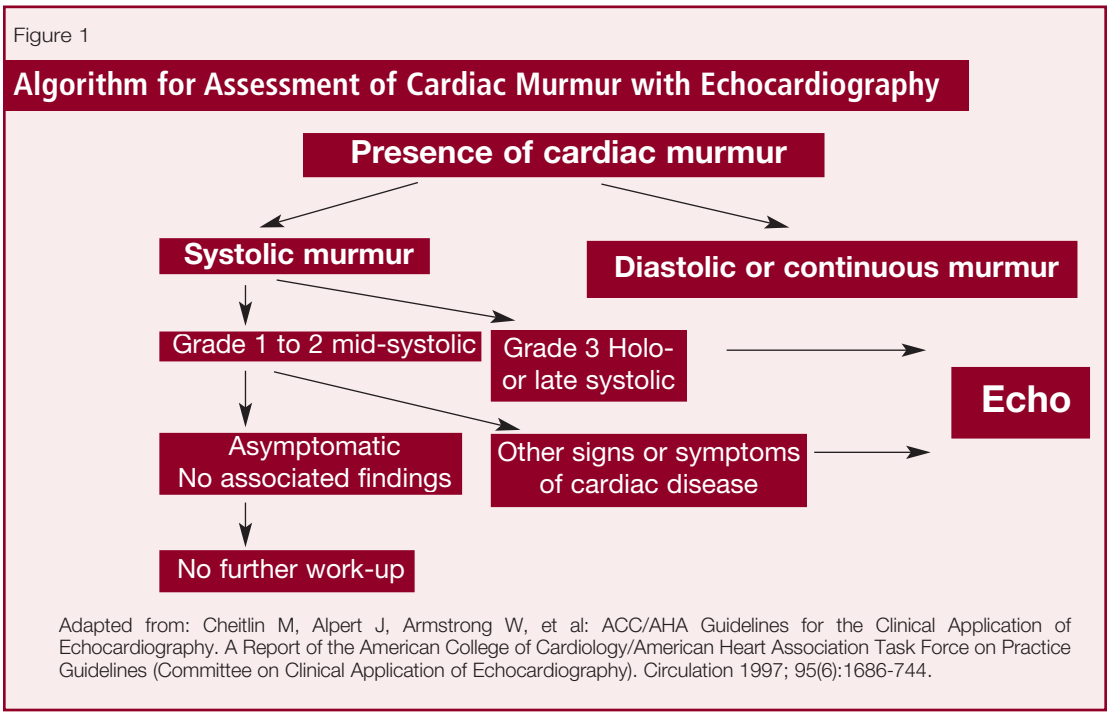
On examination, Michael's blood pressure (BP) is 145/85 mmHg and the pulse is 72 beats per minute (BPM) and regular. Auscultation of the lungs is normal. Examination of the cardiovascular system reveals a jugular venous pulsation at 4 cm above the sternal angle, a normal carotid upstroke, a normal apical impulse, and normal first and second heart sounds. There are no third or fourth heart sounds. A holosystolic grade II/VI murmur is heard at the apex. The remainder of the physical examination is unremarkable.

The patient's electrocardiogram (ECG) shows normal sinus rhythm at a rate of 75 bpm with borderline voltage criteria for left ventricular hypertrophy and left atrial enlargement.

Question: At this point, what would your clinical interventions be?

Discussion on page 34

Figure 1



Adapted from: Cheitlin M, Alpert J, Armstrong W, et al: ACC/AHA Guidelines for the Clinical Application of Echocardiography. A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Committee on Clinical Application of Echocardiography). Circulation 1997; 95(6):1686-744.

armamentarium used by physicians treating cardiovascular disease.

The ability of echocardiography to provide unique, non-invasive information with minimal discomfort or risk, without using contrast material or radiation, coupled with its portability, availability and repeatability, accounts for its use in virtually all categories of cardiovascular disease.[1] Despite these advantages, indiscriminate use of echocardiography could lead to inappropriate further testing or intervention and could result in needless expenditure of health-care dollars.

Consequently, this article will review the evidence for some of the most common scenarios in which echocardiography may be useful to general practitioners, including the assessment of:

- Murmurs and valvular heart disease;
- Chest pain;
- Left ventricular (LV) function;
- Systemic hypertension; and
- Atrial fibrillation.

Murmurs and Valvular Heart Disease

Heart murmurs are the audible manifestation of turbulent blood flow which may signify stenotic or regurgitant valvular disease or other congenital or acquired cardiovascular defects. Echocardiography can help in the assessment of murmurs by providing information regarding valvular morphology, thickness, calcification, vegetations and leaflet motion; quantification of stenotic or regurgitant lesions; and cardiac chamber size and function. While a murmur may be the major clinical feature of a cardiac abnormality, many murmurs in asymptomatic people are of no hemodynamic or functional significance.

Murmurs can be categorized into systolic, diastolic, and continuous murmurs (Figure 1). Diastolic and continuous murmurs are always pathologic and warrant echocardiographic investigation. Systolic murmurs can be divided into functional and pathologic murmurs. A

murmur in an asymptomatic patient is classified as functional if it has the following characteristics:

- Systolic murmur of short duration;
- Grade I or II intensity at the left sternal border;
- Systolic ejection pattern;
- Normal second heart sound (S_2);
- No other abnormal sounds or murmurs;
- No evidence of ventricular hypertrophy or dilation;
- No thrills;
- Absence of an increase in intensity with Valsalva's maneuver.[1]

In one study looking at the accuracy of the cardiovascular physical examination for the diagnosis of asymptomatic valvular heart disease (VHD) in 143 subjects, a complete physical examination with dynamic cardiac auscultation showed a sensitivity of 70% and a specificity of 98%. It also showed a positive and negative predictive value of 92% for the diagnosis of valvular heart disease, as compared to transesophageal echocardiography (TEE).[2] Furthermore, only two of the 10 patients with VHD by TEE (but not by physical examination) had clinically important VHD.[2]

Another retrospective study involving 169 patients with systolic murmurs aged 18 to 55, found older age, male gender, and murmur ≥ grade III were the only significant predictors of positive echocardiographic results.[3] In addition, if female patients aged ≤ 35 with murmur grade II or less had not been referred for investigation, 47% of the echocardiographic studies could have been avoided while retaining a sensitivity of 90%.[3]

Finally, a recent study involving 100 patients with a systolic murmur of unknown cause compared the diagnostic accuracy of echocardiography with physical examination by a cardiologist. It was shown that functional murmurs usually can be distinguished from an organic murmur.[4] However, the ability of the cardiac examination to determine the exact cause of the murmur, especially if more than one lesion is present, was limited and, therefore, echocardiography was recommended for patients suspected of having significant cardiac disease.[4]

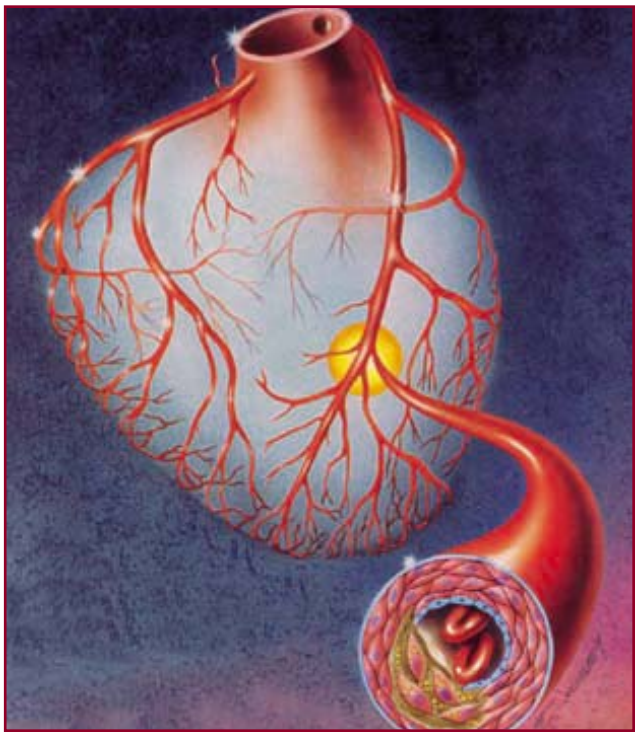
In keeping with these findings, the American College of Cardiology/American Heart Association (ACC/AHA) Guidelines for the Clinical Application of Echocardiography do not recommend echocardiography replace the basic cardiovascular evaluation as a screen for VHD.[1] However, in patients with cardiorespiratory symptoms or in asymptomatic patients with ambiguous clinical findings or features indicative of at least a moderate probability that the murmur is reflective of structural heart disease, echocardiography is the test of choice (Figure 1).[1] Among patients with known VHD and changing symptoms or signs, echocardiography is clearly the optimal method of noninvasively and accurately re-evaluating the progression of valvular lesions as well as any accompanying changes in chamber size or contractile function.[1]

Chest Pain

Coronary artery disease (CAD) is the most common cause of cardiac chest pain. While echocardiography has long been used to diagnose other causes of chest pain (*e.g.*, valvular aortic stenosis, hypertrophic cardiomyopathy, aortic dissection, acute pulmonary embolism), the use of standard echocardiography for chest pain related to CAD has not been as widespread. Unlike angiography, echocardiography is unable to directly image coronary artery occlusions or stenoses, and relies on the presence of regional ventricular wall motion

abnormalities to detect the presence of myocardial ischemia or infarction. Standard echocardiographic studies are insensitive for the detection of CAD. In fact, patients with high- grade coronary stenosis often have completely normal ventricular function. If performed during an episode of chest pain, however, the absence of regional wall motion abnormalities identifies a subset of patients unlikely to have a myocardial infarction (MI) with a negative predictive accuracy of 95%.[5] This may be useful when acute myocardial ischemia is suspected, but the baseline electrocardiogram (ECG) is nondiagnostic (*i.e.*, chronic left-bundle-branch block, ventricular pacing).

Yet another indication for echocardiography in the setting of acute chest pain is in assessing consequences of acute MI (AMI). Echocardiography is extremely useful for the assessment of LV function, which is the single most important predictor of mortality, following AMI. A LV ejection fraction (LVEF) of < 40% post-AMI is associated with a fourfold increase in six-month mortality, as compared to an LVEF of > 40%.[6] In addition, the ACC/AHA guidelines also recommend echocardiography in the peri-infarct period for the investigation of acute mitral regurgitation, infarct expansion, LV remodeling, ventricular septal rupture, free wall rupture, RV infarction, and pericardial effusion.[1] It is also the definitive test for detection of intracardiac thrombi, which are most commonly seen in anteroapical infarctions. Their presence denotes an increased risk of both systemic embolism and death.[1]



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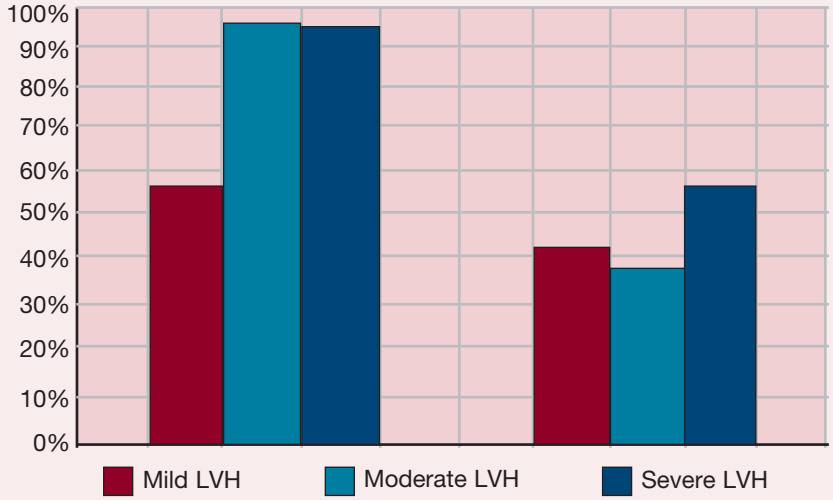
Left Ventricular Function

Perhaps the most common indication for echocardiography is for the evaluation of LV systolic function. Although other quantitative methods for determining LV ejection fraction exist, such as LV angiography and nuclear scanning, echocardiographic visual estimation by skilled observers has been shown to be equally accurate.[7,8] A clear advantage of

Figure 2

Sensitivity of Echocardiography and Electrocardiography for the Assessment of Left Ventricular Hypertrophy



Adapted from: Devereux R, Casale P, Wallerson D, et al: Cost-effectiveness of echocardiography and electrocardiography for detection of left ventricular hypertrophy in patients with systemic hypertension. Hypertension 1997; 9(2 Pt 2):1169-76.

echocardiographic assessment of LV function is that it can also provide information about cardiac chamber size, wall thickness, wall motion, valvular abnormalities, and pulmonary artery pressures. The combination of this data, along with the simplicity and non-invasive nature of the test, makes echocardiography a very attractive method of measuring LV function.

Poor LV systolic function has been well established as a marker of increased mortality.[9] In the majority of cases, systolic dysfunction is due to ischemic heart disease, hypertensive heart disease or valvular heart disease. Primary disorders of the heart muscle may also be implicated, however, in addition, impairment of LV filling (diastolic dysfunction) is now well recognized as an etiology of heart failure that may be difficult to distinguish from systolic dysfunction on routine history and physical examination. Echocardiographic evaluation permits a comprehensive assessment of ventricular morphology, function and hemodynamic status, regardless of the etiology. An example of the clinical utility of echocardiography in diagnosing heart failure was illustrated by one trial that prospectively studied 151 consecutive patients with a clinical diagnosis of congestive heart failure. That study found 34% of patients had a normal ejection fraction (LVEF > 55%).[10] Despite this, 51% of these patients were being treated inappropriately with digoxin therapy, despite the absence of an atrial arrhythmia.[10]

The ACC/AHA guidelines put these data into clinical context by recommending echocardiography for patients in whom assessment of LV size and function (systolic or diastolic) is required because of clinical suspicion of heart failure. In addition, the guidelines apply to patients for the re-evaluation of LV function in those with established cardiomyopathy and a change of clinical status or to guide medical therapy.[1]

Systemic Hypertension

Systemic hypertension most commonly affects the heart by leading to the development of LV hypertrophy (LVH) and congestive heart failure. Assessment of hypertrophy is relevant because several cohorts have shown the risks of cardiac morbidity and mortality are increased in hypertensive patients with echocardiographic evidence of LVH. These risks are independent of traditional coronary risk factors.[11] The determination of LVH by echocardiogra-

The prevalence of atrial fibrillation in both genders begins to rise > age 40 and increases rapidly > age 65.

Case Discussion

The history, physical examination and ECG have revealed some important information with respect to potential underlying heart disease in this otherwise healthy patient. There is additional information, however, that can be obtained from echocardiography that may guide medical management. The history of "skipped beats" and a prolonged episode of irregular palpitations, in the setting of left atrial enlargement on ECG, alerts one to the possibility of paroxysmal atrial fibrillation (especially with its high prevalence in this age group). An echocardiographic evaluation, to rule out structural heart disease, would be indicated in this case.

Although functional murmurs are often heard on routine examination of asymptomatic patients, the holosystolic nature and apical location of this patient's murmur make it more likely to be a murmur of significance. Given Michael's history of palpitations, increasing dyspnea on exercise, and left atrial enlargement on ECG, one would want to rule out the presence of significant mitral regurgitation by echocardiography.

The presence of mildly elevated BP by itself is not an indication for echocardiographic workup. However, given the suspicion of underlying heart disease (as manifested by borderline left ventricular hypertrophy on ECG) and potential valvular disease and atrial arhythmias, the American College of Cardiology/American Heart Association criteria for echocardiography in hypertension would be satisfied. Demonstration of significant left ventricular hypertrophy by echocardiography would confirm the presence of target organ damage and mandates more aggressive BP control.

This case illustrates a situation in which the application of the guidelines for the use of echocardiograhy by general practitioners can lead to timely and cost-effective identification of patients with significant cardiac disease.

phy has been shown to be more sensitive and specific, as compared to ECG (Figure 2).[12] In addition to providing an accurate assessment of LV mass, echocardiography can provide information regarding ventricular wall thickness, concentric remodeling and abnormalities of ventricular filling (diastolic dysfunction). In patients with borderline hypertension, therefore, a decision to initiate treatment may be based on the presence of hypertrophy or concentric remodeling.[1]

In an individual patient who is already undergoing treatment for known hypertension, the utility of echocardiography depends on the clinical relevance of the assessment of LV mass or function in that patient. In the majority of cases, target organ damage can be established by history and physical examination or ECG evidence of LVH. Echocardiography is not necessary, as it will not change the course of management. As a result, the ACC/AHA guidelines do not recommend every patient with hypertension be screened with resting echocardiography.[1] Rather, it should be reserved for those patients in whom there is suspicion of concomitant heart disease and whose clinical status deems the test relevant.[1]

Atrial Fibrillation

Atrial fibrillation (AF) is the most common

sustained arrhythmia and an independent risk factor for stroke. Its prevalence in both genders begins to rise > age 40 and increases rapidly > age 65. Its prevalence is 5% for patients between the ages of 70 to 75 years and > 10% in those > 80 years.[13] The rate of ischemic stroke in patients with AF who are not anticoagulated is approximately 5% per year and rises with increasing age.[13] The incidence of anticoagulation-associated major hemorrhages can vary from 1.3% per year to 2.3% per year.[14] Clearly, any test that could reliably determine which patients are at higher risk of ischemic stroke, based on the presence of atrial thrombus, could help prevent unnecessary complications of anticoagulation therapy.

Studies that have looked at the utility of transthoracic echocardiography (TTE) to determine a cardioembolic source of stroke have shown TTE is insensitive for the identification of atrial thrombi because of its inability to adequately image the left atrial appendage (the site of the majority of thrombi among patients with AF).[15] The sensitivity of TTE to detect left atrial thrombus is only about 20%. The presence or absence of clot on TTE, therefore, should not be used to decide whether a patient with AF should be anticoagulated. There are several studies that have found TEE to be much more sensitive at identifying or excluding left atrial thrombus; however, the use of TEE in stratifying the risks of elective car-

dioversion from AF is beyond the scope of this article.

While left atrial dilatation is a common finding in patients with AF, left atrial size is not a predictor of increased risk of stroke. Rather, patients with AF who have LV systolic dysfunction are at an increased risk for stroke and, therefore, anticoagulation is warranted.

Transthoracic echocardiography is advocated in the initial evaluation and management of patients presenting with their first episode of AF. Atrial fibrillation is frequently associated with a variety of cardiac disorders including mitral valve disease, LVH secondary to hypertensive heart disease, and ischemic heart disease. Between 10% and 30% of patients with AF will have structural abnormalities that can be diagnosed on TTE. Another extremely valuable application of echocardiography in AF is to guide the choice of antiarrhythmics, since these agents may result in increased mortality in the setting of LV systolic dysfunction.[15]

In summary, the ACC/AHA guidelines for the Clinical Application of Echocardiography have recommended echocardiography be performed for patients presenting with their first episode of AF to rule out or identify underlying structural or functional heart disease. It does not recommend repeat studies, however, unless there has been a change in clinical status or if the result might affect a therapeutic decision.[1]

Conclusion

The role of echocardiography as a diagnostic, therapeutic and management-guiding tool is becoming increasingly relevant in cardiology and general practice. While the indications for echocardiography extend far beyond those covered in this article, the evidence for the guidelines surrounding its use for the most common clinical cardiac problems have been reviewed. The appropriate application of echocardiography offers both a helpful and cost-effective way of managing patients with cardiovascular disease.

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