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EDITORIAL COMMENT

Hand-Held Echocardiography: Revolution or Hassle?*

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Running apace with progress in electronics, the echocardiography industry has rapidly integrated innovations into instrument design; in so doing, this modality has become the central diagnostic tool in cardiology. Generally, active echocardiography laboratories use "high-end" instruments that have advanced features. When operated by skilled sonographers and supervised by experienced physicians, an echocardiogram/Doppler examination can accurately identify and grade any and all valve diseases, congenital defects, pericardial diseases, myocardial hypertrophy and myopathy, ventricular systolic and diastolic dysfunction and, with stress, many ischemic syndromes. By integrating Doppler information with anatomic data, hemodynamics such as pulmonary artery-pressure or left ventricular (LV) filling pressure can be accurately deduced and provide a framework for constructing treatment algorithms. Patients referred to a modern echocardiography laboratory for suspected heart disease can expect to benefit from an accurate and comprehensive diagnostic evaluation.

Most recently, advances in electronics have enabled the ultrasound industry to create an echocardiography machine the size of a laptop computer. Inexpensive (relatively), compact and portable, these battery-operated devices enable a cardiologist to have a personal imager at the point of patient contact. If these devices are miniaturized but fully functional instruments and their performance in the hands of practitioners equivalent to a sonographer operating a laboratory instrument, a revolution in the utilization and delivery of echocardiography services will have begun with consequences that will include changes in availability, reimbursement, sonography utilization and physician practices. However, if the new devices prove to be mere derivatives of laboratory-grade instruments, they may prove to be more hassle than help and they will join tissue characterization, automated edge tracking, second-generation contrast agents and real-time three-dimensional imagers as exciting ideas that may not achieve commercial viability.

See pages 2013 and 2019

In this issue of the *Journal*, Spencer et al. (1) investigated the impact of physician use of a hand-held echocardiograph in the context of contemporary practice. Four board-certified cardiologists with a mean practice experience of five years and level II training in echocardiography (exposure typical of a clinical fellowship) were asked to perform a physical examination on 36 selected subjects with common cardiac lesions of varying severity. Immediately following, the physician imaged the patient with the hand-held echocardiograph. Both the results of the physical examination and the point of care echocardiogram were compared to a standard echocardiogram performed by an experienced sonographer using a high-end instrument.

The study found that physical examination failed to detect 59% of all cardiovascular conditions and 43% of major findings. For example, 2 of 7 with aortic stenosis, 5 of 6 with hypertrophic cardiomyopathy, 3 of 6 with mitral stenosis and 14 of 21 with LV dysfunction had their conditions missed by physical examination. After point of care echocardiography, the number of missed lesions fell to 29% overall and 21% if major. The 21% included 1 of 7 aortic stenosis, 3 of 6 hypertrophic cardiomyopathy, 5 of 21 decreased LV function and 3 of 8 decreased right ventricular function.

Superficially, these findings seem to indicate that physical examination skills have deteriorated when compared to standards during the "golden age" of cardiology (whenever that was). If true, hand-held echocardiography may be recommended on this basis alone. However, yearning for halcyon days may be based more on nostalgia than reality. For example, in the pre-echocardiography era, routine quantitation of LV function was not available and physical examination for this purpose could not have been rigorously tested. Similarly, when physical examination was ascendant (and largely uncontested), hypertrophic cardiomyopathy was largely unknown. Thus, at least some of the apparent deficiencies in physical examination revealed in this study are more likely related to an increase in performance expectations traceable directly to the role of echocardiography itself in current practice.

The findings of this study also raise several questions that will need to be addressed. If the study were continued by adding more groups of patients, how would physical examination skills and echocardiographic skills of these relatively inexperienced physicians evolve? What would be the results if the study had been performed with more clinically seasoned cardiologists with more remote echocardiography training? How much time does this procedure add to each patient encounter and does this additional time expenditure render the use of point of contact echocardiography impractical? What are the financial consequences beyond the physician's time commitment? Will third-party payers further reduce reimbursements for echocardiography services? Will a change in reimbursement further hasten the imminent conversion of echocardiography laboratories from

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profit centers into cost centers? Will these devices adversely affect the profession of cardiac sonography? Will physicians without cardiology training "take up" echocardiography now that the price of equipment has fallen?

In the study by Goodkin et al. (2), also in this issue of the *Journal*, a second similar device was tested against standard echocardiography/Doppler in the more rigorous environment of critical care. Of the 99 clinical questions posed, the hand-held device failed to obtain data in 15% and its information was deemed "incorrect" in 14% (LV function, tamponade, valve function, thrombus). In addition to this 29% failure rate, unsuspected but clinically relevant findings were missed in 15% of patients.

The findings by Goodkin et al. (2) reinforce those of Spencer et al. (1) in sounding a note of caution for the application of these devices without clear understanding of their limitations.

For the past 18 months, I have had the opportunity to test the hand-held device used by Goodkin et al. (2) in my outpatient practice and on ward and consult rounds. The device is small and lightweight and its transducer is also very light but has a fairly large footprint. It has no pulsed or continuous Doppler but is equipped with a simple color flow system of relatively low sensitivity. When conditions are favorable, the images are well resolved and have good contrast resolution but are quite small. Through trial and error, I have found the device particularly useful for checking the size and dynamics of the inferior vena cava, in spot checking ventricular size and function and in questions of pericardial disease. I do not expect it to provide information about valve regurgitation or Doppler hemodynamics. The only time I have been misled by its use was during resuscitation in the catheterization laboratory where it proved difficult to attain adequate transducer contact.

From my experience, these instruments show considerable promise but need to evolve further. The color flow Doppler, in particular, needs improvement and they should be equipped with spectral Doppler so that valve gradients, hemodynamics and diastolic function can be determined. They also need improved digital storage and transmission of images. Most importantly, regardless of the size of the instrument, it is still echocardiography and this fact means that the skill required to acquire an examination is considerable. The physics of the interaction between ultrasound beam and its cardiac target remains unchanged and continues to render the process of creating a cardiac image highly vulnerable to interposed air, bone, fat and poor skin contact.

While I can say that I am better off with access to the device than without it, the lack of a proper examining surface (excavated mattress or access from the left) in most clinical situations, the size of the transducer and the lighting conditions on the ward require considerable technical agility to obtain the desired information. Furthermore, in the context of clinical practice, routine use of this device is likely to be more time-consuming than allowed by the pace of modern practice.

Those planning to use this device should take care in positioning the patient in order to optimize access to imaging windows, should control the ambient lighting and possess the requisite skills. If you are echocardiographically challenged because you have not performed many studies yourself, these devices will amplify your deficiencies and may be more hassle than help, if not dangerously misleading. If you use Doppler for hemodynamics, valve disease and diastolic function, you simply will not have these data.

What is the future of this development in echocardiography? Its evolution beyond a niche technique depends on the willingness of manufacturers and their investors to overcome the gulf between the revolution promised in the hyperbolic rhetoric of the business plan or advertisement and the reality of clinical cardiology. That reality is that the widespread dissemination of units may lag until more studies like those of Spencer et al. (1) and Goodkin et al. (2) are published and digested, until instruments are fully equipped and fully functional and until physicians themselves decide that it is desirable to disassemble current practice and endure the hassle of performing echocardiograms themselves. Alternatively, we may be on the threshold of presenting our sonographers with a revolutionary generation of cost-effective, efficient equipment with which to continue their major contributions to patient management.

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