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EDITORIAL

Future of Echocardiography in Australia

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The Echo of Greek mythology was a nymph who spoke excessively, and who was especially fond of having the last word. In punishment, Echo was forbidden to use her voice, except in response [1]. Among others, cardiologists have been trying to make the case for her ever since, but especially now, as Echo is about to undergo a significant transformation.

Although cardiac ultrasound started with the use of industrial equipment 65 years ago [2], innovations have continued into the current era. To a major degree, this has been driven by advances in computing, including improved processing power and memory, despite falling costs. The main advances in the last decade have been three dimensional (3D) imaging and myocardial deformation imaging. Three dimensional imaging has allowed not only rendered images that have facilitated the use of echocardiography to guide structural intervention, but also avoidance of geometric assumptions, which has enhanced measurement accuracy [3]. The ability to measure myocardial deformation has enhanced the quantification of chamber function, with particular benefits from heightened sensitivity to minor change, robust sequential follow-up and greater ability to detect early disease [4]. The processes of miniaturisation and automation have led to 3D transoesophageal echocardiography, as well as handheld ultrasound, which are taking the modality to a broad mix of clinicians, including general practitioners. On the other hand, there have also been disappointments—perhaps the greatest has been the lack of mainstream progress with contrast agents. Although these have reduced the susceptibility of image quality to poor ultrasound windows caused by obesity and lung disease, their use for assessment of myocardial perfusion and therapeutic applications such as sono-thrombolysis and drug delivery has been painfully slow. In the echo lab, obtaining the resources to insert an intravenous line and effectively deliver the contrast remains organisationally challenging, and a reimbursement incentive remains lacking in Australia.

Assessment of left ventricular (LV) function is the most frequent indication for echocardiography, and continues to increase as a result of the epidemics of heart failure, obesity and diabetes. Advances in echocardiography over the last decade adopted at expert centres have not been uniformly adopted in Australian practice, for the main indications—including heart failure (HF), pulmonary hypertension, aortic stenosis, mitral regurgitation and known or suspected coronary disease (Table 1).

Echocardiography is a useful and risk-free non-invasive test that has become widely used for the investigation of cardiac symptoms. The growth of Medicare item numbers for echocardiography has been about 8% per year, and even higher for stress echocardiography [11]. There is also a substantial geographical variation in utilisation in Australia, which is not explained by disease variation [12]. Repeat echocardiograms and routine screening tests are the least useful studies and are considered rarely appropriate. Based on the performance of diagnostic coronary angiograms in <5% of stress echo tests, we might expect that the majority are normal. Indeed, this is probably also true for standard echocardiograms. While a normal result is reassuring, it does not always represent high-value care. Efforts to define appropriate use have been applied in North America but have failed to attract much following elsewhere due to variation of interpreter scores of appropriateness, discordance between appropriateness scores and guidelines, and the lack of an evidence base [13]. We currently lack a strategy to control inappropriate use in Australia. There seems to be little appetite for relatively simple steps, such as specialist referral before repeated echocardiograms are performed.

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Table 1 Standard and novel approaches for the most common indications for echocardiography.

	Standard parameters	New approaches
Assessment of LV function	Ejection fraction (EF) — often visually assessed	3D assessment of ejection fraction (which has implications regarding HF therapy (EF 40%) and device implantation (EF 35%)) [5] Assessment of diastolic dysfunction (diastolic class, E/e' (a surrogate of LV filling pressure) and left atrial volume (the HbA1c of LV filling pressure)) [6] LV hypertrophy [7] LV strain – global longitudinal strain and contractile dispersion [4]
Pulmonary hypertension	Pulmonary artery systolic pressure obtained from the Doppler gradient of tricuspid regurgitation (TR) velocity	Estimated pulmonary vascular resistance, correcting TR velocity for stroke volume. Quantification of RV function – the main driver of outcome for pulmonary hypertension [8]
Aortic stenosis (AS)	Aortic gradient, valve area, dimensionless index	Integration of LV status in the recognition of low flow-low gradient AS [9] Recognition of pressure recovery in patients with small aortic roots or mechanical valves Calculation of flow rate in reduced stroke volume.
Mitral regurgitation (MR)	Jet size	Calculation of effective regurgitant orifice area [10]
Hypertrophic cardiomyopathy (HCM)	Presence and location of LV hypertrophy	Distinction of HCM from infiltrative heart disease
	Location and severity of outflow tract obstruction	Assessment of genotype positive patients
Chest pain	Assessment of wall motion abnormalities	

Abbreviations: LV, left ventricular; RV, right ventricular; AS, aortic stenosis; EF, ejection fraction; 3D, three dimensional; HF, heart failure; TR, tricuspid regurgitation.

Another echocardiographic topic lacking an Australian strategy is quality control. Although patient selection and the incorporation of echocardiographic data into decision-making are the sources of some heterogeneity, the major sources of variation are image acquisition and interpretation. While machines and sonographers are registered, the completeness of examination, experience and reliability of the interpreting physician are undefined [14].

The critics of echocardiography in Australia see a test that is sometimes performed poorly or performed too frequently, in inappropriate people, and producing low value data. These problems are likely to be solved by the forthcoming developments in the field. Hand-held ultrasound, which already provides excellent image quality, may satisfy the clinician's need for reassurance without the need for a complete study, thereby limiting the workload of rarely appropriate studies [15]. The next major steps are likely to be an increasing role for artificial intelligence, which will impact all stages of the diagnostic imaging chain. Electronic ordering will integrate with the rest of the electronic health record via a series of algorithms to control the use of repeat and other forms of inappropriate testing. Artificial intelligence has been used to optimise image alignment during training and in non-expert hands, and this may eventually be used in combination with robotic control of the probe—already shown to be feasible at remote sites—to provide a fully automated examination. Most measurements can already be automated. Image interpretation can be facilitated by re-ordering of the sequence of viewed images to facilitate diagnosis of known entities. More sophisticated comparison of echocardiograms with imaging libraries will permit automatic diagnosis. Finally, cluster analyses of automated measurements with clinical observations will lead to decision tools that will facilitate integration of echocardiographic data into clinical pathways.

Ultrasound is the least expensive and environmentally-friendly imaging modality, and the current quality variations in image acquisition and interpretation will be addressed by current and future developments. Echocardiography will have an ongoing role in Australian cardiology, but the work processes and economic model will be far removed from how they are now.

Conflict of Interests

None.

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