

## Editor's Page

# The Future of Echocardiography

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**E**chocardiography was born more than 50 years ago. It has become an integral part of modern cardiology, with a central role in the assessment of ventricular size and function, the diagnosis and evaluation of valvular disease, investigation of chest pain, possible cardiac emboli, and congenital heart disease.

Among the other imaging modalities, echocardiography has been characterised by its safety and versatility. Furthermore it is a non-invasive technique without radiation, illustrating a vast array of clinical applications. It is widely known that the field of cardiovascular ultrasound is very broad, ranging from clinical validation of new technology to studies requiring knowledge of physics, physiology, pharmacology, molecular and vascular biology, genetics, clinical trials and outcomes research. Therefore, echo is a central link between clinical cardiologists, interventionists, surgeons and basic science. Recently, many fields of research have been developed in this field. The main topics of modern echocardiography are the assessment of regional and global function, the assessment of regional perfusion, molecular imaging, hand-held ultrasound systems and finally therapeutic ultrasound.

The formation of echocardiographic images and associated measurements based on the analysis of speckle pattern data depend upon the processing and detailed characterisation of received backscattered ultrasonic signals from the myocardium.

There are several imaging modalities used in evaluating patients with coronary artery disease (CAD). For echocardiography to remain competitive for CAD assessment, it has to provide robust measurements of regional function and perfusion. Myocardial contrast echocardiography (MCE) has been validated in ani-

mal models, but its clinical application is not so wide as expected for several reasons. There is no ultrasound contrast agent that has been approved for clinical perfusion assessment by the US Food and Drug Administration. In addition, the most interesting reason is that MCE is difficult to perform and interpret. According to several clinical studies, MCE techniques have been applied in the assessment of patients with CAD, improving the diagnostic accuracy of echocardiography. Furthermore, the evaluation of perfusion with contrast echocardiography adds incremental value in predicting outcomes, even in patients presenting at the emergency department. Another area where MCE has a unique role is in studying microvascular disease and function, such as in arterial hypertension, hypertrophic cardiomyopathy, diabetes mellitus or syndrome X.

Three-dimensional echocardiography (3D) represents one of the major recent advances. The eventual goal of 3D imaging will be to provide a series of 3D data sets in minimal acquisition times or even remotely. At present, the image quality provided by 3D data sets is not equal to 2D imaging on the basis of either temporal or spatial resolution, resulting in the lower diagnostic value of the obtained data. It seems likely that technological advances will overcome these shortcomings, permitting acquisition of a 3D data set, which could be subsequently processed off-line to reproduce a series of 2D data sets independent of the expertise of the acquiring sonographer.

Hand-held ultrasound devices may be used in a wide variety of clinical settings as part of a focused examination. We believe that this technology can also be used as an extension of the physical examination. They may be used in the intensive care unit or emergency department, or they could potentially be used in less conventional conditions, such as in an ambu-

lance, or prior to transfer to a hospital, or in an area in which echocardiography equipment is unavailable.

Molecular imaging has been broadly applied to describe non-invasive imaging techniques that have been developed to assess processes such as protein expression, metabolic status, intracellular molecular trafficking, gene transcription and enzyme activity. The most common approach for molecular imaging involves the application of targeted contrast probes that are bioengineered to identify a specific molecular process. Molecular imaging with contrast-enhanced ultrasound relies on the selective targeting and retention of a contrast agent at sites of disease. Due to the confinement of ultrasound contrast agents to the intravascular compartment, contrast-enhanced ultrasound molecular imaging can only target micro-

bubbles to antigens that are expressed within the vascular compartment.

Whereas many imaging modalities can be used to define a phenotype and monitor the effects of therapy in cardiovascular diseases, ultrasound is unique in that it also offers a great deal as a treatment modality. Interesting is focusing on the most recent aspects of ultrasound as a therapeutic modality in cardiovascular medicine—sonothrombolysis, drug and gene delivery.

With advances in molecular biology and proteomics, in the future it may be vital to study not only phenotype but also physiology, something that is very much lacking in most basic science laboratories. We believe that the next years in echocardiography are likely to be characterised by tremendous progress.