and report changes that occur in their populations, especially in those countries where acute myocardial infarction and coronary mortality remain high, even increasing in some instances. The documentation of changes that have occurred in Finland and the development of programmes addressing the public health problem of heart disease provide a very useful model for other countries to follow. Understanding that model shows the importance of Preventive Cardiology and the need for research and further documentation of prevention programmes[6-7].

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A three-dimensional perspective

See page 1584 for the article to which this Editorial refers

Medical imaging has become a critically important part of the diagnosis of virtually all forms of cardiovascular disease. This occurred most strikingly with the advent of X-ray angiography and its successor, cineangiography. They provided images of the heart and great vessels for the first time, and they had a tremendous impact on our understanding of disease states. Through quantitative measurement of these images, we began to understand both the pathophysiology of cardiovascular diseases and the spatial anatomical disturbances that accompanied them. Biplane angiography was used to understand, and attempt to construct, the three-dimensional dynamic physiology of the beating heart as well as blood flow through vessels. While these achievements were exciting and informative, they were the result of very cumbersome and time-consuming processes of measurement, computation and display. Radionuclide angiographic techniques were inherently more three-dimensional than the projectional images of contrast cineangiography for measuring blood volume. Moreover, the computers used for processing the primary data in these studies facilitated the presentation of three-dimensional data for improved efficiency compared to the clinically prevalent single plane cineangiography. Images made from counts of radionuclide emissions registered by the 'camera' got away from the concern that a single projectional image obscured possible anatomical irregularity. But anatomical detail was lacking in the 'fuzzy' images of radionuclide angiography.

Echocardiography has thrived as an imaging method for cardiovascular disease because it provides detailed images of the soft tissues of the heart, among other reasons. It is a superbly accurate method for measuring distances within the body, but it provides a tomographic or a two-dimensional image as it is most used clinically. Echocardiography allows us to see detailed motion of the cardiac valves, the myocardium, and abnormalities within the heart such as thrombus or vegetations. Those most familiar with echocardiography have become adept at mental reconstruction of the various tomographic (two-dimensional) planes to assemble a three-dimensional understanding of the anatomy. As
with cineangiography, measurement of echocardiography images has been cumbersome and time consuming, since the signal to be measured may be difficult to distinguish from the ‘noise’ surrounding it[1,2].

An important question remains: Does formal three-dimensional reconstruction from imaging techniques make a difference clinically? There seem to be two primary reasons one would expect three-dimensional imaging to be important. The first is the expectation that improved accuracy of volume determination for any structure will accrue from three-dimensional reconstruction compared with extrapolation of two-dimensional data using some pre-selected geometric model. There are impressive data to verify the improved accuracy and reproducibility of such three-dimensional volumetric measurements[3-5]. Of course, if one is satisfied with a relative value, such as ejection fraction, then the relative change in volume one obtains from two-dimensional tomographic or projectional images may be adequate for clinical purposes. These points pertain only to those cases in which the volume under consideration has a relatively uniform, predictable, and understood geometry. If one is dealing with an aneurysmal ventricle or vessel, then the three-dimensional reconstruction obviously will be more accurate compared to the others.

This is the second reason for expecting three-dimensional reconstruction to be clinically important. That is, it may provide an improved understanding of rather unpredictable anatomical irregularities that do not fit our present mental image of the structure under study. This accounts for the increasing clinical use of MRI for imaging congenital heart disease.

In this issue, Kasprzak and colleagues present their data in 21 patients using transoesophageal echocardiography, and its relatively clear images, for three-dimensional reconstruction of the thoracic aorta[6]. This is primarily a study of feasibility, as it does not test the accuracy of the diagnosis or the improvement of three-dimensional images over the two-dimensional images in a formal way. The paper is useful because it reviews the various types of reconstruction that have been proposed and/or used. The authors state their computer generated two-dimensional views provide a reliable basis for measurement, but that has not been tested. They suggest serial quantitative evaluation of aneurysm size can be of prognostic importance, but they have not tested the ability of their method for serial quantitative evaluation. Nevertheless, the authors have given their experienced opinion on the relative value of various forms of computer generated display. They have pointed out some potential artifacts and limitations and they highlight that three-dimensional echocardiography is still an investigational method.

Echocardiography is a wonderful method for rapid, relatively inexpensive and accurate recognition of a vast array of cardiac pathologies. We use it with the understanding that it is an inherently ‘noisy’ imaging method. The images in the current article are at the state-of-the art for such reconstruction using these basic data. However, comparison of three-dimensional reconstruction of echocardiographic images with similar reconstructions from magnetic resonance imaging or spiral computerized tomographic angiography make me believe that three-dimensional methods for echocardiography are less advanced compared to these others. The reasons for that are complex, but these other methods will provide directions for further development of three-dimensional display methods that use echocardiography as their basic data set.

While there are now improved methods of automated or semi-automated edge detection in echocardiography to aid in data acquisition from two-dimensional images for use in three-dimensional reconstruction, the time required for this operation still deserves attention[7]. Computers are becoming faster and faster, but the iterative manipulation of those images by interpreters takes time. When one is in the emergency situation, and needing the diagnostic information to identify acute aortic dissection, the two-dimensional image will be the standard for a long while I would judge. For chronic aortic disease, magnetic resonance imaging and computerized tomographic angiography are extremely good. The challenge to those developing three-dimensional echocardiography will be to find those areas in which the echocardiographic technique is superior, either from a diagnostic or from a cost-benefit standpoint, compared to other methods. Presently, two-dimensional echocardiography will remain the most useful, general imaging method in cardiology while chronic aortic disease is addressed by other ‘radiological’ techniques.

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Is the implantable cardioverter-defibrillator cost-effective?

See page 1565 for the article to which this Editorial refers

The implantable cardioverter-defibrillator has gained acceptance and widespread use in the management of patients with life-threatening ventricular arrhythmias. However, although this device has been found to decrease the incidence of sudden death related to ventricular tachyarrhythmias, there is no direct evidence that it decreases total mortality. Furthermore, there are no available controlled studies demonstrating the benefit of the device over other forms of therapy for ventricular arrhythmias, i.e. antiarrhythmic agents, antiarrhythmic or and revascularization surgery (when appropriate) or radiofrequency ablation.

The price of the device, at a time when cost-containment is a real concern in most countries, makes evaluation of cost-effectiveness highly desirable. Most reports on the value of implantable cardioverter-defibrillator therapy have focused on providing data suggesting that the device is associated with prolonged survival. However, these data are not derived from controlled, randomized trials and should therefore be regarded with caution. Another approach is based on the assumption that an appropriate discharge in a patient with an implantable cardioverter-defibrillator would have resulted in sudden death, had the device not been implanted. Using such an approach, Fogoros et al.[1] found a 3 year survival of 67 ± 12% in patients with a left ventricular ejection fraction <0·30 and a projected survival of 6 ± 15%, whereas in patients with left ventricular ejection fraction ≥0·30, the figures were 96 ± 3% and 46 ± 8%, respectively. The limitations of this approach are obvious. Some episodes of ventricular arrhythmias may be self-terminating and supraventricular arrhythmias may trigger implantable cardioverter-defibrillators. The latter may be detected by the newer implantable cardioverter-defibrillators, which include a Holter function. Using such a function, Bocker et al.[2] assumed that tachycardia over 240 beats min⁻¹ may have been fatal and found no sudden death in their series with an 18-month follow-up.

There is no evidence to show that a reduction in sudden death is associated with a reduction in total mortality. The population treated with an implantable cardioverter-defibrillator may be at high risk of death from heart failure, ischaemic events and non-cardiac causes, making it difficult to show a benefit over the period of observation. This controversy was discussed by Sweeney and Ruskin in a recent editorial[3]. Another approach is to demonstrate that implantable cardioverter-defibrillators improve quality of life and are cost-effective. Using this approach Saksena et al.[4] evaluated the cost per life per year. The cost with recent strategies and improvements in technology was reduced from 19 800 US dollars to 8000 US dollars using new devices and the pectoral approach. This cost should be compared to the cost of alternative therapeutic strategies.

The interesting report of Valenti et al.[5] in this issue uses a novel approach. They compared cost related to hospitalization before implantable cardioverter-defibrillator implantation to the cost generated by hospitalizations after implantable cardioverter-defibrillator implantation. They found that the device reduces frequency and duration of hospital stays, resulting in a payback of the cost over a 9 month period. Although such an approach seems appealing, it raises a number of comments. In the