Leading Boston-based cardiologist Eugene Braunwald, MD, said in the early 1990s, “Diagnostic application of ultrasound to the heart can be regarded as one of the most important investigations in cardiology apart from the heart-lung machine.” During the past 5 decades, digital microprocessor technology and miniaturisation have greatly widened the diagnostic uses of echocardiography and have led to a variety of new ultrasound-based imaging techniques, such as 2-dimensional, 3-dimensional, Doppler, and so on.

One of these techniques, still of great clinical importance in diagnostic and interventional cardiology as well as in anaesthesiology, is transoesophageal echocardiography (TOE). The development of TOE opened a new, unrestricted imaging window to specific structures of the heart (Figure 1), and the thoracic aorta (Figure 2), because of the immediate proximity of cardiovascular structures to the oesophagus. The initial idea of using the oesophagus to overcome problems of transmitting ultrasound waves through the chest wall came in the late 1970s, when US cardiologist Lee Frazin, MD, assistant professor, Northwestern University School of Medicine, Chicago, Ill, used an M-Mode crystal, but this had to be swallowed and therefore, could not be controlled once it had entered the patient. Japanese researchers took this one a step further, and developed a method using a transducer passed down the oesophagus. The first successful commercial model was introduced in 1984 by the company Toshiba, which was the first to market the transesophageal probe.

Germany occupied the forefront of the development of transoesophageal echocardiography, although it took a long time for Dr Hanrath, professor emeritus of cardiology at the University of Aachen, Germany, to bring his prototype to reality. He speaks to Emma Wilkinson, BSc, MA, about his work.

Figure 1. TOE allows imaging of specific structures of the heart. A, Vegetation on a mitral valve bioprosthesis. B, Cross section of the aortic valve with abscess formation. C, Vegetations on aortic leaflets with severe regurgitation. D, Rupture of the anterior mitral leaflet with regurgitation.
step further by introducing the first mechanically rotating 2-dimensional scanning device, incorporated into an endoscope, in 1977. At this time, Dr Peter Hanrath began to carry out research into TOE, kick-starting a process that turned an idea from laboratory technology into a globally used diagnostic tool.

In 1968, Dr Hanrath had begun to work at University Hospital in Aachen, where he would become head of the Cardiology Department 30 years later. He had just completed his medical training at the Universities of Bonn and Cologne in Germany, and he had started to carry out research alongside his clinical work.

Swen Effert, MD, chief of the Department of Cardiology and one of the pioneers of echocardiography, inspired Dr Hanrath to further investigate the potential application of the technology. In 1979, after moving to Hamburg University Hospital, Germany, Dr Hanrath developed (with the help of the Olympus Corporation) a prototype endoscope that incorporated a single piezoelectrical crystal at the tip. He removed the optics that would run down the centre of the endoscope and replaced them with an electric cable, through which they could rotate the transducer and image different parts of the heart in 2 dimensions. With this prototype, he studied left ventricular performance at rest and during exercise. A team in the United States was using a similar prototype during surgical procedures.

But the most important step may have come next. “After the very first clinical applications of a phased-array 2-dimensional monoplane probe that provided only horizontal imaging, as well as a biplane probe that provided horizontal and longitudinal imaging, I was aware of the limitations of both techniques,” said Dr Hanrath. “So, I and my colleague, Jacques Souquet, PhD, came up with the idea of a rotatable, multiplanar, phased-array probe, allowing scanning of the heart in any plane.”

Although the idea came quite early on, further development of the technology proved to be a difficult process—not least because finding a company in Europe to manufacture the modified endoscope was almost impossible. Dr Hanrath says, “It turned out to be a major technical challenge for the engineers at that time, and it took more than 10 years from the idea until the time that such a probe came on the market in 1993. But it was the real breakthrough for the TOE technique, and I am especially proud of this contribution.”

Technical problems, however, did not present the only barrier to the development of the idea. “The scientific community was very sceptical and reserved when the first data were presented, because the character of conventional echocardiography as a primary noninvasive imaging technique was changed by TOE, and the image quality in the beginning was not of such a high quality as we were able to achieve later.”

TOE proved an important diagnostic tool for the detection of intracardiac emboli, endocarditis, prosthetic valve dysfunction, and acute and chronic diseases of the aorta. It also serves a vital function during specific, catheter-based therapeutic cardiac interventions, and for intraoperative monitoring of left ventricular function during major surgical operations. However, the technique has continued to evolve; by the late 1990s, TOE formed the basis for reconstructive 3-dimensional cardiac imaging. This concept of a stable central axis with a rotation of the image plane in small-degree increments remained the only acceptable solution for high-quality 3-dimensional reconstructive data for several years.

The advent of transthoracic matrix array transducer technology, which allowed external real-time 3-dimensional imaging, significantly reduced the use of reconstructive 3-dimensional imaging. Dr Hanrath says, “The latest technical development by the industry—and clearly a highlight in the continuous success story of TOE—is the implementation of a miniaturised matrix array transducer into the tip of an endoscope, allowing real-time 3-dimensional imaging of the beating heart.” Dr Hanrath is clearly impressed by how the technology continues to improve. “The advantage of real-time 3-dimensional imaging, including all Doppler modalities, is important for monitoring interventional procedures or for the examination of valvular or other complex congenital lesions,” he adds.

This also likely will become the method of choice in intraoperative mitral valve surgery. “When I started with TOE, I did not expect that this technique would be of such clinical importance as it is today,” he concludes.

Emma Wilkinson is a freelance medical writer.
Viewpoint: Heart Failure Treatment in Italy

Renata De Maria, MD, is a Member of the Association of Italian Hospital Cardiologists’ Working Group on Heart Failure

The biggest challenge in the treatment of heart failure in Italy is its rapidly ageing population, according to Dr Renata De Maria, research fellow, CNR Clinical Physiology Institute, Milan, Italy.

At 82 years, Italians already have one of the longest life expectancies in the world, and this is increasing. Not only is there the problem of attempting to prevent the development of heart failure, there is the issue of ensuring that patients receive equitable treatment regardless of their age.

Dr Renata De Maria, a research fellow at the CNR Clinical Physiology Institute, Milan, Italy, says that, whereas in general Italian doctors are quite knowledgeable about heart failure, they do not take it seriously enough in the elderly. “In general practice and internal medicine, heart failure is seen as a natural consequence of getting old, so sometimes it may not be taken seriously enough,” she says. “It is not seen as a separate disease in itself, a pathological entity, but rather as a side effect of ageing. This has got to change.”

It appears that the major reason why patients of different ages receive different levels of care is that they tend to present to different medical departments. Research by the Association of Italian Hospital Cardiologists’ Working Group on Heart Failure, of which Dr De Maria is a member, has shown that younger patients with fewer comorbid conditions are most likely to be admitted to cardiology departments and receive more appropriate assessment and treatment, whereas older patients tend to end up in internal medicine.

She says that 90% of heart failure patients admitted to a cardiology department received an echocardiogram during admission, compared with only around 50% in internal medicine (Figure 1). “It’s that old story of heart failure being seen as a side-effect of ageing, so we don’t need to go through it as deeply as we do in a younger patient. This of course is not true. But these older patients therefore get assessed less deeply, and sometimes they receive less effective medication.”

“Not surprisingly,” explains Dr De Maria, “knowledge and adherence to guidelines on care get looser the more you move down the pyramid of severity of patients. Everyone knows that there are guidelines, but what is basically lacking is a cooperation and understanding about what is the appropriate level of care.”

Even though care by a cardiologist might be the ideal for all heart failure patients, there are not enough cardiologists to go around, so patients have to be moved up through the different levels of the healthcare system until they get to the appropriate level for them. “To enable this to happen, there needs to be a network of physicians and nurses in which everyone knows what his or her role is in caring for the patient,” she says. “This requires cardiology to be connected to the community setting—including GPs and internists—so that everyone should feel confident that they are able to care for a heart failure patient at the level of their professional responsibility.”

Although age inequalities exist in investigation of heart failure and treatment of acute episodes of heart failure, Italy does marginally better on prescription of drugs, says Dr De Maria. “At the community level, >75% of heart failure patients in Italy admitted to a cardiology department receive an echocardiogram, compared with only 50% in those admitted to an internal medicine department.

Figure 1. X-ray showing left ventricular failure: 90% of heart failure patients in Italy admitted to a cardiology department receive an echocardiogram, compared with only 50% in those admitted to an internal medicine department.
patients are getting angiotensin-converting enzyme inhibitors or angiotensin blockers—that is a very good proportion,” Dr De Maria says. “But with β-blockers it is a different story because it is a more complicated type of medication to titrate and start, and in general practice and nonspecialist cardiology situations there is a misconception that it may harm patients.”

However, research has shown that it is possible to drive up prescription of β-blockers in the community setting for both general heart failure patients and for patients who are elderly or with severe disease. The BRING-UP (β-Blockers in Patients With Congestive Heart Failure: Guided Use in Clinical Practice) study23 showed that prescription of β-blockers to general heart failure patients could be increased from 27% to 50%, and to 57% in elderly patients and those with severe disease. These increases were achieved through practical clinical trials in the Association of Italian Hospital Cardiologists’ Working Group on Heart Failure network.

Dr De Maria says, “Even the country’s average 27% prescription rate is not so bad when compared with β-blocker use in the rest of the world, but obviously Italy could do much better. Not only would this have health benefits it would also decrease the cost of treating heart failure in Italy.” Currently, 77% of Italy’s healthcare expenditure on heart failure goes to the direct costs of hospital admissions, and this proportion is much higher than in other European countries. Less than 20% of the heart failure expenditure goes to drugs and only 3% to specialist assessment.

“One quarter of these admissions are repeat admissions, so there is a huge potential for savings in terms of better allocation of resources,” says Dr De Maria. “People get admitted, then go back home, where their general practitioner does not know exactly what to do, so they get admitted again. This is a problem for the patient’s quality of life as well as for health expenditures.”

Italy spends around €2 000 per capita on health. Around 2% of this health budget goes to the direct costs of heart failure—hospital admissions, drugs and specialist services. This percentage is greater than in other countries, which tend to spend 1.6% to 2% of their health budgets on heart failure.

Dr De Maria believes that there needs to be a change of emphasis away from intervention in acute episodes of heart failure to managing the chronic condition effectively and ultimately to preventing it. This has to be a priority for Italy, which like Sweden and Japan, has a population with one of the highest life expectancies. She says, “We have got to start working now on stage A from the American guidelines. With people who don’t have the disease at the moment, we must try to prevent it through effective control of conditions such as hypertension and diabetes, which are the most prevalent conditions leading to the development of left ventricular dysfunction.”

The key to achieving this is to change the perception at all levels that heart failure is related to a tired old heart. Dr De Maria explains, “We need to educate people better about the problem and how it can be prevented. People don’t know that they must reduce salt and not drink too much alcohol.” She adds, “As well as continuing their efforts to make sure that different tiers of the health service ensure that heart failure patients of all ages are appropriately assessed and managed, the cardiology networks also need to increase the awareness—from the community level upwards—of how it can be prevented.” Dr De Maria concludes, “We are working with general practitioners on this problem, because it is their problem actually and they must learn to do this well.”

Ingrid Torjesen is a freelance medical writer.

References

The opinions expressed in Circulation: European Perspectives in Cardiology are not necessarily those of the editors or of the American Heart Association.
In the past, few young cardiologists chose to specialise in myocardial and pericardial diseases, which are notoriously difficult to diagnose and treat. But this is changing, says Dr Andre Keren, who heads the European Society of Cardiology’s Working Group 21. “There really is an increased interest in this field now, and we have been getting more and more interest in the working group recently,” says Dr Keren. “Everyone realises that in the near future we will have the possibility of genetic testing, which is now available mostly for research purposes. We are in a transition period where new technologies will allow us, in perhaps 2 to 3 years, to use genome chips to check all new mutations in our patients in a very efficient way, both financially and in terms of time.”

Dr Keren, of the Hadassah–Hebrew University Hospital in Jerusalem, Israel, (Figure 1) has served as chair of the working group for 8 months and will step down in September 2008. Born and educated in Romania, Dr Keren earned his medical degree there in 1971. But he left Romania 2 years later to escape Nicolae Ceausescu’s oppressive Communist regime and settled in Israel where he did his specialist cardiology training. He has returned to Romania many times since then and is an honorary member of the Romanian Cardiac Society. “I do my best to provide professional help to Romania because I really feel I owe the Romanians, who are a wonderful people. Romania is where I had my best teachers,” he says. Dr Keren developed his interest in the cardiomyopathies in the United States; he served as a postdoctoral fellow at the Department of Medicine in Stanford University, Palo Alto, Calif, between 1982 and 1984, where he worked with Dr Richard Popp, MD, a former president of the American College of Cardiology, and Dr Margaret Billingham, MD, the heart-transplantation pioneer.

One of the most important projects that the working group has been collaborating on recently is a position statement on the classification of the cardiomyopathies, which was recently submitted for publication. The working group has taken a different approach from the one adopted by Barry Maron, MD, and his US colleagues, who published a contemporary classification scheme in Circulation last year. “The American classification takes into account the great advances made in the genetic evaluation and understanding of cardiomyopathies. It’s a very, very genetically oriented approach, which is difficult at this point to translate into clinical practice,” says Dr Keren. “Our approach is different because even though huge advances have been made in the genetic understanding of the disease process over the last 15 years, genetic testing is very expensive, slow, and not widely available,” he says.

“We are not ready to call hypertrophic cardiomyopathy ‘sarcomeric protein-associated disease’,“ says Dr Keren. “This might be correct scientifically in most but not all cases, but it is not very applicable yet in clinical practice. This is why we opted for a classification that still preserves the phenotypic–morphologic division of the patients the way we see them in clinical practice,” he explains. “Perhaps the American classification is more advanced, but we decided to preserve the phenotypic classification while incorporating recent advances, particularly in the field of genetics.”

William McKenna, MD, FRCP, FESC, professor of cardiac medicine at St George’s Hospital Medical School, London, United Kingdom, one of the leading pioneers in the...
cardiomyopathies, cites Dr Keren, saying, “A good family history is the poor man’s genetics, which is available to every caring physician. We believe our classification proposal provides a practical framework that encourages practicing physicians to look beyond basic diagnostic categories, look for the familial nature of the disease, and apply available tools—including genetics, if available—to reach specific aetiologies of heart-muscle diseases.”

Like other European Society of Cardiology working groups, Dr Keren’s group has a nucleus of 9 members, in addition to a chair and vice chair, who contributed heavily to the European consensus document on the classification of the cardiomyopathies. “I believe that the Americans were more effective than us,” jokes Dr Keren. “We probably started thinking about the need for a new or updated classification at around the same time. While their classification, which is a very important piece of work, is already published, ours has just been submitted, as we exchanged hundreds of mailings and met repeatedly at every single conference—every single word was debated until we reached agreement.”

The working group also has been developing a registry of European patients with inherited cardiomyopathies. Dr Keren points to a real need for such a registry, because most inherited cardiomyopathies, with the exception of hypertrophic cardiomyopathy (Figure 2), occur very rarely. “We need to cooperate so that we have enough cases to understand the disease processes properly,” he says. “Epidemiologically, if we know the extent of the disease, we can better manage our resources. So, this database and registry issue is very hot, and we are at last reaching the point where we are actually going to implement it.”

Dr Keren says that the working group has repeatedly applied for European Framework Programme grants to fund a registry project, but without success to date. “We always were short by 1 or 2 points. When you compete with more general programmes on heart failure, you are at some sort of disadvantage,” he explains. The working group plans to apply again this year with a proposal for an integrated approach toward inherited heart-muscle diseases and diagnosis.

The European Union has issued a call for proposals for projects that address congenital pathologies affecting the heart, so Dr Keren feels hopeful that this time they will succeed. “There is an extraordinary need for cooperation, much more so than for common diseases like hypertension or ischaemic heart disease that have fantastic cooperative studies supported by both pharmaceutical companies and by scientific societies,” he says. “Even rare diseases should have their say.”

James Butcher is a freelance medical journalist

Reference

Forthcoming Working Group 21 Conferences
1. Fourth European Conference on Myocardial and Pericardial Disease and Women in Heart Disease, Marburg, Germany, October 11–14, 2007
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