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CARDIOLOGY 2018

NEWS AND TECHNOLOGY UPDATES FOR CARDIAC CARE

MUNICH • GERMANY 25 AUG – 29 AUG 2018

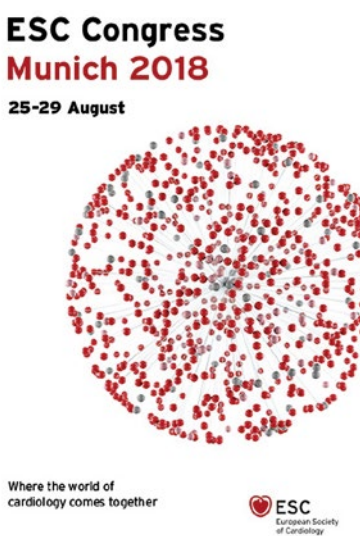
At the heart of research

Scanning impacts on cardiology

When delegates from around 150 countries converge on Munich for ESC Congress 2018 they will no doubt reflect on what they themselves eat. Yes, nutrition is up for debate, questioning, for example, whether weight loss therapies can also prevent heart attacks and strokes. Results from the CAMELLIA-TIMI 61 trial of 12,000 overweight individuals with established cardiovascular disease or diabetes could tell us 'whether becoming slimmer with weight loss therapies also makes you healthier,' explained Professor Stephan Achenbach, Chairperson of the ESC Congress Program Committee and ESC President Elect. That trial is being presented at the congress.

Results with big impact

Additionally, the huge PURE study, which examined what constitutes a healthy diet in over 200,000 people from more than 50 countries, will be aired. 'The results will give us new insights on the relationship between the types of food we eat – for example fruit, vegetables, nuts, dairy products and meat – and health and disease,' Achenbach explained. The Chair also expressed excitement about other trials to be presented, with results 'set to have a big impact, either because they affect large population groups or involve innovative treatments.'



For example, two aspiring trials to examine for preventing first heart attacks and strokes prevention will be presented – the ARRIVE trial involved more than 12,000 individuals at moderate risk and the ASCEND trial involved over 15,000 diabetics. 'We had assumed that taking aspirin can only be good for you, and what's the harm?' said Achenbach. 'But then we discovered that, while aspirin can protect against heart attacks and stroke, it causes bleeding. So it's not at all clear who will actually benefit from taking aspirin to prevent a first heart attack or stroke. These two trials will shed light on this issue, impacting many millions of people worldwide.'

2018 European Society of Cardiology (ESC) and European Society of Hypertension guidelines on hypertension are another important talking point. 'The American guidelines (released in 2017) were very strict and lowered the definition of high blood pressure. It will be exciting to see what the Europeans say about what blood pressure qualifies as "high" and how strictly it should be treated,' Achenbach surmised.

The MARINER trial will reveal whether potentially fatal blood clots can be prevented in acutely ill patients by continuing to administer oral anticoagulation therapy after they return home. 'Treating patients after discharge is a completely new concept and could affect the millions of people hospitalised every year with heart attack, pneumonia, or broken bones,' Achenbach prophesied.

Oral anticoagulation is also a focus of the COMMANDER HF trial, which will reveal whether these drugs improve survival and reduce heart attack and stroke in heart failure (HF) patients who do not have atrial fibrillation. Achenbach: 'This is a massively large patient group that so far not been considered for oral anticoagulation unless they have atrial fibrillation and the trial could change our approach to their management.'

Prof. Jeroen J. Bax, FESC President 2016-2018 of European Society of Cardiology

Trials and more

Achenbach also highlighted the MITRA.fr study, which indicates whether treating the mitral valve with a device inserted via a catheter is advantageous in HF patients.

An entire late breaking science session is devoted to transcatheter aortic valve implantation (TAVI) and is aligned to the congress spotlight, Valvular Heart Disease. This includes the LRT Clinical Trial and GARY registry in low-risk patients, the TAVI-PM study on the durability of TAVI, and the five-year follow-up from the FRANCE-2 Registry, which will report on clinical outcomes and valve durability in high-risk patients.

Major drug trials include ATTR-ACT, which assessed the efficacy and safety of tafamidis in transthyretin amyloid cardiomyopathy, a condition that currently has few treatment options. The High-STEACS trial of more than 47,000 patients will reveal whether using high-sensitivity troponin to confirm the diagnosis in those with suspected heart attack leads to more or less deaths and repeat heart attacks after one year.

'I'm excited by how diverse cardiology is and feel it is my responsibility to represent and balance the needs of the cardiologists, healthcare providers and researchers in every country that belongs to the ESC and also across the entire spectrum of cardiovascular disease,' Achenbach pointed out.

This ethos includes spreading news of scientific findings from ESC journals and registries, guidelines, congresses, and other educational activities.

In our special Cardiology section you will also learn from medical science experts how far machines and scanning skills are shaking the very roots of your discipline.

Enjoy the stimulation of new concepts and technological developments. Enjoy EH along with ESC 2018. Welcome!

Prof. Stephan Achenbach, FESC Chairperson 2016-2018 of ESC Congress Programme Committee

Study examines genes and lifestyle links to dilated cardiomyopathy

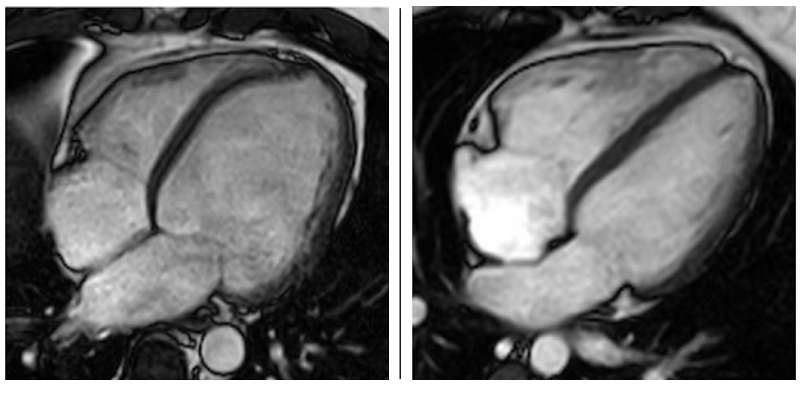
Titin: the commonest genetic cause of DCM

Report: Mark Nicholls

A major study has been launched to investigate the interaction between genes and lifestyle factors and dilated cardiomyopathy (DCM). Led by Professor Stuart Cook, at the National Heart and Lung Institute, this, the largest ever DCM study, will investigate why people develop DCM, with a focus on who is most at risk of sudden death or heart failure (HF).

Six hospital trusts across England – including the Royal Brompton and Harefield NHS Trusts and Imperial College London – will recruit patients for the study.

DCM thins cardiac muscle, making it less able to pump blood around the body. About one in 250 (260,000) people in the UK are affected, with around one in 100 (650,000) believed to be at risk of developing the condition due to a common mutation in the titin protein.



Due to thinned cardiac muscle, a heart affected by dilated cardiomyopathy (left) can pump less blood around the body than a normal heart (right)

This mutation predisposes the heart to developing DCM when it is placed under stress such as during pregnancy, some cancer treatments and possibly alcohol abuse.

Study to improve diagnostics and therapy

DCM is a complex condition and can be caused by a variety of genetic and environmental factors but cardiologists also recognise it is poorly understood, with most causes unknown.

A leading course of heart transplantation, and after coronary heart disease, DCM is the leading cause of heart failure. The condition has poor outcomes with research suggesting that 15% of patients do not survive beyond five years after diagnosis, and up to half of deaths occur within the first two years of diagnosis.

In the new multi-centre study of more than 2,000 patients researchers will use advanced DNA sequencing, biological markers in the blood and cardiac imaging approaches to assess interactions between genes as they seek to discover new genetic mutations underlying DCM, as well as to assess potential environmental interactions.

Ultimately the study aims to find better ways to diagnose, treat and prevent deaths from DCM.

Stuart Cook is Professor of Clinical & Molecular Cardiology at Imperial College London in the UK and head of the Cardiovascular Genetics and Genomics group within Genetics & Imaging at the National Heart and Lung Institute (NHLI). He also directs the genetics and genomics group that plays an integral research role within the Royal Brompton Hospital cardiovascular biomedical research unit. An expert in cardiovascular MRI, with special interest in genetics in cardiac muscle disease, his research focuses on the genetics of cardiovascular disease, particularly inherited cardiac conditions that cause electrical abnormalities of the heart and heart failure.

Professor Cook, who is also Professor of Clinical and Molecular Cardiology at Imperial College

Continued on page 3

Refined guidance with no need for anaesthetic

Intracardiac echocardiography

Intracardiac echocardiography (ICE) is an increasingly important guiding tool for structural heart disease interventions – without general anaesthesia. José Ribeiro, who works in the thorax and circulation unit at Gaia Hospital Centre, Portugal, who has worked with this technology for the past two years, explained its benefits and limitations in an exclusive interview with *Daniela Zimmermann* of *European Hospital*.

Discussing developments in Intracardiac echocardiography (ICE), José Ribeiro, cardiologist at the thorax and circulation unit in Gaia Hospital Centre, Portugal, explained that recently the need for a different ultrasound tool to guide patient treatment beyond transoesophageal echocardiography (TEE) became clear. 'Consequently,' he added, 'a significant number of interventional cardiologists have started to use ICE.

'We still have limitations with ICE for structural heart disease, because we don't see all the structure in the same plan and need to navigate with a catheter inside the heart. That's why it's so important for 3-D imaging to guide procedures.

'We don't need too much imaging to guide the intervention for structural heart disease. But we need to have a good pre-procedure evaluation and to plan the procedure, and after that we only need specific steps to ensure procedure quality and check the results. If we can get the cardiac structures on 3-D, we have a significant advantage for guidance.

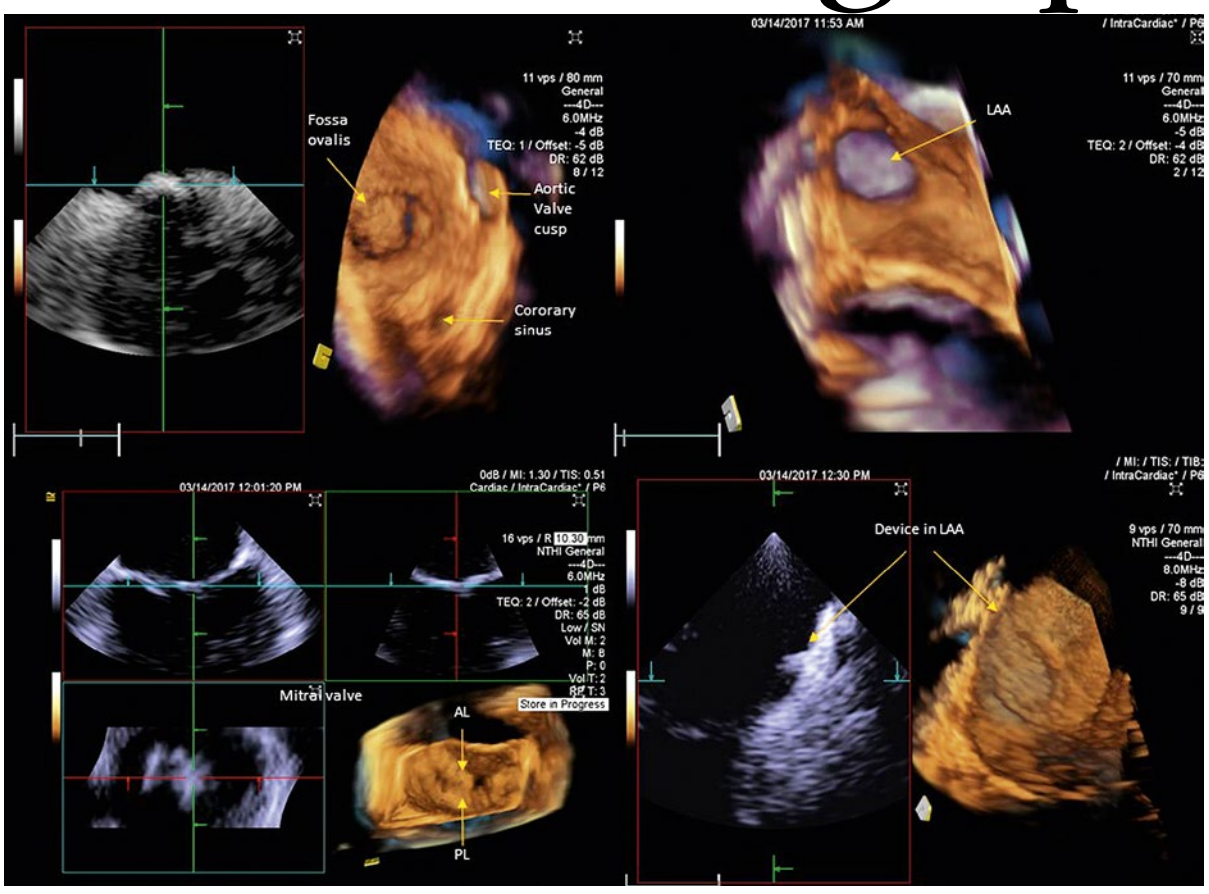
'We initially had a narrow angle catheter, which only enabled us to view small volumes of the heart. This is not enough to image entire structures, for instance a valve, left appendage or oval fossa. So we developed a new device with a wide opening angle; it's a 12.5-Fr catheter and this enables us to view significant volumes of the cardiac tissue, including the whole mitral valve. This development appears to be a great advantage for guidance.'

DZ: When using ICE, is the image in front of you and can you see the relation between the structures?

'Yes. When we have a volume, we can look inside and decompound it in a different 2-D plan to navigate more easily, which enables us to be more confident when doing the procedure.

'With a 3-D wide angle ICE catheter, we have the same benefits as with 2-D ICE, meaning we don't need an anaesthetist, the interventional cardiologist can do the intervention him- or herself, by putting the catheter in the right place to see the heart.

'But we can also obtain a significantly higher amount of information and anatomy, so that the interven-



Images of intracardiac echocardiography obtained with Acunav V wide angle catheter (Siemens Healthineers); on 3D images we can see entire cardiac structures: on top right the fossa ovalis, on top left the left atrial appendage opening (LAA), on bottom right the mitral valve with anterior (AL) and posterior (PL) leaflets and on bottom left the device occluding LAA.

More people need nuclear cardiology training

Ischaemia: Advances in nuclea

Experts outlined approaches to ischaemia imaging during the recent British Cardiovascular Society conference. In a 'Detection of ischaemia by cardiac imaging in 2018' session, comparisons were made between solid state SPECT cameras, whether spatial resolution or visual assessment was of the greater importance, if CT-FFR offered advantages over CT perfusion, and the challenges in defining a gold standard of imaging ischaemia

Discussing 'Advances in nuclear ischaemic testing, from SPECT to PET and beyond', Dr Kshama Wechalekar, who heads Nuclear medicine and PET at the Royal Brompton Hospital in London, and is President of the British Nuclear Cardiology Society (BNCS), told delegates that advances in nuclear imaging with solid state technology offered improved ability to detect ischaemia. 'There is improved spatial resolution from multiple solid state CZT (Cadmium Zinc Telluride) detectors and therefore sensitivity is very high,' she explained. 'You can reduce the acquisition time at least by half with excellent quality and the equipment has a small footprint. The advantages of solid state detector cameras is that you can reduce the radiation dose by one third, have high sensitivity and resolution, an open design suitable for claustrophobic patients, and good image quality even in obese patients.'

President of British Nuclear Cardiology Society **Dr Kshama Wechalekar** leads nuclear medicine and PET at the Royal Brompton Hospital in London, where she specialises in heart/lung nuclear imaging. Her main interests lie in using hybrid-imaging techniques, such as SPECT-CT and PET-CT, to improve understanding of pathophysiological processes affecting the heart and lungs. She has special interest in cardiac sarcoidosis and other inflammatory conditions of the heart.

SPECT, PET and CMR

Recent studies have shown ability to do dynamic imaging offering potential in quantitative myocardial perfusion with SPECT, Wechalekar pointed out, adding that SPECT is less expensive than current PET and MRI.

'The future of SPECT Nuclear cardiac imaging,' she concluded, 'is in solid-state technology. Dynamic imaging, although technically challenging, can add value to MPI in the detection of ischaemia. Whilst PET is the most accurate imaging technique for ischaemia assessment and prognosis, it remains expensive and less accessible.' She also felt that the new tracer, Flurpiridaz, with results of phase III trials in the UK pending, might change the future of PET MPI.

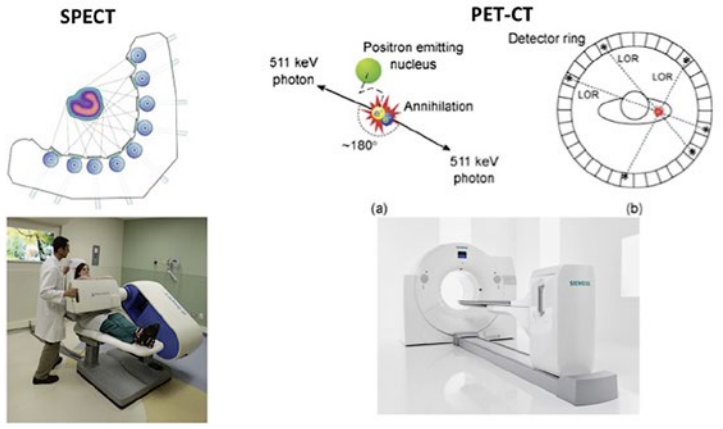
One area of concern was how to persuade more people to train in nuclear cardiology with falling numbers in the field. 'The BNCS Council is working hard to improve curriculum, organise level 1 and 2 training courses, and to identify centres that can offer nuclear cardiology training across the country that is easily accessible for trainees,' she said.

Dr Chiara Bucciarelli-Ducci is Consultant Senior Lecturer in Cardiology/non Invasive Imaging at the Bristol Heart Institute, University of Bristol, and co-Director of the Clinical Research and Imaging Centre (CRIC Bristol). She is currently one of the vice-presidents and chair of cardiac MRI of the European Association of Cardiovascular Imaging (EACVI).

Dr Chiara Bucciarelli-Ducci, Consultant Senior Lecturer in Cardiology/non Invasive Imaging Bristol Heart Institute, University of Bristol, explored the issue of quantitative versus visual assessment in CMR stress perfusion. She explained that stress CMR has been included in the ESC guidelines since 2014 (ESC revascularisation guidelines) based on evidence using visual assessment of ischaemia, rather than quantitative.

Bucciarelli-Ducci discussed pros and cons of both visual and quantitative assessment, limitations and opportunities to increase spatial resolution, and very recent studies showing that there is no difference in diagnostic accuracy visual vs. quantitative. Quantitative perfusion is promising, but the acquisitions and analysis need simplification to meet the need of a busy clinical service.

'CMR perfusion (visual) is a good clinical tool already,' she concluded, 'but can get better while quantitative CMR perfusion is evolving into faster and robust tools. While several methods are available, more in-vivo and clinical validation is needed with a number of studies in the pipeline.'



Single photon vs. Positron ET

Dr Marc Dweck is Senior Lecturer and Consultant Cardiologist at the University of Edinburgh and the Edinburgh Heart Centre. A British Heart Foundation Intermediate Clinical Research Fellow, he is a keen advocate of multi-modality cardiovascular imaging and is trained in echocardigraphy, carotid ultrasound, computed tomography (CT), cardiovascular magnetic resonance (CMR), PET/CT and PET/MR imaging.

Function addition can improve specificity

Dr Marc Dweck, BHF Reader in Cardiology and Consultant Cardiologist at the University of Edinburgh and the Edinburgh Heart Centre, posed the question 'CT-FFR/CT perfusion - neither or both?'

'CT Perfusion,' he acknowledged, 'is interesting, but I'm not sure how we are going to use it in clinical practice. With CT-FFR you get beautiful pictures, where you can look down the coronary arteries and see areas that are not getting enough blood. The advantage of this technique is that you can use it on a post-hoc basis, on scans where you are not sure if a lesion is obstructive or not, without any extra radiation or medication for the patient. This may be useful in lowering the rates of patients being sent

(ICE) has benefits

tional cardiologist can do the whole procedure without having to navigate with the image catheter. We can put the catheter in the right place, and then we don't need to move it to see what we need to see.'

What are the benefits of not having to move the catheter?

'Moving the catheter to view the cardiac structures means more work, more time, more risk and more radiation.

'In the interventional lab, we always use angiography and ultrasound. Angiography, i.e. radiation imaging, helps us to carry out the procedure and navigate to place the ICE catheter inside the heart. If we don't need to move the catheter because we can see everything at once, we of course also need less radiation.

'If we have a technology that gives us everything with the catheter in the same place, it's much better.'

Many specialists are needed in such an intervention. One day, could just one person do this?

'That's the big point. But we need to train interventional cardiologists, to change their mind-set. They typically use angiography and ignore ultrasound.

'However, this is changing now. Everything is changing in the interventional lab. We are using TEE in a significant number of procedures; but with TEE we also need specialists. With ICE, we can do everything while the patient is awake, without discomfort and anaesthesia, and with fewer people inside the room and less radiation.

'In the lab, for ICE guidance we use the echocardiography machine to direct the image and ICE catheter manipulation beyond the angio room equipment. In future, we could have all the controls on the table – connecting angio and ultrasound controls. Also, we need to improve the imaging display software, with specific play sets for detailed procedures, to give the right plans for each interventional procedure.

'Right now, in our hospital, we simultaneously use display ultrasound imaging and angio imaging on the same screen. We can switch to all the positions we need, but we need lots of training to be able to see it.

The learning curve for interventional cardiologists is long. Some interventional cardiologists already have experience with 2-D imaging, and they have a significant advantage to give the final step to use 3-D imaging in ultrasound. The learning curve is more important when you are using angio only.'

For which cases do you use TEE and ICE?

'In our lab we check all patients in the echo lab in a selection process and, when we are very confident about the pathology or anatomy, we use the ultrasound image (TEE or ICE) for guidance and to improve confidence during the procedure.

In simple cases, such as ASD or PFO closure, we use ICE. As mentioned earlier, ICE gives us many advantages - no anaesthesia needed, more comfort, etc. For more complex cases we must decide how much imaging we need.

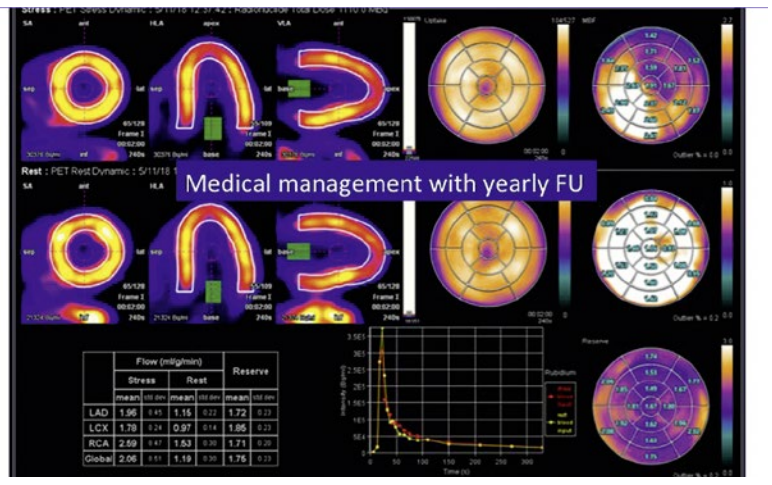
'We also use ICE in normal mitral valve repair and left a; we have initial experience with this wide angle 3-D ICE catheter that crosses the inter-atrial septum to scan left side structures, for instance.

'So far, our experience with ICE is limited. But even with more experience, in complex cases we tend to prefer the technique or imaging tool with which we have more experience. So TEE may still be preferred in such scenarios. The main limitation of ICE is lack of experience with the technology. In addition, if the case is too complex, we may need to cross with the catheter to the left side, so we need to move the catheter to be sure.'

'ICE could be useful in some patients who cannot be imaged with TEE. Both methods are alternative. ICE is a step forward, especially with this new dimension – 3-D ICE. But,' he concluded, 'in the future we need to check what's the best option for each patient.'

José Manuel Coelho Ribeiro MD directs the Thorax and Circulation Unit at Vila Nova de Gaia Hospital Centre in Portugal. Having graduated from Oporto medical school in 1992 he became a cardiology specialist in 1996, which was followed by an echocardiography fellowship at Onze-Lieve-Vrouwziekenhuis in Aalst, Belgium. He also became a member of the Portuguese Cardiology College. Since 2001, he has led the echo lab (with 9,600 studies in 2017) and, from 2006, has been cardiology consultant in the Espinho Hospital Centre at Vila Nova de Gaia, where he has implemented new techniques, including transoesophageal echocardiography, as well as coordinated several telemedicine projects.

r imaging



Quantitative myocardial perfusion reserve with Rb-82 PET

Professor Darrel Francis is Professor of Cardiology, Imperial College London. His work in ischaemia has included the ORBITA trial of revascularisation and the BRAVO trial of automated haemodynamic optimisation of cardiac resynchronisation therapy pacemakers.

to the cath lab following CT.' Patients most likely to use CT-FFR, he added, are those with borderline lesions, though he stressed the key lies in a patient's history and only using CT-FFR in patients with recalcitrant angina symptoms.

CT is a powerful imaging technique that informs about coronary artery anatomy (plaque burden, stenosis severity, plaque characteristics), he concluded, but emphasised that the addition of functional technique to the scan protocol can improve its specificity to identify obstructive stenosis, providing a comprehensive assessment of anatomy and function.

With CT perfusion, radiation dose is increased, while CT-FFR has increased cost, though CT-FFR potentially fitted in better with patient workflows.

Professor Darrel Francis discussed the problems of computed tomography in the presentation 'Ischaemia detection - are all our ideas completely wrong?' He pointed out that all previous speakers had described sensitivities and specificities, concepts that are meaningful only if ischaemia is dichotomous (present versus absent). His audience poll revealed cardiologists unanimously considered ischaemia to be a continuous gradation rather than dichotomous. mn

At the heart of research

Continued from page 1

London, said: 'For about 1 in 4 patients with DCM we can find a genetic cause.

But that leaves us with hundreds of thousands of people with DCM that we cannot explain, which hinders our ability to diagnose and treat the patients or help their families. 'There are currently no targeted treatments that are specific for DCM but, as we get a better understanding of the genes which cause the condition, we can hope to develop new treatments which target these genes and pathways.' Professor Sir Nilesh Samani, Medical Director of the British Heart Foundation, which has delivered £2m funding for the study, said: 'In many cases, we can track the inheritance pattern and test family members of people with inherited heart conditions. But unfortunately, genetic testing is often not helpful for people with DCM, as we only know about a small number of genes which cause the condition.' In 2011, Professor Cook and his team established the genetics and genomics group at NHLI and have developed and applied unbiased, integrated systems genetics and genomics approaches combined with high-resolution cardiovascular phenotyping to identify new genes and mechanisms for cardiac hypertrophy and dysfunction.

The team has used genome-wide association in humans to identify new loci and genes for DCM and has already identified titin as the commonest genetic cause of DCM.

Coronary angiography will lose diagnostic value

The changing face of imaging in cardiology

While the question is still debated as to whether MRI is the better CT, along comes a potential game changer – a new data based 3-D reconstruction method of heart anatomy and function that aims to replace diagnostic coronary angiography. In the near future not only adult patients with coronary heart disease could benefit from this new technique but also children with complex congenital heart defects. Meanwhile imaging is conquering the cardiac operating room (OR).

The physician, using smart glasses, in the virtual space has just removed the aorta at its root from the heart to examine it separately. Observers can follow on conventional screens. Courtesy: S. Engelhardt

Report: Emilie Hofstetter

Long before coronary heart disease (CHD) manifests its presence on an ECG, CT and MRI can detect it due to low perfusion caused by a stenosis of the coronary vessels. Dr Bettina Baessler, radiologist and researcher at the University Hospital Cologne, Germany, looks into multiparametric imaging strategies. She considers both techniques complement one another although MRI definitely produces images that are 'more beautiful, almost works of art'.

Professor Ulf Teichgräber, Head of Radiology at University Hospital Jena, Germany, agrees and thus predicts the demise of cardiac angiography. His opinion is corroborated by the recently completed SYNTAX III study, whose results will be presented at the Transcatheter Cardiovascular Therapeutics Symposium 2018 in San Diego in September. A team comprised of a radiologist, cardiologist and surgeon (Heart Team A) evaluated the angiogram of a patient, calculated the SYNTAX II score and decided on the type of therapy, either invasive or non-invasive.

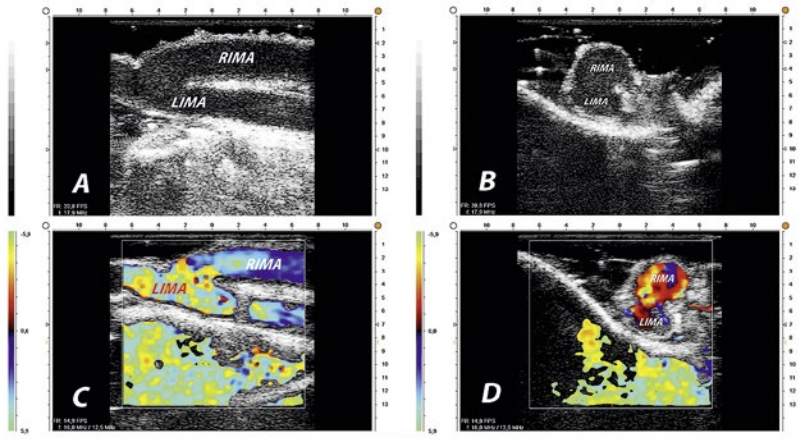
The team members then saw the multislice CT (MSCT) scan with 3-D reconstructed coronary vessels and the relevant fractional flow reserve (FFRCT) and could either confirm or revise their decision. A second team (Heart Team B) of those professionals received CT and FFRCT of the same patient first. The team members calculated the Syntax III score, decided on the type of therapy and then saw the angiogram in order to either confirm or revise their decision. 'The Syntax score was designed to inform the decision "invasive or non-invasive", based exclusively on anatomical features,' Teichgräber explained. 'Syntax II took comorbidities into account and now Syntax III includes a functional component – FFRCT. Thus coronary angiography will lose importance in diagnostics and therapy planning.'

Non-invasive first

To date, only the California-based HeartFlow Inc. can calculate FFRCT. Based on data obtained in a conventional CT, the company's software, using flow mechanics, can reconstruct heart, aorta and coronary vessels in terms of geometrics as well as pathophysiology and function in 3-D. Moreover it visualises the flow and can thus show whether a haemodynamically relevant blockage is present, i.e. whether the patient needs a stent or a bypass.

In 2015, Professor Pamela S Douglas, cardiologist and Head of Multimodal Imaging at the Duke Clinical Research Institute in Durham, North Carolina, USA, showed the potential benefit of this method using 584 patient cases from 11 hospitals. Ten patients with suspected CHD underwent diagnostic cardiac catheterisation, but the suspicion was confirmed only in three patients – seven underwent unnecessary catheterization. Six out of ten patients with suspected CHD, whose FFRCT was determined first, did not need angiography. In three out of the four patients who did receive angio, the suspicion was confirmed – i.e. only one patient underwent an unnecessary angiography. 'This feasible and safe method shows a significantly lower rate of unnecessary invasive angiographies,' Douglas confirmed. Investors seem to buy in: HeartFlow, which today is already cooperating with the Big Three – GE, Siemens, Philips – recently raised USD 240 million to further develop the technology, launch new studies and drive commercialisation of its product.

To establish 3-D imaging in congenital heart disease treatment, paediatric cardiologists Animesh Tandoon and Tarique Hussein founded VARYFII Imaging, LLC, in Dallas, USA. They construct complex anatomical models of the individual patient's pathologies using MRI or CT data. Cardiologists as well as surgeons can enter the virtual and augmented realities of the anatomical models with the help of data headsets to lift certain structures, analyse and reposition them and thus devise the best strategy to correct the heart defect prior to surgical intervention.



Y-conduit of right and left internal thoracic artery in epicardial ultrasound. A: 2-D Long axis view, B: 2-D short axis view, C: Colour Flow Mapping long axis, D: Colour flow short axis. Courtesy: Di Giammarco

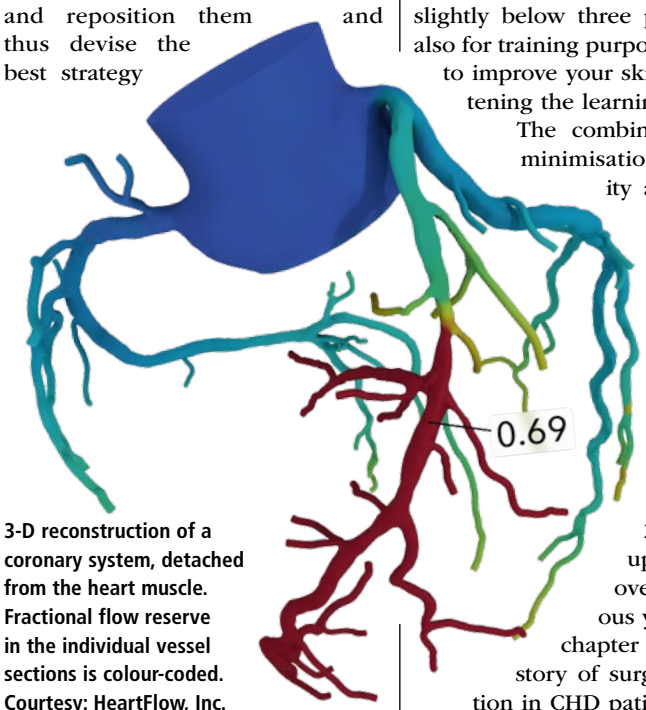
'Our heart beats in 3-D, so why not examine it in 3-D?' asks Dr Sandy Engelhardt, researcher at the Computer-Assisted Surgery Group at the Department of Simulation and Graphics in Otto von Guericke University, Germany. In addition to treatment planning and education she envisages a further application of this new technology: informing the parents of the young patients.

The flow must continue

Imaging has arrived in cardiac surgery – during the intervention itself and combined with flow measurements. Professor Gabriele Di Giammarco, cardiac surgeon at Gabriele D'Annunzio University Hospital in Chieti, Italy, considers the combination of high-frequency epicardial ultrasound (ECUS) and transit time flow measurement (TTFM) in a single device 'decision making' and explains: 'Hard calcifications in the aorta, I can feel. I do not feel the dangerous soft plaques. With MiraQ, I see them in intraoperative ultrasound, can adapt my strategy and perform surgery in no-touch technique and off-pump.'

Dr Daniel Wendt, Managing Senior Physician at the Cardiac Surgery Department of University Hospital Essen, Germany, uses intraoperative flow measurement of newly created bypasses not only for quality assurance purposes – he records a follow-up intervention rate of slightly below three percent – but also for training purposes: 'It's a tool to improve your skills, helps flattening the learning curve.'

The combination of risk minimisation and quality assurance has proved successful. In 2017, the Oslo-based manufacturer Medistim sold products and procedures worth NOK 229.8 million, up 14.6 percent over the previous year – another chapter in the success story of surgical intervention in CHD patients.



3-D reconstruction of a coronary system, detached from the heart muscle. Fractional flow reserve in the individual vessel sections is colour-coded. Courtesy: HeartFlow, Inc.

The future POCT heart attack test

On the way: mobile cMyC analysis

Experts report that a new blood test to diagnose heart attacks could be carried out on a hand-held device in the not-too-distant future.

Report: Mark Nicholls

The test, devised by a team at Kings College London, uses similar technology to the troponin test, but instead analyses cardiac myosin-binding protein C (cMyC).

In research presented at the British Cardiovascular Society conference in Manchester, UK, this June, Dr Tom Kaier, BHF Research Fellow, explained that levels of cMyC in the blood increase more rapidly after a heart attack and to a higher extent than troponin. With this offering the opportunity to rule out a heart attack in a higher proportion of patients instantly, the research team believes it has a role in providing a swift diagnosis in Accident & Emergency (A&E) departments.

Scientists are optimistic that this relatively straightforward test could be used as a hand-held point of care test (POCT), and avoid samples being sent to the laboratory.

cMyC outperformed troponin

Kaier, who was among the lead researchers, emphasised the importance for doctors and patients to know, as early as possible, who has had a heart attack and who has not.

'Now that we know this test is sensitive enough to give an almost immediate heart attack diagnosis,' he said, 'we need to work on developing a testing device.'

As work on developing a POCT device continues, the team hope that it could be used in wards - or ambulances - within five years, replacing time-consuming despatch of samples to hospital labs.

Trials of the test have been conducted around Europe by international collaborators. In Denmark, blood was taken from 776 patients travelling to hospital by ambulance, which the King's College London researchers then tested for cMyC protein.

In patients who had suffered heart attacks, Kaier said, the protein was present in high enough concentrations 95% of the time for an on-the-spot diagnosis.

The cMyC test outperformed the existing troponin test, which diagnosed only around 40% of patients in this way, mainly because troponin takes longer to reach detectable levels in the blood after a heart attack.

'A stand-out feature is cMyC's ability to more effectively triage patients,' Kaier said. 'This distinction is likely related to the documented greater abundance and more rapid release profile of cMyC. If used on a POCT platform, cMyC could significantly improve the early triage of patients with suspected AMI.'

Better rule-in and rule-out rate

Figures show that more than 65% of people who attend A&E with chest pain have not had a heart attack, though all will receive an ECG and a blood test to measure troponin levels.

With the cMyC blood test shown by the KCL team to have a better rule-in and rule-out rate for heart attack, the research team believes this will be a valid tool in reassuring patients sooner and avoiding unnecessary hospital stays for further tests.

In part, the research has been funded by the British Heart Foundation, which said the initial results from the cMyC test look 'very promising' for patients and acknowledges that it could lead to quicker diagnosis and treatment, or see patients reassured and discharged.

However, BHF Associate Medical Director Professor Jeremy Pearson stressed that further research was necessary before cMyC could be recommended as a replacement for the troponin test.

Dr Tom Kaier is a BHF Research Fellow, having previously been a Specialist Registrar in Cardiology at Barts Health NHS Trust and the Royal Free London NHS Foundation Trust in the UK. .

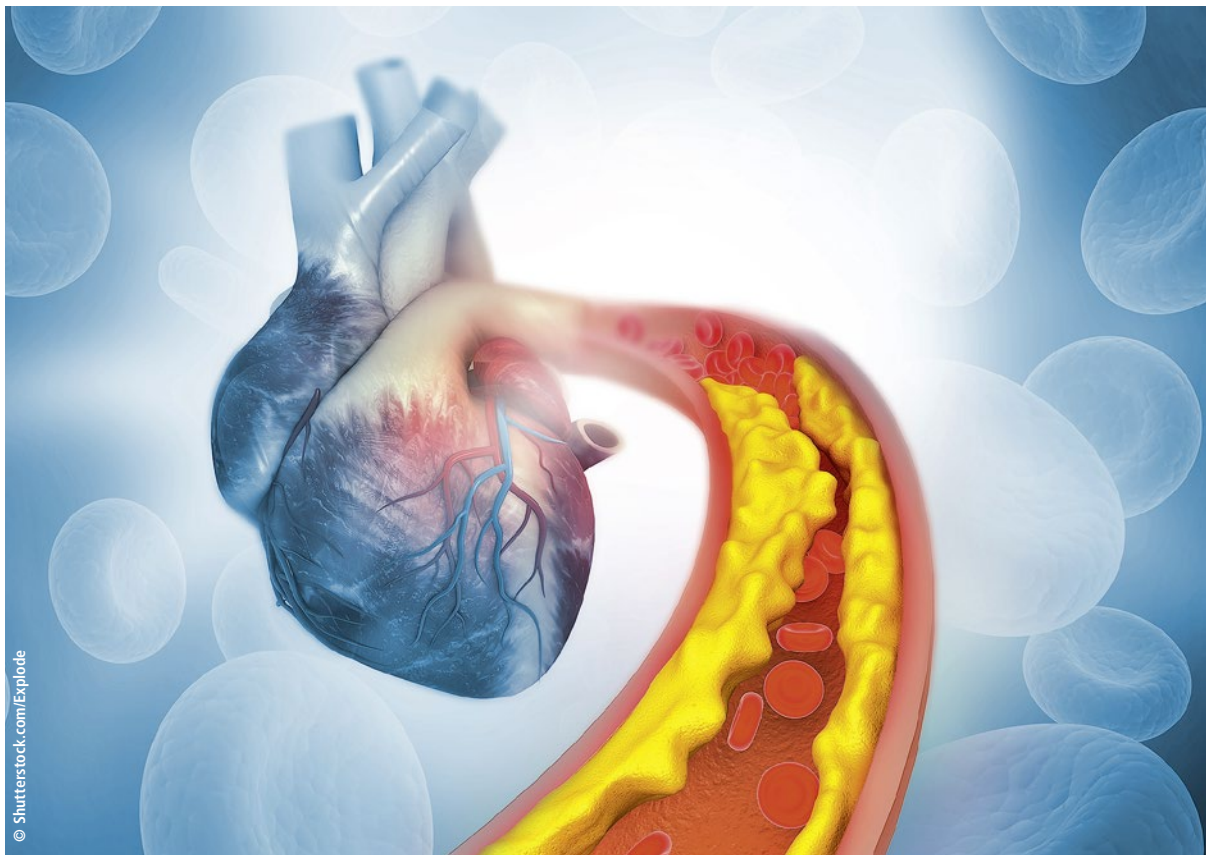
Arrhythmia news from CMR 18

Multidisciplinary cardiology

Eminent Spanish cardiologist highlights the evolving role of imaging in ventricle arrhythmias treatment

Report: Melisande Rouger

Intervention in ventricular arrhythmia has improved dramatically over the past three decades thanks to advances in imaging and cooperation between cardiology and radiology, according to Professor Josep Brugada MD, director of the paediatric arrhythmia unit at Sant Joan de Déu Hospital in Barcelona.



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'Echocardiography, CT and MRI, combined with cardiology,' he said, 'have revolutionised the field into what it is now a truly multidisciplinary field.'

Cardiologists have learned to use echocardiography. Collaboration with radiologists has enabled them to understand ventricular tachycardia and ventricular fibrillation, two life-threatening diseases that are most commonly associated with heart attacks or scarring of the heart muscle from previous heart attack.

As a result, knowledge of physiopathology and arrhythmia mechanisms has grown over the past thirty years, first with understanding the location of arrhythmia, a parameter that remains crucial for treatment.

Decades of developments

'Thirty years ago, we were performing diagnostic electro-physiological studies, and at that time our relationship with imaging was very simple – we just used X-ray. But in the late 1980s, we understood that we could start treating these patients and that we could start targeting the points that we identified as the points of arrhythmia, and with more and more accuracy to understand where these points were,' he explained.

Using X-ray and echocardiography combined with the electric signal first enabled very simple arrhythmic substrates to be located. Cardiologists soon understood that they needed, and could get, more information from imaging.

In the late 1990s, CT enabled the visualisation of more complex arrhythmia substrates, such as ventricular tachycardia. 'It was not enough to use echocardiography anymore. At that time we needed to have information on the position and size of different structures, for instance the pulmonary veins. We used the CT scan to help us to do just that. That was a very important step,' Brugada pointed out.

Inside cardiac tissue

Ten years later, around 2010, the medical team realised that they had to go even further in their understanding of arrhythmia, beyond anatomic knowledge; they also needed to know what was inside the heart tissue.

'We wanted to see how the tissue is built in the heart, to assess tissue structures and understand how different elements of cardiac tissue can be identified as normal or abnormal areas. This can only be done with nuclear magnetic resonance imaging. Only then did we begin to understand what the true nature of the tissue is,' Brugada said.

MRI enables us to depict details in both ventricles. Checking the left ventricle, especially, remains crucial because of the various potential origins of arrhythmia. 'If you have a myocardial infarction, we know the abnormal tissue can be located in the endocardium site and even the mid-myocardium site. So you need to see the structure of this tissue. That's why all the efforts are now focused on understanding how the tissue is structured and built in the ventricles.'

MRI provides information on the nature of tissue, and, used in combination with electrical mapping system, helps identify electrical pathways or channels that may cause arrhythmia. Unveiling the electrical anatomy of pathways in the muscle is crucial at the time of eliminating arrhythmia, Brugada explained.

'Using MRI, to extract anatomic information, and our mapping system, which enables us to identify where the electricity goes through, we can determine the exact point that may be responsible for arrhythmia. We can then target this point with radiofrequency and burn it, and thus prevent the electricity going through the pathways that cause arrhythmia.'

Major contribution

MRI is also used to guide intervention and correct potential error; this is a new and major contribution of imaging to arrhythmia treatment.

'You need to integrate this imaging and perform 3-D imaging of the heart because you want to see exactly what is happening,' Brugada explained. 'That's a technique we use every day, and increasingly to treat atrial arrhythmia in atrial fibrillation,'

The main interventional treatment of AF consists in blocking the pulmonary veins using radiofrequency, i.e. by burning around the veins to create a line of electrical block. During the procedure, gaps may occur in these lines of block; these breaches can only be spotted on MRI. Being able to pick these gaps will lead to redoing the procedure and improving treatment success and patient outcome. In the future, MRI will continue to improve treatment efficiency in AF, a disease that affects millions of patients worldwide, and ventricular tachycardia patients, whose only chance of survival is to receive adequate treatment. 'There are fewer cases of ventricular tachycardia than AF, but these are very severe patients who need a cure. It is fundamental for their survival and the only thing we can do right now is to target the right electrical pathways.'

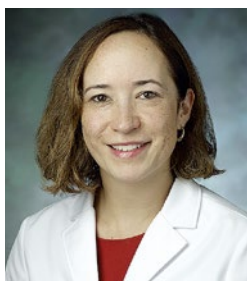
Professor Josep Brugada studied medicine at the University of Barcelona, Spain, before moving to the University of Montpellier, France, to specialise in cardiology. He continued training in Maastricht, Netherlands, to specialise further in the clinical and basic aspects of cardiac arrhythmias, and he worked simultaneously in the basic and clinical electrophysiology laboratory. Brugada then became Assistant Professor at the University of Limburg and was the first foreign established investigator of the Dutch Royal Academy of Arts and Sciences. In 1991 he returned to the hospital at the University of Barcelona, where he became professor of medicine, head of the arrhythmia unit, and of cardiology, director of the thorax institute and finally medical director. He is now professor of medicine, director of the paediatric arrhythmia unit at Sant Joan de Déu Hospital in Barcelona.

Session arrest i

MRI has a central role in picking up myocar nary disease, a condition that particularly a with potentially fatal outcome.

Heart attack in women presents differently than in men and requires a different approach when it comes to detection and prevention, according to Allison Hays, a cardiologist and assistant professor at the Johns Hopkins University School of Medicine, speaking at CMR 2018 meeting in Barcelona.

'Women don't present typically with chest pain, but rather with tiredness or shortness of breath. When they eventually come in for diagnosis, women have much less rates of having abnormal cardiac catheterisation test, which shows degree of stenosis in coronary arteries. So, much more commonly, they



Allison Hays MD is a general cardiologist and interim Director of Echocardiography Programs at the Johns Hopkins Heart and Vascular Institute. She is also an assistant professor at the Johns Hopkins University School of Medicine. Having graduated from Stanford University she received medical training at the Columbia University College of Physicians and Surgeons. Following her residency at the New York Presbyterian Hospital at Columbia Hays pursued cardiology fellowships at New York University Medical Center and at the Johns Hopkins University School of Medicine. Today she studies ways to use non-invasive imaging to detect cardiovascular disease. In terms of research, Hays uses cardiac MRI as a tool to study coronary and systemic endothelial function.

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ISSN 0942-9085

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Subscriptions
Liane Kaiser, Theodor-Althoff-Str. 45, 45133 Essen, Germany

Subscription rate
6 issues: 42 Euro, Single copy: 7 Euro.
Send order and cheque to:
European Hospital Subscription Dept

Printed by: WVD, Möhrfelden, Germany

Publication frequency: bi-monthly

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Heard at CMR 2018

n highlights cardiac n women

rdial infarction with non-obstructive coro- ffects women but is often left untreated,

do not have disease in the coronary arteries,' Hays explained.

Instead, women who suffer a heart attack usually present with myocardial infarction with non-obstructive coronary disease (MINOCA), a much less common condition in men. This difference suggests that biology of the coronary arteries differs greatly between sexes. Women have a much higher incidence of microvascular diseases, i.e. the very small vessels that are embedded into the heart muscle itself.

Worse prognosis for women

Treatment usually includes lifestyle modifications and traditional ways to lower risk factors such as blood pressure and high cholesterol. Nonetheless, heart attack has a worse prognosis in women than men, because it is generally not treated as aggressively as it should be, Hays argued.

'A lot of women don't have complete heart blockages and sometimes they're left untreated. So it's very important to recognise that even when a woman comes in with a heart attack and they don't have heart blockages that are detected on cardiac cath, it's very important that you still treat them for the small vessels disease aggressively with heart medication,' Hays said.

A main focus of CMR 2018 was to highlight the different and atypical presentation of women compared to men when it comes to heart attacks and how they can be detected, prevented and addressed in women, to improve outcome in the future.

Although cardiac arrest is the first cause of death in women as well, it was the first time the conference featured a dedicated session on the topic, probably because women are now better represented in the organising societies, Hay believes.

'In the last two years of the Society for Cardiovascular Magnetic Resonance, membership of women has grown significantly, going up from 20% to 40% today. So women are now more represented and more involved. I myself was one of the organisers, and found it was important to talk about that issue. The session was well attended, and we've had very good questions from the audience. I think this topic should be there every single year, because there's a lot of research in that area,' she said.

Stress MRI is a good tool for women

Awareness of that issue among the medical field must be increased, and the approach in detection must change, particularly regarding stress perfusion MRI, because this is an ideal tool to image heart disease in women, Hays believes. 'Some stress tests are better tailored to women because they are more sensitive. Stress MRI is particularly suited to heart attack detection in women because it's better at imaging microvasculature. EKG is not so sensitive for women and you can miss a lot. The same is true for CT, because you're just taking pictures to know how much narrowing or blockage there is, but it does not capture how much small vessel disease you have. Both modalities miss a lot of disease in women,' she pointed out.

The novel field of non-contrast MRI, which uses T1 and T2 mapping, may be an additional tool to detect areas of microvasculature perfusion in women. The technique has a lot of prospects but it is still a very new area of research and requires more investigation, Hays underlined. In the USA the Women's HARP study, a multi-centre, diagnostic observational study that aims to compare perfusion MRI results of women with heart attack to cardiac catheterisation techniques using optical coherent tomography will bring more knowledge of MRI's value within the next two years. It will also provide information on plaque inflammation and see whether this correlates with microvascular abnormalities. 'That will be interesting, to determine the reasons why there is microvascular dysfunction,' Hays said. MRI is usually less available than other modalities, but it is worth the extra effort to find centres of excellence because of the unique insights it offers, and not just in microvasculature, she believes. 'CT and nuclear tests are not so sensitive to image microvasculature. MRI plays a critical role not only for microvasculature disease, but also for heart failure, since a lot of women have heart failure with preserved injection fraction.'

mr

HemoDynamic Analytics in Ultrasound

A new tool box enhances heart failure diagnosis

One of the challenges for every echocardiography lab is the technically difficult patient. Conventionally, labs use contrast agents to enhance endocardial border visualization. The application of contrast agents increases the exam time, resources and costs. Additionally, the use of contrast turns a previously non-invasive exam into an invasive procedure.

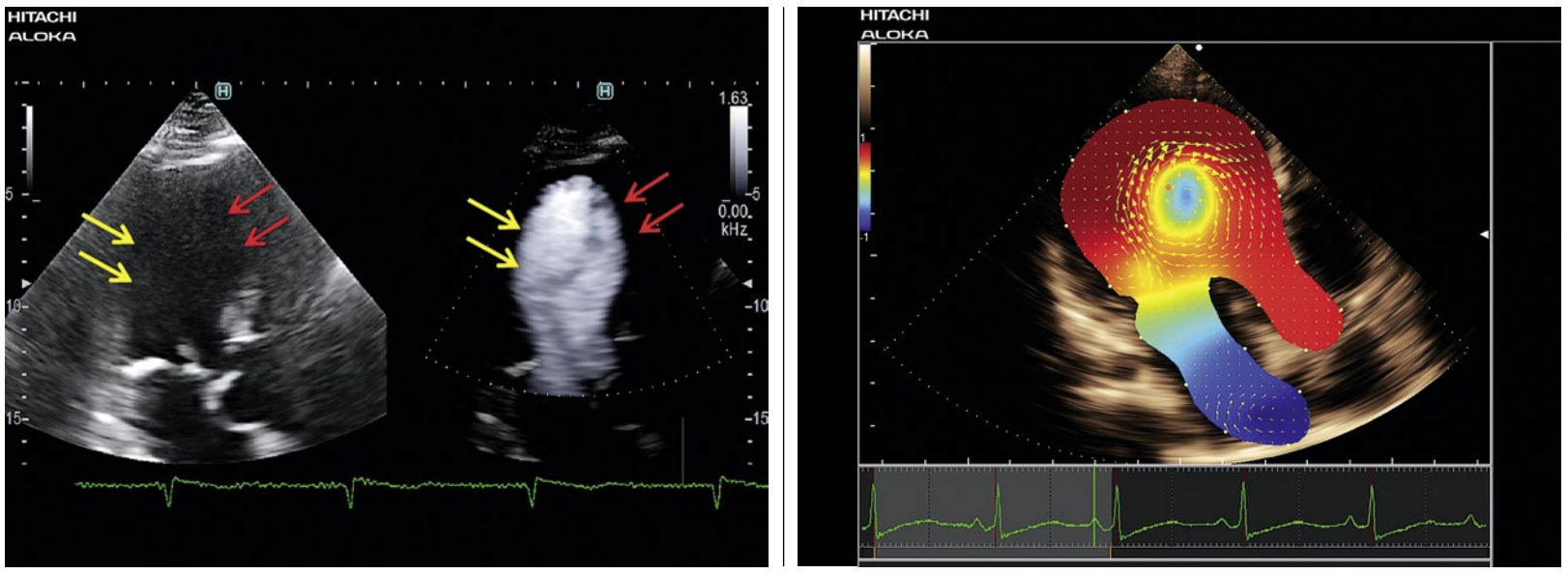
Hitachi Healthcare has now developed a collection of cardiovascular analytic tools called HemoDynamic Analytics (HDAnalytics). These tools can be used for evaluation of the left ventricle (LV) when visualization is limited. One of the main applications of the collection, LV eFlow was designed to demonstrate the discrimination between the blood flow and the cardiac tissue and offer an alternative to contrast agent use in some cases.

LV eFlow is a high-definition left ventricular cavity blood flow imaging mode which substantially improves spatial and temporal resolution for a better visualization of the endocardial border in the left ventricle. The new tool operates with higher sensitivity and resolution than conventional methods. LV eFlow may change a technically difficult study into a diagnostic exam without using contrast agent.

Head-to-head with echo contrast

Dr. Zuyue Wang and technologist Marvin Tyson of MedStar Washington Hospital Center had an opportunity to use this technology in their practice over a period of 3 months. Their protocol included identifying patients that were candidates for contrast agents due to the difficulty in visualizing the endocardial border of the left ventricle. LV eFlow was added to the exam protocol for this patient set. Following the exam, the quality of the endocardial border delineation was evaluated by comparing the LV eFlow images with the images using contrast agents.

Dr. Wang and Marvin Tyson compared LV eFlow and echo contrast agents in patients with suboptimal image quality and were impressed with the results. They found that "LV eFlow was comparable to echo contrast in improving visualization of difficult-to-image segments in selected patients". Additionally, they found "a markedly more precise endocardial border delineation" and stated that "contrast agents should only be utilized when LV eFlow fails to enhance the endocardial borders".



Left: LV eFLOW – technically difficult patient; right: VFM – relative pressure with a dilated cardiomyopathy. Source: Hitachi Medical Systems Europe

Vector Flow Mapping & Dual Gate Doppler

Another tool in the HDAnalytics collection is Vector Flow Mapping (VFM), a novel and validated application that allows users to assess cardiovascular blood flow distribution in an observation plane. This non-invasive technique is derived from the Color Doppler velocity data and generates the velocity fields on the 2D image. This allows to visualize, measure and analyze different parameters from the blood flow distribution. For example, energy loss which is the rate of energy dissipation due to blood viscosity, increases where turbulence flow occurs. In addition, wall shear stress, relative pressure and vortex characteristics can be evaluated.

The Dual Gate Doppler (iDGD) generates a full Fast Fourier Transform (FFT) analysis and display from two separate sample gates allowing measurements from two different locations during the same cardiac cycle. Hitachi Artificial Intelligence technology enables automatic sample gate placement and measurement at appropriate heart beats, resulting in 5 seconds to get E/e' (83% shorten time compared with conventional measurement). Furthermore, iDGD works well for PW/PW and TDI/TDI combinations.

2D tissue tracking (i2DTT)

With 2D Tissue Tracking (i2DTT), the HDAnalytics set also provides an advanced tool which allows users to track the displacement of the cardiac tissue by using a novel and accurate algorithm of "Speckle Tracking". Doppler based methods such as TDI are limited in evaluating the displacement velocity of the tissue due to angle dependency. i2DTT allows the detection of velocity components perpendicular to the beam which is impossible with conventional Doppler techniques. Tracking image by image, the natural patterns of the cardiac tissue in B-Mode permits the user to quantitatively evaluate the movement and the thickening of the myocardium. i2DTT provides precise quantitative information such as longitudinal and radial strain, torsion rotation angle, displacement, wall thickening and various other parameters to visualize, quantify and analyze myocardial mechanics. Applications include cardiac function analysis, resynchronization therapy, cardiomyopathy, stress echo and other global and regional studies.

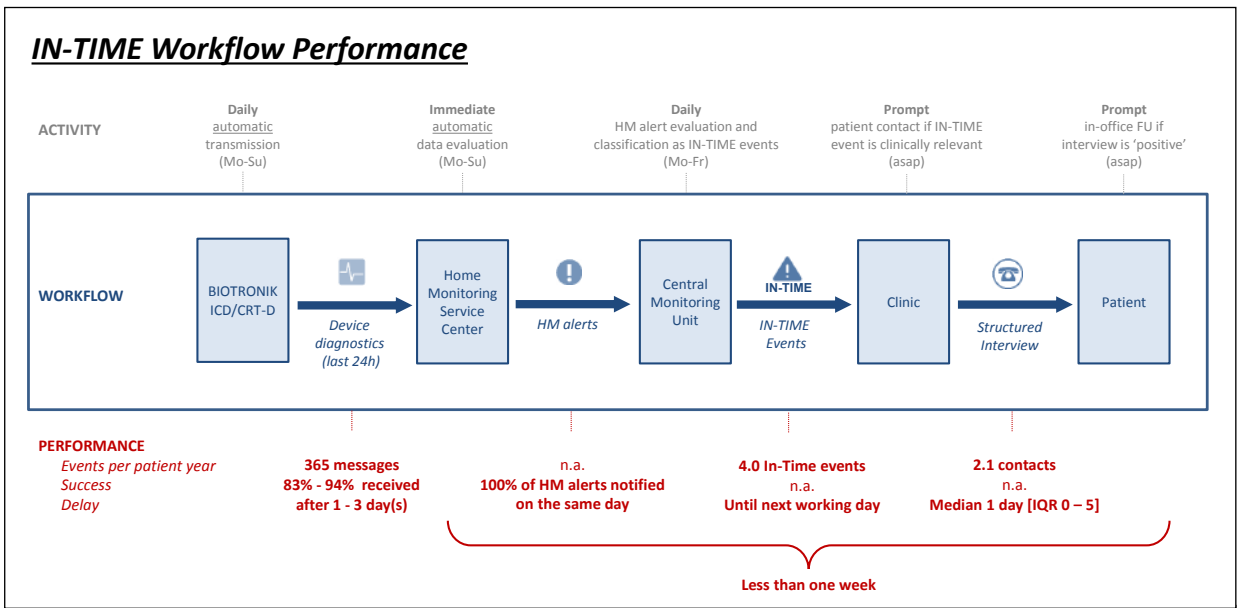
New analysis suggests workflow is key in remote monitoring

It's time to look again at IN-TIME

As the world's largest cardiology congress gets underway in Munich, it's worth looking back to previous ESC sessions to see how scientific debates have evolved. At ESC 2016, held in Rome, REM-HF investigators presented data suggesting remote monitoring in implantable cardiac devices offered no added clinical benefit. Two years on, there are new reasons to re-examine that conclusion, with a recent analysis of the IN-TIME trial suggesting the key to remote monitoring benefits might be found in workflow processes.

Published in *The Lancet* in 2014, the IN-TIME study is the only trial, to date, to have demonstrated a clear benefit of implant-based remote monitoring in heart failure (HF) patients – showing a more than 50% reduction in all-cause mortality – while eight other studies included in a 2015 meta-analysis, and three other recent trials, found no significant clinical benefit.

However, IN-TIME was also the only implant-based remote monitoring trial using a transmission technology that sent daily updates to a central monitoring unit. By contrast, REM-HF used technology that transmitted implant data on a weekly basis. So why does IN-TIME show positive results when other remote monitoring studies don't? What is so fundamentally different in its methodology that might account for its results?



Multiparametric data

This is a central question in the recently published *Remote Monitoring and Clinical Outcomes: Details on Information Flow and Workflow in the IN-TIME Study* by Husser et al. The authors note that IN-TIME featured multiparametric data that was transmitted daily. Crucially, a workflow process was set up such that study investigators could typically contact patients less than a day after receiving an event alert and arrange any necessary follow-ups for less than a week later.

The study authors point out that, in the recent TRUECOIN meta-analysis, the IN-TIME approach was shown to be beneficial for patients with heart failure, since it provides early enough warning to potentially prevent deterioration in the patient's condition due to new onset atrial fibrillation, asymptomatic ventricular tachycardia, or other adverse events. It is this early appraisal – facilitated by efficient workflow processes, including multiparametric daily transmissions — that make the difference in the IN-TIME study, authors argue.

As the European cardiology community gathers for ESC 2018, it's an excellent time to re-examine existing evidence for clues we may have missed, alongside the latest breaking research. That's why it's time to look again at IN-TIME.