Professor Jeanette Schulz-Menger

Jeanette Schulz-Menger is from Berlin, Germany. She is married and has a 22-year-old son, who is studying medicine. She is a cardiologist by training and active in CMR since 1996. In 2008 the Charité University Medicine Berlin created a chair in Cardiovascular Imaging housed in Cardiology, based on a close collaboration with the HELIOS-Clinics, Germany, and appointed Professor Jeanette Schulz-Menger to this chair. She heads a group focusing on clinically oriented CMR-research that has been able to establish new structures including a CMR-driven research setting working in close collaboration with the Max-Delbrueck-Center (MDC). The main interest has remained the CMR-driven understanding of myocardial injury and its relation to the cardiovascular system. They have established new structures including the extension of CMR-research from 1.5 Tesla (dedicated cardiac system) to 3T to 7T. Over recent years a new post-processing lab (CMR reading and development) has been installed, allowing to speed up processes. In 2011 an academic outpatient department of cardiology was founded under Professor Schulz-Menger's leadership, allowing a personalized phenotyping and the

Cardiovascular Magnetic Resonance – a routine tool for clinical decision-making and an exciting research instrument. The non-invasive chance to improve the understanding of cardiology

Dear colleagues,

Writing an editorial without repeating the ideas of the authors is always a challenge, and an editorial is always, of course, a personal view. It has become a welcome tradition that MAGNETOM Flash has a special SCMR edition. That means we are lucky ones, as we are always the first publication of the new year – an exciting start.

Although CMR itself has a longer history, SCMR celebrates its 20th anniversary in 2017.

This issue of MAGNETOM Flash nicely reflects the different aspects we wish to see covered by CMR. I had already used one of the last SCMR-Newsletters to share with you the thought that we as the Board of Trustees of SCMR developed during our last strategic meeting: That it is our responsibility to convince patients and referring doctors that CMR not only has a place in guidelines, but is suitable in the clinical environment. Utilizing CMR instead of other non-invasive imaging techniques means that one will get more definitive, relevant, and actionable answers because a CMR exam provides comprehensive information and has superior diagnostic and prognostic power, without the need for radiation. Furthermore, there are CMR-only capabilities including virtual heart biopsy, high-resolution perfusion imaging, and advanced blood flow analysis.

This MAGNETOM Flash issue provides aspects from sequence development to clinical application as well as tips and tricks helping to meet the overarching aim.

The authors share exciting news, as well as cookbook-like approaches to improve image quality. This aspect has a high priority, as it will help technologists not only to meet the needs of high-quality CMR, but also to enhance the understanding that CMR is doable today on a routine basis. As evidence of this, CMR is today mentioned in more than 29 guidelines of the European Society of Cardiology [1]. We have well-accepted and standardized SCMR protocols [2] and advices for post-processing [3]. But the aim to make the method easier and more time-efficient is also reflected in technical developments and has already allowed us a short time later e.g. to publish a consensus statement with a proposal for a 20-minute stress perfusion [4].

establishment of a research database dedicated to patient oriented research. The group is committed to CMR education, offering courses in different structures and they have established a teaching network within the HELIOS-clinics. As a cardiologist, Professor Schulz-Menger also has clinical responsibilities regarding imaging. One major achievement has been the leading participation in the successful application for the German Center of Cardiovascular Research (GCCR) within which Professor Schulz-Menger is one of the Principal Investigators of the Charité.

She was Founding Director and interim Co-Director of the Berlin Ultrahigh Field Facility of the Max-Delbrueck-Center and thus one of the leading forces in the successful application for the 7 Tesla human scanner at the MDC and the implementation of a fruitful collaboration between MDC, Charité, PTB and Siemens Healthcare. She is an elected member of the Council of the Charité. Following the intention to bring CMR-research into clinical reality, she has also been active in several imaging societies, including the Society of Cardiovascular Magnetic Resonance.

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In the following I will aim to reflect on the articles in this issue of MAGNETOM Flash in the light of these thoughts.

Fast free-breathing techniques assist considerably in the goal towards a reliable and efficient exam, easy for patients. Peter Kellman and co-workers are introducing a free-breathing Late Enhancement Imaging technique. The Phase Sensitive Inversion Recovery (PSIR) with Respiratory Motion Corrected (MOCO) averaging[1] allows high-resolution free breathing imaging. The technique gives not only the chance to increase diagnostic accuracy, but also to broaden the application of CMR to a vulnerable population. The images nicely demonstrate the high quality that is achievable.

Whilst the constant focus of attention is the patient, the ease of handling may also be an obstacle for technologists. That is often the case, for example, if CMR is not the only application at a dedicated scanner. However, it should be the norm, that all indications are covered, from knee, to brain, to heart.

Armando et al. report on their experience with an upgrade from MAGNETOM Avanto to Avanto^{fit}. The Italian group shares the experience of the improved ease of use and the resulting effectivity. They have been able to reach a reduction of acquisition times of about 40%. Interestingly, that was also translated in a use of more challenging techniques. They state that they are now able to perform the complete Lake Louise protocol [5] for assessment of acute myocarditis including early enhancement increasing the number of positive findings. As the assessment of inflammatory diseases and cardiomyopathies reflect a unique capability of CMR, this has an implication for clinical decision-making. Our own experiences with the need for fast and efficient scanning are illustrated by some case-examples. In our own environment the referring doctors don't pay particluar attention to arrhythmias or other limiting factors like patient's conditions e.g. the capability to hold their breath or the case of deafness. We try to scan all patients and in nearly all of them we are able to provide a diagnosis and therapeutic guidance. But that means that techniques like real-time cine or motion-corrected perfusion are crucial. The latter is already a routine tool leading to free-breathing stress perfusion in all patients. That is convenient for patients and also for medical staff, as the sequence can be started immediately when reaching the adenosine effect and furthermore, the slice position is much more predictable.

Ease of use and reproducibility of a scan were also the reason for Jonathan Richer to summarize in a cookbook like approach the imaging of the coronaries themselves.

However, CMR would not be CMR if we did not have scientists crossing the borders of our known and familiar world. Those thoughts are often the driving forces for further developments. But no doubt, new possibilities, new awareness can be initiated from both sides: the clinical and the scientific. It is a pleasure to recognize that the basic idea of our joint ISMRM/SCMR workshop is also present in several articles. The exchange of existing knowledge and beyond is the basis for a network in medicine as introduced by Chan and Loscalzo in 2012. They referred to the interaction of basic research and clinical research [6].

Christoph Forman and co-workers introduce in their article the potential of Compressed Sensing[2] for CMR. They explain the current stage and its potential in detail. Compressed Sensing will allow rapid CMR imaging based on a dedicated data acquisition and image reconstruction. The acceleration can be translated into a reduction of the acquisition time or into spatial and/or temporal resolution. Compressed Sensing in a clinical setting would allow an improved real-time imaging reducing the need for breath-holding. This new feature of the Siemens Healthineers-Team will be integrated in the scanner environment, allowing a further introduction of applications.

[1] WIP, the product is currently under development and is not for sale in the US and in other countries. Its future availability cannot be ensured.

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"Utilizing CMR instead of other non-invasive imaging techniques means, that one will get more definitive, relevant, and actionable answers because a CMR exam provides comprehensive information and has superior diagnostic and prognostic power, without the need for radiation. Not to forget unique CMR capabilities like virtual heart biopsy, high-resolution perfusion imaging, and advanced blood flow analysis."

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While Compressed Sensing sounds like a future tool in CMR, one can already appreciate first examples especially in vessel imaging. Yamamoto et al. demonstrate a Compressed Sensing based Time-of-Flight MR Angiography[1]. The technique has been used for visualization of cerebral arteries and was able to reduce the scan time while minimizing loss of image quality at high acceleration rates. It is impressive to see these first experiences in clinical setting using highly accelerated CS-TOF. Compressed Sensing seems also to allow the imaging of medium-to-small sized pulmonary vasculature. Wintersperger et al. describe their promising experience with iterative TWIST[1] as a dynamic angiography. If IT-TWIST were really to allow "a straightforward inject-and-shoot CE-MRA protocol without the need for any bolus timing" as stated by the authors, it would again help us to simplify CMR.

First clinical experience is also demonstrated using exercise CMR as described by group from Australia. Strugnell at al. have used a prototype of a Compressed Sensing[2] bSSFP sequence exercise ergo-metry in healthy volunteers as well as in patients. They conclude that in this pilot test the application of this highly accelerated imaging sequence has allowed the assessment of biventricular response during exercise with a reliability that was not previously possible. Both groups agree that further trials are needed to confirm these results. Nevertheless, this could be the start of a new era.

Improvement of assessment of ischemia is an ongoing research field, despite its accepted value in clinical routine. Juliano L. Fernandes et al. have successfully aplied parametric mapping for assessment of myocardial ischemia. T2* mapping is already known to be suitable for assessment of myocardial perfusion abnormalities. However, they applied T1 and T2 mapping sequences during stress, potentially reflecting changes in the myocardial intravascular components. The authors indicate that the application of native T1 mapping could reduce the need for gadolinium-based contrast agents, as T1 mapping allows the detection of different pathologies. At the current stage it should be one part of a protocol in most of the indications.

CMR allows the assessment of the heart itself, but at least as important is the capability to assess the cardiovascular system. The interaction between myocardial, structural and vascular diseases is one of the true challenges in clinical decision making. The assessment of the vessels themselves has a long history in MRI, where 4D Flow experienced an increasing recognition in recent years. Michael Markl and co-workers provide a comprehensive update on 4D Flow MRI. 4D Flow opens the door to a noninvasive assessment on hemodynamics and its impact on prognosis. An increasing number of groups are currently working in this field, so one could assume that in the near future multi-center trials will help to identify the value of 4D for clinical decision making in different fields. In congenital heart disease this value is already demonstrated.

A next step could be high-quality 4D magnitude images to overcome the need for an additional angiography. But on the other hand, it is an advantage that high-quality MR-angiographies are part of a clinical routine. It is generally accepted that, depending on anatomy and pathology, MRAs can be challenging.

Botelho et al. from Chicago provide protocols for the imaging of calcified vasculature using PETRA and FREEZEit StarVIBE. These protocols allow use at different field strengths. The imaging of calcified vessels will experience growing impact due to the increasing number of complex interventions in the ageing society.

The assessment of atherosclerosis in all vessel territories is a clinical need. But more relevant than the visualization itself is the plaque characterization and/or the impact on perfusion. There is an ongoing effort to identify the vulnerable plaque. It seems that application of MR/PET using new tracers will help to cut the Gordion knot.

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Colleagues from New York and Edinburgh present a case using ^{18}F-NaF applying coronary MR/PET. They have been able to detect disease activity in the coronaries. Using MR/PET instead of PET/CT would again allow a reduction in radiation dose. MR/PET in CMR is currently mainly recognized as a research tool. But the group from Mount Sinai demonstrated a case with an active cardiac sarcoidosis. The combination ^{18}F-FDG PET and MR may help to indicate disease activity and this could have a clinical impact soon.

This MAGNETOM Flash gives us a flavor of the multiple features of CMR. CMR is here, and today it can be applied quickly and efficiently in clinical routine. I will conclude with the words of German writer Bertolt Brecht. In one of his *"Stories of Mr. Keuner"* he describes how a man who had not seen the protagonist Mr. K for a long time greeted him with the words: "You haven´t changed at all". "Oh!" replied Mr. K, and turned pale."

In my view, this says a lot about our work and life. It is no compliment to be told you haven't changed. Change is desirable and necessary. It is this constant drive for change that is the motor for all scientific progress.

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