The role of musculoskeletal ultrasonography (MUS) in rheumatology is evolving rapidly [1, 2]. No longer is it restricted to the detection of Baker’s cysts or deep venous thromboses. MUS has become a sophisticated tool for the assessment of patients with a range of rheumatic diseases from inflammatory arthritis to vasculitis and soft tissue rheumatism [3]. The potential benefits to patients and increasing use by rheumatologists are highlighted in two articles in this issue by Kane et al. [4, 5]. The authors discuss the wide range of applications of ultrasonography in rheumatology practice and discuss potential barriers to its future dissemination, including important issues regarding training and competency, the rheumatology–radiology interface and the challenges of integrating this technology into everyday rheumatology clinical practice.

The mid 1990s heralded a new era for MUS and a vastly improved quality of ultrasound image. This was due to the availability of high-speed digital processing and developments in transducer technology. To fully understand the capabilities and limitations of ultrasonography warrants a brief review of the technology. First, what is ultrasound? Ultrasound waves are longitudinal mechanical waves which are above the hearing frequency range of the human ear (>20 kHz) [6]. In fact, diagnostic MUS systems use much higher frequencies, ranging from 3 to 18 MHz. Sound waves abide by the same physical properties as light waves in that they may be reflected, refracted, absorbed, diffracted or scattered. Unlike electromagnetic waves, such as X-rays, sound waves need a medium for transmission—solid, gas or liquid. They also travel through different media at different speeds, unlike X-rays, which travel at a constant velocity [6]. The speed of sound through any material depends on the internal resistance of the material. This is known as the ‘acoustic impedance’. Reflection of sound waves occurs where there is a mismatch between the acoustic impedances of adjacent tissues. The greater the acoustic mismatch, the greater the reflection. Fat and synovial tissue may have similar values and therefore vary significantly. This is why gel is applied to the skin in order to reduce the reflection.

Secondly, why is the frequency of the ultrasound wave important? The higher the frequency, the greater both the axial and lateral resolution of image, but at the cost of reduced tissue penetration. Therefore, a higher-frequency transducer is best used for superficial structures, such as the small joints of the hand and feet (e.g. 7–18 MHz), and a low frequency transducer is used for deeper joints, such as the hip (e.g. 3–5 MHz).

Thirdly, what is Doppler ultrasonography? Most applications in rheumatology currently relate to grey-scale imaging. This is where the image is black and white—each white dot on the monitor indicates a reflected sound wave. Fluid, therefore, is black as it is a good transmitter of sound, and bone and soft tissue are varying degrees of white. Doppler ultrasound, however, although used in medicine for many years—predominantly for fetal heart monitoring during labour and for evaluating flow through the carotid artery, has only relatively recently found a role in rheumatology. It works on the principle that there is a frequency shift of the reflected sound wave when it hits a moving object, the target usually being red blood cells. There are two main types used: ‘colour Doppler–CFD’ and ‘power Doppler–PDS’. The CFD represents an estimate of the mean Doppler frequency shift and relates to the velocity and direction of red blood cells, whereas the PDS denotes only the amplitude of the Doppler signal, which is determined by the volume of blood present. In this way, CFD is better suited to the evaluation of high-velocity flow in large vessels (e.g. carotids), whereas PDS is better suited to the assessment of low-velocity flow in small vessels (e.g. synovium) [7, 8]. As Kane et al. [4] indicate, the sensitivity of Doppler may be further enhanced by the use of bubble contrast agents, which are microparticles to which gas bubbles adhere. In addition to Doppler, 3D and 4D ultrasonography may also be of future value.

Finally, what are the specialized features of the ultrasonographic transducer? The transducer contains multiple crystal components, which are responsible for emitting and receiving the sound waves when a voltage is applied across them—the piezoelectric effect. Rapid stimulation of each component in turn produces the real-time image. Recent developments, particularly in crystal production, have resulted in smaller transducers capable of generating the higher frequencies that are more suited to musculoskeletal work. The physical properties of the crystals and sound waves currently limit the size of the transducer. However, recent developments have led to the production of smaller transducers, allowing better access to the small joints of the hands and feet and adequate angulation to reduce the chance of artefact. In general, the larger the transducer the greater the lateral resolution of the image.

There is increasing evidence to support the use of MUS in rheumatology practice, as outlined in the second review by Kane et al. [5], with a growing number of publications from rheumatology units performing their own scans. This reflects the increasing number of rheumatologists who are now conducting MUS examinations of their patients as part of their routine clinical practice [9]. However, there remain a number of challenges that have to be faced if the potential of MUS is to be realized. These include important unresolved issues of training, competency and clinical governance, the relationship between the rheumatologist sonographer and the radiologist, issues of reproducibility, and further justification of the value to patients of rheumatologists learning a new skill and becoming proficient ultrasonographers, balanced against the possible impact on their clinical workload.

The discussion about who should perform MUS is an important but complex one. There is a general paucity of musculoskeletal radiologists nationally and very few with expertise in joint ultrasonography. Additionally, joint ultrasonography is a developing technique, putting additional pressures on existing MUS imaging services. Is the answer to get more radiologists? Probably, form a practical view point, it is unlikely that the radiologist can provide a walk-in service, often required by rheumatologists in decision-making. Kane et al. [4] argue the case that rheumatologists already routinely perform ultrasonography in many European countries, such as Germany, Italy and Spain. There, MUS training is already a compulsory part of rheumatology training. But is this justified? Should training be compulsory or an optional extra?
Whether ultrasonography should be an obligatory part of training is not clear and there is a wide spectrum of opinion. Kane et al. [4] highlight a broad range of applications for MUS, although currently some are used only occasionally or for research purposes. However, given the many advantages and clinical utility of MUS in a number of areas, it seems sensible that there should be some core skills that we can all learn relatively easily. For example, possessing the ability to use MUS effectively to identify synovitis in a joint, differentiate fluid from synovium, identify a bone erosion or direct a needle to facilitate accurate aspiration or injection would be a valuable additional skill for most rheumatologists.

Regardless of who performs an MUS assessment, it is imperative that the ultrasonographer is competent in order to minimize the risk of misdiagnosis or unnecessary examination. However, recent data [10] suggest that formal and quantified assessment of competency is uncommon, even amongst radiologists, and there are limited mechanisms in place to facilitate appraisal, revalidation and lifelong learning.

The expectation that all rheumatologists should be competent at performing sonography for all the indications listed in the review by Kane is perhaps too ambitious and is likely to be met with some opposition from the radiology community. A more realistic approach would be to be more targeted in what the needs of the rheumatologists are, to decide where the evidence is of greatest benefit and where the gaps are in the traditional radiology service. A period of consultation and discussion with radiology colleagues should take place, which will enable clarification of each others’ roles—there may be some overlap where compromises could be made or areas defined as unique to each specialty. It is not unreasonable, however, that training and practice should be focused in areas where MUS is of proven clinical value (and is relatively straightforward to learn). Of course there will be always be research centres continually pushing the boundaries and developing the technique. For now we should perhaps concentrate our efforts on more fundamental issues, such as a precise definition of appropriate practice for the rheumatologist ultrasonographer, and establish the necessary educational framework to equip the rheumatologist with the necessary knowledge and skills to perform a competent ultrasonographic assessment.

If rheumatologists are to provide a musculoskeletal MUS service, obviously the provision of training becomes an important issue. Who should provide it and what form should it take? Until recently, most rheumatology sonographers have been self-taught, their learning supplemented by working alongside an expert and attending the occasional training course. Learning has largely been apprentice-based, with pattern recognition achieved by repetitive examination of a large number of cases. Self-taught sonographers have to be highly motivated and have considerable free time apart from their existing workload. One current difficulty, as with any new technology, is a lack of experienced physician sonographers (or enthusiastic radiologists) to provide the training. Training is usually also limited to teaching hospitals or research centres, where the equipment is more easily affordable and there are staff who have the time to learn and teach. However, it is important that this knowledge and expertise is disseminated into the wider rheumatology community.

Recently, the Leeds Imaging Group [10] have begun to tackle the problems of a lack of a unified approach to training by developing an educational framework to ensure competency amongst rheumatologist ultrasonographers. They have worked to address some of the important fundamental issues, including the development of an interdisciplinary consensus of appropriate anatomical areas and indications suitable for MUS assessment by a rheumatologist, and the skills that they require to perform this to a satisfactory standard. Further research has enabled the development of specific competency standards, which are being used to develop an outcome-based curriculum of training and assessment for rheumatologists performing this imaging technique.

In conclusion, MUS is a hugely flexible imaging modality and offers exciting diagnostic and therapeutic possibilities for the future care of our rheumatology patients. It is likely that MUS will become a routine part of clinical management. Its introduction, however, remains controversial, although this partly reflects the relative infancy of the area. Problems to overcome include the significant investment in time and money required to set up a service, the lack of a formal training structure and outcome data, in particular ones which demonstrate improvements in clinical care.

This year, the first British Society for Rheumatology study group in MUS will be held in Edinburgh, offering a forum for UK rheumatologists to discuss some of the issues raised above. Additionally, the first special interest group will be held at the seventh OMERACT meeting in Monteray, California. This aims, in conjunction with EULAR, to review current literature, to propose future methods of standardizing joint examination, and to develop an agenda for future research.

The authors have declared no conflicts of interest.

R. J. WAKEFIELD, A. K. BROWN, P. J. O’CONNOR1, Z. KARIM, A. GRAINGER1 and P. EMERY

Academic Department of Musculoskeletal Medicine and 
Department of Radiology, General Infirmary at Leeds, Leeds, UK

Correspondence to: R. Wakefield, Academic Department of Musculoskeletal Medicine, First Floor, Old Nurse’s Home, General Infirmary at Leeds, Great George Street, Leeds LS1 3EX, UK. E-mail: medrw@leeds.ac.uk

References