



# The Role of the Clinical Scientist in Medical Ultrasound

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## 1. Introduction

Ultrasound is used to diagnose and treat a large number of clinical conditions and disorders. Diagnostic ultrasound is a real-time, non-ionising imaging modality that is particularly well suited to soft tissue investigation and haemodynamic assessment. Major applications are found in the specialities of radiology, cardiology, ophthalmology and obstetrics but ultrasonic, or acoustic, imaging is also widely used in emergency medicine, musculoskeletal imaging and vascular medicine. Ultrasound-derived images and video sequences assist diagnosis, inform treatment and provide non-invasive follow-up. Ultrasound imaging is also used in real-time to guide interventional procedures, such as tissue biopsy, drain placement, regional anaesthesia and is finding increased use in the guidance of Brachytherapy for Radiotherapy. A second major medical application is found in therapy, where higher output levels are applied in order to selectively stimulate or destroy tissue. Applications include physiotherapy, lithotripsy and HIFU (High Intensity Focused Ultrasound). Many new ultrasound technologies have emerged in recent years, including 3D/4D visualisation, harmonic imaging and elastography innovations. The Clinical Scientist plays a vital role within the multidisciplinary team that develops and delivers such ultrasound techniques with responsibilities that include equipment procurement, quality assurance, technique optimisation, device safety and staff training and education, as well as research and development activities.

## 2. Equipment Specification

A Clinical Scientist specialised in medical ultrasound will possess expertise concerning the interaction of ultrasound with tissue, the theoretical principles underpinning ultrasound technologies, limitations of these techniques and appropriate clinical applications. With this knowledge, the Clinical Scientist is uniquely placed to provide an objective assessment regarding equipment specification and procurement, as well as oversee subsequent acceptance testing and commissioning of new diagnostic or therapeutic devices. Unlike other physical modalities, such as X-ray based imaging or laser light technologies, the infrastructural and regulatory requirements of the diagnostic ultrasound environment are not excessive. However, the increased portability of ultrasound units, and their relatively high patient throughput, requires expert consideration to ensure that ultrasound devices, and particularly transducers, remain electrically safe and continue to perform optimally. The Clinical Scientist with ultrasound expertise may perform this role outside the general hospital environment, for example in local health centres or medical practitioner clinics.

## 3. Quality Assurance

The Clinical Scientist is involved in ensuring the safe and effective operation of any ultrasound technique in healthcare, through the process of quality assurance (QA). Under controlled conditions, repeatable measurements of image quality and/or acoustic output are

used to identify sudden or gradual deterioration in unit performance as well as ensure that the device is operating safely. There are a wide variety of QA tests, depending on the complexity and purpose of individual acoustic devices and their medical application. IPEM Report 102 (see Bibliography) outlines appropriate procedures for an imaging QA programme, while IPEM Report 84 details QA considerations for physiotherapy devices. The Clinical Scientist may also establish, oversee and support user led QA activities which may form a significant part of the testing of an ultrasound system. Simple QA activities are a recommendation of both the RCR and BMUS. Additionally, the Clinical Scientist may be involved in implementing novel QA processes and strategies for bespoke purposes, such as Elastography or Brachytherapy planning.

The Clinical Scientist will also be responsible for acceptance testing to ensure that equipment initially works to specification and is suitable for clinical use. In many cases, acceptance testing involves overseeing the commissioning tests of suppliers and establishing a set of appropriate independent baseline measurements for future QA testing. Clinical Scientists may also provide first line assistance to sonographers or clinicians in the case of equipment failure or fault, and liaise with manufacturers during device repair. They may also provide basic fault finding training to clinical users.

#### **4. Optimisation of Techniques/Clinical Applications**

Clinical Scientists should liaise with clinical users and manufacturer's specialists to ensure that ultrasound equipment is configured for optimal use in each clinical protocol. This may involve the adjustment of factory preset parameters on diagnostic ultrasound scanners, selection advice regarding choice of imaging transducer for specific clinical applications, ensuring adequate data archiving of studies, advising on the application of contrast agents or installing software enhancements or upgrades. Advising clinical users of the uncertainties and limitations of the technique is also a key part of the role of the Clinical Scientist within the clinical environment. Validation studies may be required for new clinical technologies or applications at the developmental stage. Such actions should be taken by the Clinical Scientist with careful consideration of current national safety guidelines (see Bibliography).

#### **5. Safety**

The Clinical Scientist has an important role in ensuring that ultrasound is applied to the patient in a safe manner. Diagnostic or therapeutic efficacy should be assessed regularly as part of a QA programme. Electrical safety testing is also essential as ultrasound devices operate in direct contact with, or inside, the human body. Protocols involving the exposure of sensitive tissues, most notably the developing baby, but also poorly perfused tissues or bony surfaces prone to rapid temperature rise, need special consideration. The Clinical Scientist may also undertake periodic auditing of such clinical protocols.

#### **6. Research and Development**

Clinical Scientists are essential to the continued development of therapeutic and diagnostic techniques in ultrasound. They are involved in developing new technologies from first principles such as ultrasound-mediated gene transfection, speckle-based tissue tracking algorithms and novel diagnostic techniques exploiting the photoacoustic effect, which offer multidisciplinary involvement for the Clinical Scientist in research and development. Such work requires the Clinical Scientist to typically engage with clinicians, engineers and other multidisciplinary experts in both experimental stages and the dissemination of findings through peer-reviewed papers, patents or conference proceedings. Specialised scientific

expertise may also be sought in the preparation of research council or charity grant applications to attract funding.

## **7. Education and Training/Staff Development**

The Clinical Scientist involved in ultrasound will maintain an up to date knowledge of the current scientific, technological and regulatory developments in the field. Passing on this knowledge to other Healthcare Professionals is an important aspect of the Clinical Scientist's work. Clinical Scientists are often involved in teaching courses covering the physical principles and the effective/safe use of ultrasound in medicine, and take a role in running continued professional development activities for hospital staff.

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