Report on the Ultrasound Physics Workforce 2016

Background

This report details the findings of a survey carried out of the ultrasound physics workforce during 2016. It describes the landscape of ultrasound physics service provision, predominantly within the NHS, as only one response was received from an independent service provision. This report concludes with recommendations as to how IPEM can best support the profession in this area of work.

Key Findings

38 responses were received, which represents approximately 50% of the known centres providing Diagnostic Radiology Services. Of these, 35 provided some support to ultrasound physics, and 3 were not involved in ultrasound.

Information was gained on a total of 13.06 WTE Clinical Scientist time spent on ultrasound physics, across 35 departments/groups, carried out by 42 individuals. This reflects the very low proportion of time many Clinical Scientists have available to spend on ultrasound, and the low number of specialists.

38.3 WTE technologist time, provided by 43 individuals was identified. Many of the technologist posts are close to full time, and they tend towards maintenance, repair and QA roles. Like Clinical Scientists, many ultrasound specialist technologists are approaching retirement, with 8/43 (18%) aged over 55.

Introduction

Ultrasound installation and background to imaging

Ultrasound is a widely-used imaging modality, ubiquitous because of the intrinsic safety of ultrasound waves and capability to image in real-time. In addition to imaging, ultrasound is also used for therapeutic purposes. In 2013 NHS England reported that 3 million ultrasound scans[1] carried out were carried out by NHS Trusts in England. All acute hospitals and many clinics will utilise at least one ultrasound scanner, with the average number for hospitals likely to be considerably higher. One responding multi-hospital Trust reported supporting over 80 scanners. NHS England Data from 2013 also shows that 189 Trusts are engaged in ultrasound imaging (both obstetric and non-obstetric). It is very likely that ultrasound is similarly prevalent in Scotland, Wales and Northern Ireland. The actual installation of ultrasound scanners is unknown but it does not seem unreasonable to suggest that there are of the order of 10000 scanners in the UK.

Ultrasound imaging is a relatively mature technology; nevertheless, it is still an evolving technique and there are several peer-reviewed journals publishing research. It is widely believed that research and development is hampered by the lack of time and expertise to devote to activities over and above providing a basic clinical service.

Ultrasound Quality Assurance and Maintenance

Every scanner ought, for good practise, be within a Quality Assurance (QA) program to assure accurate imaging and consequently diagnosis. The Abdominal Aortic Aneurysm (AAA) Screening programme specification[2] mandates Medical Physics input throughout the UK at the requirement of 5 days/annum/7000 screens, however, other Screening

Programmes do not explicitly state a similar requirement, and there is no legislation explicitly requiring QA. The Breast Screening Programme requires QA by implication (a service cannot meet requirements of ensuring accuracy without QA) although anecdotally it is believed that only around 50% actually do so.

Even in the absence of any explicit legislative requirement, good practice would clearly dictate regular QA to ensure accurate diagnosis from measurement or images. Despite this, it is believed that the intrinsic safety of ultrasound scanning has made QA and maintenance in this area a target for cost and efficiency savings, as many working in diagnostic radiology believe that in many Trusts and Health Boards QA and appropriate maintenance is not carried out on all scanners or probes.

Service Provision Structure

There are two broad categories of ultrasound work: physics and engineering. Ultrasound Physics is almost entirely carried out as a subset of work by radiology physicists who have frequently specialised in another area of non-ionising radiation or diagnostic radiology. There are very few specialists, and those who are specialists are either approaching retirement or unable to spend all of their working time in this area of work. There is a specialist ultrasound equipment services team (engineering), which was one of only two specialist ultrasound teams responded (the other was Ultrasound and Optical Imaging Team). Aside from these, the majority of work is carried out in Radiation Physics, Diagnostic Radiology Physics, non-ionising radiation or Imaging Physics Departments

The activities that are carried out in the area of Ultrasound physics & engineering are

- Quality Assurance and Quality Control, including image quality
- First line maintenance and investigations
- Co-ordinate with servicing/maintenance companies/OEM
- Provide advice and assistance in using ultrasound safely
- Developing user testing regimes
- Service development and research
- Procurement advice and acceptance testing

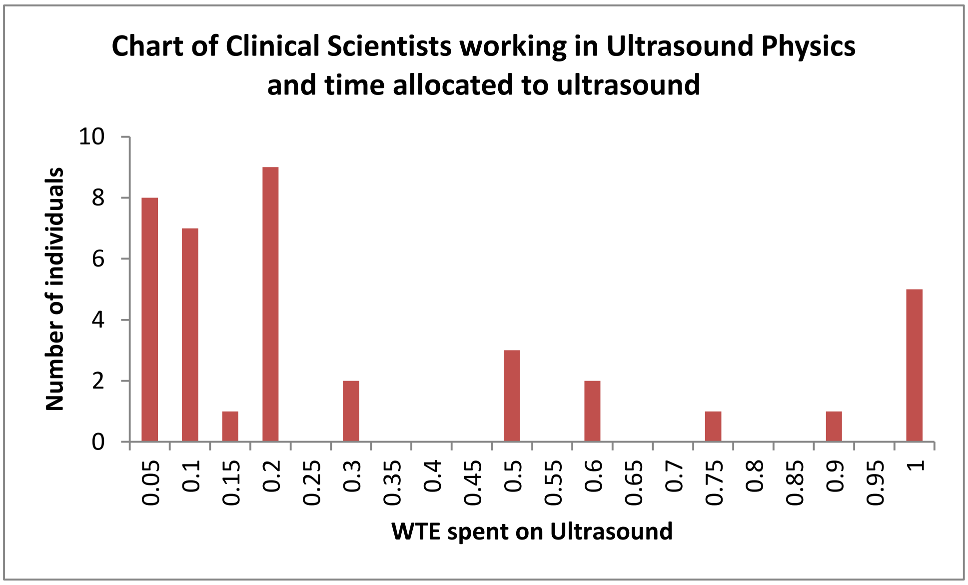
These activities are carried out by a combination of Clinical Scientists and Technologists (both physics and engineering).

Survey Results

An online survey, constructed with aim of taking less than 30 minutes to complete was distributed through a network of contacts, displayed on IPEM's website, and disseminated via twitter and the JISCmailbase for Medical Physics and Clinical Engineering.

38 responses were received, of which 3 replied that they were diagnostic radiology departments who did not support ultrasound. In these organisations, there is either no physics involvement in ultrasound, or support is provided via another organisation under a service level agreement. The remaining 35 represents approximately 50% of the known centres providing Radiology or Ultrasound Physics Services. Survey responses would typically be skewed towards those who do provide support, so it may not be valid to extrapolate directly from this. Information was gained on a total of 13.06 WTE Clinical Scientist time spent on ultrasound physics, across 35 departments/groups, carried out by 42 individuals. This reflects the very low proportion of time many Clinical Scientists have available to spend on ultrasound, and the low number of specialists.

38.3 WTE technologist time, provided by 43 individuals was identified. Many of the technologist posts are close to full time, and they are generally more engaged in engineering roles than physics, covering maintenance, repair and QA roles. Like Clinical Scientists, many ultrasound specialist technologists are approaching retirement, with 8/43 (18% aged over 55)



Establishment and vacancies

There was just 1 WTE Clinical Scientist vacancy identified; this post has been vacant for some time, and the organisation has been unable to appoint a suitable individual. Predominantly, ultrasound physics is carried out as a minor part of many roles, and vanishingly few employers are recruiting specifically ultrasound physics expertise. There are very few ultrasound-specialist posts established, and those that are are likely to be frozen once the incumbent retires.

The reasons are believed to be a combination of a low visibility of the benefit of ultrasound physics, and no overt legal requirement to carry out quality assurance or control. A historical lack of expertise available to recruit has further eroded the establishment as organisations have necessarily had to make do with less support.

Experiences regarding the volume of work are mixed

> *"I work mainly in diagnostic radiology but have seen a steady decline in useful ultrasound work since I started working in my department 8 years ago"*

> *"As the only clinical scientist with substantial experience in Ultrasound, the scientific service has no resiliance. In addition the quality of the service provided does suffer."*

> *"Probably the biggest concern is with training/staff budgets, as ultrasound QA is generally not considered to be a high priority within Trusts, with the exception of NHS screening programmes. Again, increased ultrasound clinical governance requirements/awareness could motivate Trusts to invest more in the quality assurance service and therefore workforce budgets."*

One respondent predicts

> *"Ultrasound applications (both diagnostic and therapy) will potentially significantly increase in the future as the technology improves and more US machines (both diagnostic and therapy) come into clinical service."*

And another that

> *"The development of ultrasound technology is rapid as it is strongly linked to computer performance and has a relatively low cost to entry. It is likely that in the next decade or two it will*

> *be available to almost every doctor at one level or another. - - There will be a huge requirement for training on safety and technology and the development of appropriate local testing protocols. With these real time imaging systems it is of paramount importance that their performance is audited at least annually by professional QA testing which will need to evolve with the technology. Established testing regimes quickly become obsolete in ultrasound and proactive scientific input will be required to maintain efficacy and safety. Without these and with the lack of peer review available of the diagnostic images the risks become very significant"*

Both the above respondents predict an increase in the need for ultrasound physics expertise over the coming years, just as an aging workforce and lack of recent training will be reducing the availability. Equally there is a disconnect between work that could be done, and work that is requested or required to be done, and in some services, work is declining owing to a lack of driver. Possibly there is an argument to be made regarding restructuring of services to ensure best use of Clinical Scientist and technologists availability and skills.

Recruitment and Training

With no specialists available to recruit, at a time when there is intense pressure on funds, recruitment is not taking place, which results in a further reduction in activity, visibility and research. 26% (11/42) individuals working in ultrasound are aged over 55 so this situation will accelerate in the next 5-10 years.

The lack of visibility, is resulting is a lack of posts, thus meaning that in order to progress ultrasound specialists are obliged to diversify.

While the current Scientist Training Programme does include ultrasound physics as a requirement in Year 1, the shortage of expertise does make it difficult for training centres to deliver the required modules. In year 2, a specialism of Imaging with Non-ionising Radiation (MRI and Ultrasound) is possible, but the belief is that the majority who opt for this do so in order to specialise in MRI, although there are competencies specifically relating to ultrasound imaging. In addition, some report that trainees are discouraged from opting for ultrasound.

> *"Very little pressure to prioritise ultrasound. Trainees actually warned off subject."*

> *"I am concerned that if we lose our existing staff then it will be difficult to fill a vacancy with someone wanting to work in US physics. Most of the STP trainees we had in our department tend to specialise in other areas (eg. nuclear medicine, radiotherapy), possibly because there are more opportunities for finding a job and career development in other areas."*

> *"Have not been able to recruit Clinical Scientist post at Band 7 and currently recruiting at Band 8a."*

> *"STP Trainees that we see don't want to do non-ionising radiation because of the lack of career progression"*

Impact on Service

In terms of providing a high quality clinical service, Quality Assurance is essential. While physicists are not required to carry out all routine QA, physics input, considered over an annual period, in some form is essential. As the survey was intended to cover workforce, rather than equipment it has not identified the number of probes or organisations which do not carry out any form of QA. A 2016 study found that around 1/3 of ultrasound probes are faulty in some respect, and that the rate is lower in organisations where there is some level of QA, which certainly suggests, along with anecdotal descriptions that many, many probes and services do not undergo adequate QA.

At the same time as the decline in the available expertise, there is an increasing range of possible technique advancements. If these cannot be progressed, owing to a lack of expertise in this area, then a whole range of possibilities are missed. Ultrasound is a very safe imaging modality, which is not being exploited to its full potential.

The few experts risk becoming professionally isolated, as well as overstretched. The Consortium for Accreditation of Sonographic Education (CASE) is continually striving to uphold and maintain the physics content of courses, but there is a shortage of physicists available to provide CASE with assessors. IPEM is a member of CASE. This consortium cooperatively accredits ultrasound MSc and other courses through a group of accreditors. In recent years IPEM has struggled to identify suitable individuals to offer as accreditors, and at present only 4 IPEM members are CASE accreditors, compared with over 10 from SCoR and other consortium members. There is on-going concern over the physics content in ultrasound courses at the same time as a limited and shrinking pool of those qualified to comment.

This represents an on-going professional risk.

Next Steps?

It is apparent that the specialism of ultrasound physics is in a close to terminal decline. With even provision of physics support to provide a basic service, being neglected, there will be no expertise available for more complex work, development and research. Little recognition, training difficulties and no explicit statutory requirement for Quality Assurance expose this as an area likely to be targeted to make the currently required cost savings. As Dudley and Woodley (2016) point out[3], the Health and Social Care Act 2008 (Regulated Activities) Regulations 2014 in England requires that equipment be suitable for purpose, properly maintained and that risks are assessed and mitigated.[4] . Despite this statutory requirement it appears that this is not widely translated into comprehensive coverage of probes by Trusts. At the same time, ultrasound imaging is increasing, and accurate diagnosis depends on the accuracy of images.

> *"It seems like I'm doing ultrasound much more frequently - probably as they are due around the same time each round. It ties in nicely with the rest of breast screening QA - a complete service. The major advantage in this is the user support we give, making the user's far more aware of the capability of what their units have and making them aware of what is a fault which the manufacturer should remedy."*

While we do not have information regarding the legislative requirements in the devolved administrations, the situation is likely to be similar.

IPEM could consider having a position underlining the necessity of QA in ultrasound, and a policy of raising the awareness of the benefit to patients and clinicians in utilising the least-invasive imaging modality more fully. In 2014, the BMUS published guidelines for regular quality assurance testing of ultrasound scanners[5], noting that imaging with ionising radiation, which is subject to quality assurance testing by statute includes QA relating to image quality. Image quality is of key importance in diagnosis, as QA declines

> *"…the number of ultrasound scanners in our Trust is expanding, so we can't maintain a service for them all. We are selective."*

> *"Our ultrasound physics service offers support to only around one quarter to one third of the scanners used in the Trust, due to work force/funding restrictions - ideally more staff time should be allocated to cover the service fully e.g. an increase from WTE to 0.15 to around 0.5 WTE would benefit my Trust."*

> *"We have recently lost key members of staff with a lot of U/S experience. We have gone from a department which does research in this field to one which provides a basic service to the clinical departments, and we are still working out how much time we need for this level of service. Imaging physics covers U/S, NM, X-ray and MRI. At the moment, we are very squeezed, with other imaging modalities taking up our time - the two clinical scientists involved in ultrasound are currently busy commissioning a PET/CT scanner."*

Will diagnostic errors increase? One respondent suggested that

> *..”facilitate an audit of patient scans to find cases of incorrect diagnosis due to poor equipment performance or incorrect image optimisation then that would go a long way to raising the importance of Physics involvement in Ultrasound.”*

IPEM believes that such a survey would be extremely challenging, in the absence of a commonly agreed metric against which to measure ultrasound image quality. Perhaps the first step ought to be consideration and agreement on a common metric.

A survey conducted in 2015, published in 2016[1] , of 219 probes over 12 sites, found that over 1 in 3 ultrasound probes were faulty, and 13% were not fit for clinical use. The authors of the paper concluded that the high fault rate suggests that employers are not fulfilling their duties under the relevant legislation.

The AAA Screening programme specification mandates Medical Physics input throughout the UK at the requirement of 5 days/annum/7000 screens. Assuming 260000 men reach the age of 65 in England and Wales annually, this would require 185 days of MP effort, approximately 1 WTE post per annum. The Fetal Anomaly Screening Programme, though dependent on ultrasound, does not have a required specification for Medical Physics support, though providers must, as for other care, comply with the Health & Social Care Act 2008 and its Regulations (2014), in which Regulations 12 & 15 apply requiring assessment and mitigation of risks. Allowing the use of faulty probes is a risk that has neither been assessed nor mitigated. The general standards of the RCR and SCoR also support a higher QA involvement.

There is a concerning picture emerging, of an un-appreciated, under-resourced workforce and inadequate service provision, a situation which has developed, and will persist owing to the perception that ultrasound is a safe modality. Even though the nature of the imaging modality is safe and non-invasive, key clinical decisions are based on the outcome. There has been media interest in the failure of such decision in the last five years[6] and peer-reviewed papers published regarding concerns over misdiagnosis in distressing circumstances[7].

Background to Training in Non-Ionising Radiation Physics, Scientist and Practitioner

Clinical Scientists

IPEM Training Scheme

Prior to 2011, IPEM ran a four year training programme for Clinical Scientists (Medical Physics and Clinical Engineering), leading to a Diploma from the Institute of Physics and Engineering in Medicine, assessment by the independent Association of Clinical Scientists (ACS) and registration with the Health and Care Professions Council as a Clinical Scientist. The training consisted of two parts; Part 1 and Part 2, each taking a minimum of two years to complete. In 2011, England moved to training via the Modernising Scientific Careers (MSC) Scientist Training Programme (STP), and Part 1 applications were only considered from Scotland and Northern Ireland. Wales adopted the STP in 2012, and Northern Ireland in 2013. Scotland implemented an alternative 3-year supernumerary training scheme in 2014.

ACS Route 1

Part 1: Individuals would be registered on the scheme, and join IPEM as Associate Members. Working in a Training Centre, they would be trained in-house, and would specialise in three areas of medical physics and/or clinical engineering, with Ultrasound being one of the available options. Trainees also completed an MSc in medical physics and some opted to interrupt their clinical training in order to complete a PhD. After a minimum of two years, once their training co-ordinator was satisfied that their work was of the appropriate level, trainees would submit for assessment. This took place by portfolio and viva voce examination conducted by IPEM assessors. Up to two resits, and/or resubmission of the portfolio were permitted. Occasionally individuals left the training programme, either following failure, or for other reasons. Trainees could take more than two years to complete if:

- their training co-ordinator felt they needed longer to reach the required level;
- they opted for a PhD;
- they were required to re-sit, or re-submit a portfolio;
- personal circumstances forced a leave of absence for a period of time, eg maternity.

Part 2: for the second part of their training, trainees could take one of two routes.

1) Register with IPEM on the Part 2 programme: IPEM would provide a mentor or “external advisor”, who would oversee and comment on their training programme, and assist in ensuring trainees acquired a sufficiently large range of experience to pass ACS assessment.

OR

2) Not register on Part 2, but rely on internal assistance from their workplace to acquire a sufficient range of experience to pass ACS assessment.

   Often candidates were turned down for registration on Part 2 if too great a period of time had elapsed between completion of Part 1 and application for Part 2 (at one time application was required within 6 months of completion, but this was waived in later years)

Following a further two years of work, amassing a further portfolio and sufficient experience, following successful completion of Part 1, individuals could submit for assessment by the Association of Clinical Scientists (ACS) in one or two of their specialties from which they could progress to registration as a Clinical Scientist. Ultrasound Physics was included in the Non-ionising Radiation Techniques sub-modality, along with MR Physics, lasers and optical techniques.

Route 2

In an alternative route to registration, known as Route 2, sufficiently qualified and experienced candidates could submit a longer portfolio to ACS and undergo assessment against the same standards as Route 1 candidates. Sometimes, but by no means always, these individuals registered for Part 2 of the IPEM scheme and were provided with an external assessor to guide them through ACS assessment.

Modernising Scientific Careers (MSC) Scientist Training Programme (STP)

This has been operating in England since 2011, in Wales since 2012, and in Northern Ireland since 2013. Trainees are recruited nationally, and take part in a three-year programme leading to an MSc in a relevant discipline. They undertake specialty rotations and then specialise in one of these areas. STP trainees are assessed by an Objective Structured Final Assessment (OSFA) in their final year. If successful, they obtain a Certificate of Attainment, which allows registration with the HCPC. As this is a three-year, rather than a four year, programme, individuals are achieving registration with less experience than under the previous scheme.

Scotland has elected to run a separate but similar scheme which maps to the outcomes of STP and enables Scottish trainees to be assessed for equivalence by the Academy for Healthcare Science.

Ultrasound physics is covered under the Imaging with non-ionising radiation rotation in year one, along with Imaging with Ionising radiation, Radiation Safety Physics and Radiotherapy Physics. Trainees can then opt to specialise in the final eighteen months in Imaging in non-ionising radiation, or one of the other three options. Even though the OSFA assessment places equal weight on MRI and ultrasound, exiting trainees are frequently more confident in MRI than ultrasound, perhaps because this is where their interest lies.

Provision of a mentoring scheme whereby those whose role involves ultrasound but do not consider themselves an expert can access the expertise of those with many years' experience in ultrasound physics would benefit the continuity of skills and knowledge in this area.

Clinical Technologist training

IPEM Technologist Training Scheme

IPEM has offered a training scheme for clinical technologists since 2001, and continues to do so. This scheme offers the opportunity for individuals employed as trainees in an accredited training centre to complete a training programme and achieve registration on the Register of Clinical Technologists (RCT). A Diploma in Clinical Technology is awarded. This scheme continues to run, but progression through the scheme is currently slow, owing to a shortage of moderators or a reluctance of employers to release these moderators for professional activities.

RCT Equivalence

This route onto the Register of Clinical Technologists requires applicants to be working at a standard equivalent to degree, and present a portfolio of work demonstrating the required competencies. This would be open to physicists or engineers with a general physics or engineering degree, as well as those who have trained in-house, once they have amassed a suitable portfolio.

Modernising Scientific Careers (MSC) Practitioner Training Program (PTP)

This has been operating in England since 2011, in Wales since 2012, and in Northern Ireland since 2013. Applicants apply to a university offering an accredited course through the UCAS application procedure, in an analogous way to applying for radiography, nursing or midwifery. Students exit after a 3-year course, involving a clinical placement in years 2 and 3, eligible to join the Academy for Healthcare Science Register or the Register of Clinical Technologists. Students on healthcare science undergraduate degrees are not eligible for any financial assistance with course fees.

Four Higher Education Institutions in the UK (University of Cumbria, University of Liverpool, University of Swansea and University of the West of England) have opted for accreditation in Radiation Physics. The content of ultrasound physics in the curriculum is low, and three of the courses have only accepted students from September 2016, so the outcome in terms of practitioners produced is unknown.

PTP does not operate in Scotland, and to the best of IPE's knowledge all Technologist Training in Scotland is via IPEM's Technologist's Training Scheme.

Recommendations:

The profession could be supported by IPEM by:

1. Publicising the role and benefit of Physics involvement in Ultrasound
2. Supporting existing training and improve visibility
3. Providing a forum for development of skills through CPD or informal mentoring
4. Lobby for improvement in training and implementation of review of PTP
5. Considering if there is an alternative way to consider/review the physics content of accredited sonography courses

The Practitioner Training Programme is not currently producing a large number of staff. IPEM has been active in raising concerns over this with Health Education England, which resulted in a proposal of funding for PTP commissions. Unfortunately these were withdrawn at the Autumn Comprehensive Spending Review, to which IPEM responded in January 2016.

---

[1] https://www.england.nhs.uk/statistics/wp-content/uploads/sites/2/2013/04/KH12-release-2012-13.pdf

[2] NHS England, NHS public health functions agreement 2016-17, Service specification No.23 , NHS Abdominal Aortic Aneurysm Screening Programme (https://www.england.nhs.uk/commissioning/wp-content/uploads/sites/12/2016/04/serv-spec-23-abdominal-aortic-aneurysm.pdf)

[3] “A multicentre survey of the condition of ultrasound probes”, Dudley, NJ & Woolley, DJ, **Ultrasound** (2016) Vol 24(4)190-197

[4] National Health Service, England, Social Care, England, Public Health, England. The Health and Social Care Act 2008 (Regulated Activities) Regulations 2014. London: HMSO, 2014

[5] **The BMUS guidelines for regular quality assurance testing of ultrasound scanners (**Nick Dudley1⇑**,** Stephen Russell**,** Barry Ward**,** Peter Hoskins**,** BMUS QA working party)

[6] Time Oct. 14, 2011
[7] BMJ 2015;351:h4579

Useful links

https://www.cqc.org.uk/sites/default/files/documents/ra_8_diagnostic_and_screening_procedures.pdf