



Ultrasound in Anaesthesia and Intensive Care: A Guide to Training

Published by
The Association of Anaesthetists of Great Britain & Ireland
The Royal College of Anaesthetists
The Intensive Care Society

July 2011

Membership of the working party

(Details correct at the start of the working party process)

Dr N M Denny	AAGBI (Chair)
Dr K Fox	British Society of Echocardiography
Dr C Gillbe	AAGBI
Dr A W Harrop-Griffiths	AAGBI
Dr M Jones	Society for Acute Medicine
Dr N Love	Group of Anaesthetists in Training
Dr P MacNaughton	Intensive Care Society
Dr R McWilliams	Royal College of Radiologists
Dr B Nicholls	Regional Anaesthesia (UK)
Dr P Nightingale	Royal College of Anaesthetists
Dr J Pilcher	British Medical Ultrasound Society
Dr S Price	Intensive Care Society and British Society of Echocardiography
Mr J Sloan	College of Emergency Medicine
Dr S Ward	British Pain Society

The Association of Anaesthetists of Great Britain & Ireland
21 Portland Place, London, W1B 1PY
Tel: 020 7631 1650
Fax: 020 7631 4352
Email: info@aagbi.org
Website: www.aagbi.org

The Royal College of Anaesthetists
Churchill House, 35 Red Lion Square, London, WC1R 4SG
Tel: 020 7092 1500
Fax: 020 7092 1730
Email: info@rcoa.ac.uk
Website: www.rcoa.ac.uk

The Intensive Care Society
Churchill House, 35 Red Lion Square, London, WC1R 4SG
Tel: 020 7280 4350
Fax: 020 7280 4369
Email: info@ics.ac.uk
Website: www.ics.ac.uk

Contents

1.	Introduction	3
2.	Clinical governance and ultrasound	10
3.	Recommended essential ultrasound knowledge and skills	11
4.	Regional anaesthesia and pain medicine	15
5.	Vascular procedures	21
6.	Thoracic ultrasound	25
7.	Abdominal ultrasound	30
8.	Echocardiography	34
9.	References	40
	Appendix 1 – RCoA DOPS form	43

To be reviewed in 2016

© The Association of Anaesthetists of Great Britain & Ireland, The Royal College of Anaesthetists and The Intensive Care Society 2011

1. Introduction

This document presents a goal for the delivery of training of procedures using ultrasound in anaesthesia and critical care. The document not only sets out a practice-based curriculum for those who already hold a Certificate of Completion of Training (CCT) but also describes how the trainee might organise their own training within the Royal College of Anaesthetists' (RCoA's) CCT curriculum or Out-of-Programme Training (OOPT) to match these aspirations.

Over the last 10 years, ultrasound has developed into an indispensable tool in anaesthesia and intensive care. The combination of National Institute of Health and Clinical Excellence (NICE) guidance for central venous access [1] and the availability of small, portable, 'point of care' machines has led to the introduction and increasingly widespread use of ultrasound in clinical practice. More recently, further NICE guidance on the use of ultrasound for epidurals [2] and regional anaesthesia [3] has ensured that ultrasound is now deeply embedded within anaesthetic practice. Other uses now include: thoracic scanning for diagnosis and treatment of pleural effusions and pneumothoraces; abdominal scanning (Focused Assessment with Sonography in Trauma - FAST) looking for intra-abdominal fluid; and focused transthoracic echocardiography in non-traumatic resuscitation (Focused Echocardiography in Emergency Life support – FEEL).

The widespread introduction of ultrasound has brought with it many concerns relating to competency and training. Ultrasound is not new to medicine but its use in anaesthesia is. With the greater availability of machines and an increasing number of clinical indications, it is important to remember that there is a requirement for employing hospitals to ensure that clinicians are competent in the use of any equipment used by an employee [4]. Ultrasound has a distinct learning curve and trainee usage is characterised by common novice behaviour and mistakes [5,6].

The aim of this document is to produce a set of broad guidelines for current trainees and those who completed their formal training programmes before the introduction of ultrasound. Whilst the core knowledge and skills required to perform ultrasound are identical in both groups, it is recognised that the competencies will be gained in different ways. These can be termed the 'trainee-based College programme pathway' and the 'practice pathway' for non-trainees.

Recommendations for the use of ultrasound for non-radiologists have been published by the Royal College of Radiologists (2005) [7], the European Federation of Societies for Ultrasound in Medicine and Biology (EFSUMB) [8] and the College of Emergency Medicine (CEM) [9]. The importance of these recommendations is that they specify both a training syllabus and requirements that should be met by an individual using ultrasound.

Training should consist of both theoretical and practical aspects, and be modular in nature, allowing trainees to acquire different levels of competency depending upon the practical skills needed, with competency assessment and multidisciplinary training. The levels of training have been broadly divided into three (Levels 1, 2 and 3), the boundaries of which are not precise and are difficult to define and, as such, should be seen as a guide to different levels of competence and experience. It is important to realise that an appropriate level of training in ultrasound is one that allows for the provision of a safe and effective ultrasound service. This may be purely diagnostic, predominately interventional or a clinically-focused service.

Equivalent training and experience: the 'Grandfather Clause'

This working party recognises that many practitioners have received *ad hoc* training and have learned ultrasound techniques 'on the job'. While this pathway is not prospectively supported, it is recognised that for many such individuals their knowledge and experience makes them entirely appropriate practitioners and teachers of others. Furthermore, clinicians from specialties other than anaesthesia or intensive care medicine may hold equivalent qualifications or training. The recognition and awarding of an equivalent qualification to one achievable by a structured training programme is termed a 'Grandfather Clause'. Failure to recognise such individuals is likely to lead to a loss of training opportunities for others, and loss of enthusiasm by the individual. In general, the working party therefore encourages individuals to seek recognition rather than making this process obstructive.

The following should be included in any application for recognition under these circumstances:

- A description of the approximate number of scans performed and any relevant training experience obtained, e.g. sabbatical or work placements.
- A description of the current job plan outlining the role ultrasound plays and the typical range of scanning techniques used with representative frequencies.
- Confirmation that the individual is in a permanent UK NHS non-training post of Staff Grade, Associate Specialist, Specialty Doctor or Consultant, including any UK recognised qualifications of training, e.g. FRCA.
- A declaration from the Service Director, Governance Lead or Ultrasound Lead confirming substantial experience in ultrasound and ongoing use in clinical practice.
- Any equivalent training or recognition awarded by other specialties, e.g. CEM Level 1 and 2 ultrasound, British Society of Echocardiography (BSE) certification, or similar.
- Any further information demonstrating experience and knowledge of ultrasound, e.g. developing a service.

There is at present no specific body to award such 'Grandfather' status, but with the increased development of ultrasound groups within hospitals to monitor the use and training of non-radiology ultrasound, these groups may fulfil this role. In awarding equivalence of training, clinicians need to ensure they keep up to date with developments in ultrasound and, where feasible, obtain appropriate qualifications in their sphere of practice. The status of 'Grandfather' will need to be agreed by the head of that individual's department and the head of Clinical Governance. This 'Grandfather Clause' should be withdrawn in the future when robust training capacity exists.

Training levels

The concept of levels of training is a way of standardising training requirements across specialties. These levels are a guide to training and do not necessarily correspond to individual College recommendations and curriculum needs, e.g. CEM Level 1 is the standard of knowledge and practice that Emergency Medicine doctors should have in the future. This is also the case in anaesthesia and intensive care, where the use of ultrasound is not routinely practised or taught in all departments. Currently, it is likely that only a few trainees in anaesthesia or intensive care will be trained to be a Level 1 practitioner in all the aspects of ultrasound applicable to their clinical practice. Therefore, although Level 1 is the desired level of training for all trainees, it is at present too comprehensive to be achievable within the current RCoA curriculum.

Level 1 – core training

This is the expected standard of knowledge and practice that anaesthetic and intensive care consultants should have in the future and that should be achievable during normal postgraduate specialist training.

Level 1 practice may be defined by the following generic competencies:

- Ability to perform common examinations and interventions safely and accurately.
- Ability to recognise normal and abnormal anatomy and pathology.
- Ability to use ultrasound in real time to guide common invasive procedures (Level 1 specific to anaesthesia and intensive care).
- Ability to recognise when referral for a second opinion is indicated.
- Ability to understand the benefits of ultrasound imaging and its value and relationship to other imaging modalities used in anaesthesia and intensive care, e.g. x-ray.

In the future, Level 1 will be considered to be **core** and fundamental to the practice of anaesthesia and intensive care, and the components therefore considered essential parts of a specialist training programme. At present there is no restriction on the training that can be achieved within an anaesthetic and intensive care training programme, and it may be common to find individuals who have Level 1

training in certain areas and Level 2 training in others at the time of completion of training and award of a CCT.

Level 2 – extended training

This is a more advanced level of practice and can be considered **extended**.

This would be the expected level of practice for those with a special interest in ultrasound. A Level 2 practitioner would have the following abilities:

- Significant experience of Level 1 practice, e.g. >12 months.
- Ability to perform the complete range of examinations in the area of practice.
- Ability to recognise significant pathology within the relevant organ system.
- Ability to use ultrasound to guide the full range of procedures in the particular area of practice.
- Ability to act as mentor and trainer for Level 1 practitioners.
- Ability to accept referrals from Level 1 practitioners.

Level 2 practice is likely to require a period of additional training and experience beyond that obtained during normal postgraduate specialist training and the RCoA's requirements for a CCT. A modular nature of practice is proposed such that an individual may be a Level 2 practitioner in one area of ultrasound practice, e.g. vascular access, and Level 1 in another, e.g. regional anaesthesia.

Level 3 – advanced training

This is an **advanced** level of practice and is equivalent to a consultant radiologist with a special interest in ultrasound or a cardiologist specialising in echocardiography. A Level 3 practitioner will be able to accept referrals from Level 2 practitioners and perform specialised examinations. They are involved in all areas of ultrasound training and may undertake research within the field of ultrasound. This level of practice is unlikely to be relevant to the majority of those practising anaesthesia and intensive care.

Training

Although the training pathway may differ between established specialists and trainees, the core content of the programme will be the same. The outcomes should also be the same for anaesthetists and others undertaking similar procedures.

Theoretical training

Preliminary theoretical training should cover relevant anatomy, the physics of ultrasound, levels and sophistication of equipment, image recording and reporting, artefacts and the relevance of other imaging. This element of training may be delivered by existing national courses, local 'in-house' courses or by the use of e-learning modules.

Practical training

Practical training should include both training with phantoms and models before

using ultrasound in a clinical situation. Practical experience should be gained under the guidance of a named supervisor trained in ultrasound. Practical training should focus on demonstrating competence rather than performance of an arbitrary number of procedures undertaken. However, to ensure optimal training and timely acquisition of the required competencies, practical training should involve frequent supervised examinations. In all cases involving a patient, an explanation of the technique and consent must be obtained before initiating a practical procedure; this is even more important in a training situation. A logbook of all training cases should be kept and ideally should include a number of more detailed case studies. The ability to store ultrasound images (still and video) for later review is an invaluable part of training and is essential in certain areas such as echocardiography. The trainee should ensure that all examinations performed during training are logged. Examinations should concentrate on the core areas of practice. A competency assessment sheet should be completed for each area of practice during the course of training, as it will help to determine in which area(s) the trainee can practise independently.

Generic training

Training pathways

The training pathway will differ between those who are established anaesthetists with no previous ultrasound experience, those who have been practising ultrasound without formal competency assessment, those who have achieved formal competency in other modules, and specialist trainees in anaesthetics.

Clinical practice pathway

For established anaesthetists, with no previous experience of ultrasound, practical training will depend upon exposure to it and should be based on a combination of in-house and external courses. A basic skills and knowledge course (outlined below) is mandatory before practising on patients. All departments need to develop a training programme that is appropriate for them, but the following strategies are useful.

1. Complete basic knowledge and skills course; consider e-learning modules or web-based courses.
2. Attendance at a dedicated 'hands-on' ultrasound course.
3. Practise of normal scanning on colleagues or volunteers.
4. Use of web-based courses and textbooks.
5. Use ultrasound on patients, with their consent, under supervision by a recognised trainer.
6. Use of commercially available or 'home-made' phantoms or meat products to practise ultrasound-guided needle co-ordination.
7. Clinical practice should be supervised by a Level 2 practitioner or a Level 1 practitioner with at least 12 months' experience.

In addition to the suggested competency assessments described below, clinicians

should keep a logbook of cases that may include some key images. This could form part of an overall ultrasound portfolio that would include documentation of theoretical and practical training and assessments, any related self-audit and relevant Continuous Professional Development (CPD) teaching. Ideally, those clinicians already practising without formal competency review should, for the purposes of appraisal and good clinical governance, seek some form of recognition, e.g. a letter from a recognised Level 2 practitioner or radiologist confirming their competency.

Trainee pathway

Although ultrasound is yet to be formally incorporated into the RCoA curriculum, it is being increasingly taught by ultrasound enthusiasts during trainees' subspecialty attachments. Much of the core learning can be self-driven through a variety of educational media, or possibly by linking to one of the university courses with Consortium for the Approval of Sonographic Education (CASE) approval [10]. Practical training should ideally be on a weekly basis and overseen by a named supervisor. A logbook of all training cases should be kept and ideally should include a number of more detailed case studies.

1. Basic knowledge/skills course (vide supra).
2. Practical training should be overseen by a clinical supervisor at least Level 1.
3. If practical training is not possible in the current training scheme, the trainee should consider applying through the Deanery for OOPT or Out-of-Programme Experience (OOPE) [11].

It is envisaged that all anaesthetists using ultrasound need to know and have the basic skills and competencies outlined in this section. Thereafter, trainees will follow the training curriculum, and everyone else will follow a clinically based pathway.

Trainers

Level 1 training should be delivered by a Level 2 practitioner or a Level 1 practitioner with at least 12 months' experience. The modular nature of training allows trainers to be competent to train in a focused area of practice, e.g. vascular access, without needing to be proficient in all areas of ultrasound practice. To become a Level 2 practitioner, the appropriate level of experience and competence must be demonstrated by completion of a logbook. A Level 2 practitioner will need to undertake frequent examinations commensurate with their area of practice. In addition, an existing Level 2 practitioner will need to confirm that they have the required competencies. Although there is no formal recognition or certification of 'level of training', it is beholden upon the individual clinician to act responsibly and meet the competencies necessary for the level of personal practice and revalidation in the area of expertise. These can be enhanced by personal CPD and completion and maintenance of a current log book. For trainees, assessment will be under the auspices of their respective Colleges and approved trainers. For all others, it will be

up to individual departments to train and assess competencies using this document as a guide, the use of either individual hospitals' assessment tools or College-based assessment tools are to be encouraged. Overall training will be achieved by a combination of CPD recognised external courses as well as 'in-house' training.

Basic skills and knowledge training

All clinicians should be familiar with some basic concepts and practicalities before placing an ultrasound probe on a patient with the intention of either making a diagnosis or performing a practical procedure. Ultrasound is different to other commonly used imaging modalities and as such an understanding of the basic physics is mandatory. The production of sound waves and their interaction with tissues is determined and limited by the laws of physics. Knowledge of these principles enables a clinician to optimise the image with respect to the ultrasound frequency, probe design, focus and gain. The resulting image is formed from reflection of the ultrasound waves from multiple tissue interfaces. This reflection is dependent on the angle of the ultrasound beam, the ultrasound frequency used and tissue characteristics, which will be weaker at increasing depths. Accurate interpretation of the image is made with a knowledge of the ultrasound appearances of the different tissue seen, e.g. veins and arteries, nerves, muscle, bone and pleura, and the common artefacts encountered. Interpretation of any ultrasound image is dependent on a thorough and detailed knowledge of the anatomy of the area of interest. It is important to understand that when using ultrasound, you 'only see what you know': the structures are not labelled and may appear different from individual to individual.

A variety of ultrasound machines is now available to clinicians, including small hand-held (pocket-size) devices, laptops and cart-based machines. These machines will have a variety of probes (hockey stick, linear, curvilinear and phased array) and preset imaging modalities (harmonic imaging, multibeam function, trapezoid display and 3D volume rendering). All this can lead to total confusion for an ultrasound novice; familiarity with the machine and its capabilities before use is vital.

Theoretical training

Theoretical training and assessment should be undertaken before using ultrasound in clinical situations, but sometimes this may go hand in hand with supervised clinical training. Preliminary theoretical training should cover relevant anatomy, the physics of ultrasound, machine familiarisation, image recording and reporting, artefacts and the relevance of other imaging modalities to ultrasound. This element of training may be delivered 'in-house' (using 'Level 1 plus 12 months' and Level 2 practitioners: anaesthetists, radiologists, ultrasonographers, cardiac physiologists, cardiologists or medical physicists), and by distance learning or web-based packages. The identity of who delivers this training is not as important as the assessment of the individuals to ensure that they have understood and can apply this knowledge to clinical practice.

2. Clinical governance and ultrasound

Keeping records

Logbook data of patients treated during training should be recorded in accordance with RCoA standards. It is recommended that electronic recordings of ultrasound examinations and anaesthetic or therapeutic interventions are made and retained during training. It is recommended that hospitals develop the routine electronic recording of all ultrasound examinations and anaesthetic or therapeutic interventions. Even after completing training in ultrasound-based skills, it is recommended that logbook data are continually recorded.

Audit

The success or failure of ultrasound-based interventions and complications of these interventions should be recorded to inform audit, appraisal and revalidation processes. When learning a new skill, cumulative sum control chart (CUSUM) analysis of success has been shown to be useful in the evaluation of ability and the need for supervision [12-14]. Even after training, a failure rate in excess of commonly accepted norms should cause the practitioner to seek advice and, if appropriate, remedial training.

Maintenance of skills

All manual skills need to be maintained, and it is recommended that after a break in the performance of an ultrasound-based intervention, the practitioner should be aware that their practical skills may have deteriorated. The individual has the responsibility to ensure that their skills are adequately maintained and should seek supervision where necessary. Having reached Level 1 competency, clinicians will need to maintain their ultrasound skills, minimising the time between successive examinations. The number of scans performed should be commensurate with their area and level of practice. It is recommended that CPD time is directed towards ultrasound, either through educational meetings, self audit, or case reviews with a mentor.

Clinical governance standards [15]

It is the responsibility of individual hospitals to establish clinical governance processes that will determine the experience and training appropriate for the unsupervised performance of ultrasound-based examinations or interventions. Practitioners should make themselves aware of these processes and should only practise within local clinical governance guidelines. It is recommended that within each department a designated consultant or permanent member of staff competent at Level 2 or 3 should oversee ultrasound training and be responsible for basic training and competency assessment. These activities should form part of their job plan, and time should be allocated within the job plan for the proper fulfilment of these duties.

3. Recommended essential ultrasound knowledge and skills

Basics of ultrasound

Basic components of an ultrasound machine.

Types of transducers and production of ultrasound with an emphasis on operator controlled variables.

Use of ultrasound controls – ‘knobology’.

An understanding of the frequencies used in medical ultrasound and the effect on image quality and penetration.

The interaction of ultrasound with tissue including biological effects.

Understanding of hyperechoic, hypo-echoic and anechoic and how it relates to tissues, structures and formation of the image.

Sonographic appearance of tissues, muscle, blood vessels, nerves, tendons, etc.

The safety of ultrasound and of ultrasound contrast agents.

The basic principles of real time and Doppler ultrasound including colour flow and power Doppler.

The recognition and explanation of common artefacts.

The storage and recording of still and video images, and integration with Picture Archiving and Communication Systems (PACS).

Administration

Image recording, storing and filing.

Reporting of images.

Medicolegal aspects – outlining the responsibility to practise within specific levels of competence and the requirement for training.

Understanding of sterility, health and safety, and machine cleaning.

Value and role of departmental and hospital protocols and guidelines.

Resource implication of ultrasound use.

Interpersonal and communications skills

Patient preparation and information.

Sensitive and effective communication with patient and family regarding ultrasound findings.

Explanation of findings and the complexities of ultrasound techniques in terms that the patient can understand.

Development of team leadership and management skills in developing and maintaining an ultrasound service.

Needling techniques

Understanding of terminology of planes of view, e.g. transverse, longitudinal.

Understanding of terminology of needle insertion: in-plane and out-of-plane.

Relationship of needle gauge, angle of insertion, depth and needle visibility.

Limitation of out-of-plane needle insertion with regard to visibility of needle tip.

Limitation of in-plane technique: beam width, parallelism.
The use and limitations of needle guides and ultrasound visible needles.
Knowledge of common causes of failure to see the needle during placement.

Practical

Demonstration of knowledge of equipment selection (probe) and settings.
Ergonomic position of patient and equipment.
Pre-scan technique or understanding of benefits.
Correct application of gel and probe contact with skin.
Applications of probe cover, sheath or condom.
Correct orientation of probe with screen image.
Successful identification of the target within phantom or patient.
Adjustment of resolution to improve image of structures.
Correct use of depth and sector width controls to optimise structures being observed.
Understanding of how to adjust the gain to optimise image quality and consistency.
Demonstration of knowledge of the relevance of the angle of insonation to visibility of relevant structures (anisotropy).
Correct use of focus or multiple focal zones to optimise image.
Use of Doppler, including continuous wave and pulsed wave Doppler.
Demonstration of the understanding of the longitudinal (long axis) and transverse (short axis) planes of view.
Ability to store images.
Cleaning the probe and machine before storing or use on another patient.

Needling

Demonstration of understanding of the term 'in-plane' approach by placing needle under the long axis of the ultrasound probe.
Demonstration of understanding of the term 'out-of-plane' approach by placing needle at 90 to the long axis of the ultrasound probe.
Precise control of the probe and needle with minimal unintentional movement.
Demonstration of techniques to maximise the visibility of the needle, parallelism, rotation, tissue movement and hydro-dissection.
Positioning of the needle within a vascular structure using both in-plane and out-of-plane technique in a phantom or clinical situation.
Demonstration of correct and appropriate spread of fluid or local anaesthetic around a nerve in either a phantom model or clinical situation.

Following completion of basic theoretical and practical training, some form of assessment of knowledge and practical skills should be completed. This can be achieved by either multiple-choice questions (MCQs) for the theoretical knowledge and formal Direct Observation of Procedural Skills (DOPS) or other 'in house' (individual hospital) assessment. In any case, some form of documentation should be filed within an individual's appraisal record or logbook. In an ideal situation, this

initial assessment of practical skills should be performed on a phantom or model, but clinical needs will dictate whether this is the case or if the initial assessment should be done in a clinical situation. The following table of competencies, and all others provided in this document, should be assessed using some form of assessment such as DOPS. The current RCoA DOPS form is provided in Appendix 1.

Basic ultrasound competencies

1	Demonstration of knowledge of the equipment and probe selection
2	Ergonomic positioning of self, patient, ultrasound machine and equipment
3	Correct use of gel and probe contact
4	Application of probe cover, sheath or condom to protect probe from contamination
5	Correct orientation of probe with screen image
6	Ergonomic probe handling and movement
7	Successful identification of target structure within phantom, model or patient
8	Adjustment of resolution to improve image of structures being imaged
9	Correct use of depth control to optimise structures being visualised
10	Understanding of how to adjust the gain to optimise image quality and consistency
11	Demonstration of knowledge of the relevance of the angle of insonation to visibility of relevant structures (anisotropy)
12	Correct use of focus or multiple focal zones to optimise image
13	Demonstration of use of Doppler for identification of vessels and the use of M mode, continuous wave Doppler and pulsed wave Doppler where appropriate
13	Demonstration of the understanding of the longitudinal (long axis) and transverse (short axis) planes of view
14	Demonstration of understanding of the term 'in-plane' approach by placing needle under the long axis of the ultrasound probe
15	Demonstration of understanding of the term 'out-of-plane' approach by placing the needle under middle of the probe at right angles to the long axis of the probe
16	Precise control of the probe and needle with minimal unintentional movement
17	Ability to save and store images transfer to PACS or transfer to encrypted memory stick
18	Cleaning of probe and machine after use to minimise transfer of infection; storage of probe and machine to minimise damage

4. Regional anaesthesia and pain medicine

Over the last five years, ultrasound has revitalised and rejuvenated interest in regional anaesthesia amongst anaesthetists in general and trainees in particular. The availability of portable, high-resolution machines driven by NICE guidance on the insertion of central venous catheters [1] has made it possible for most anaesthetists to have easy access to a machine. Ultrasound allows direct observation of target nerves and their surrounding structures, recognition of anatomical variance, real-time guidance of the needle and direct observation of the spread of local anaesthetic around the nerve. This is something that established techniques (peripheral nerve stimulation or paraesthesia) cannot achieve, and improved success rates, decreased volumes of local anaesthetic solutions, decreased incidence of side effects and improved patient comfort have all been demonstrated when using ultrasound.

Ultrasound-guided regional anaesthesia (UGRA) as a technique is rapidly gaining momentum as shown by the increasing numbers of publications and advertised workshops. A recent NICE interventional procedure guidance [3] supports the use of ultrasound guidance in regional anaesthesia, stating “that clinicians wishing to perform this procedure should be experienced in regional nerve blocks and trained in ultrasound guided techniques”. This has been supported by American Society of Regional Anesthesia and Pain Medicine (ASRA) and the European Society of Regional Anaesthesia and Pain Therapy (ESRA) Joint Committee recommendations for education and training in ultrasound guided regional anaesthesia [16]. NICE has also produced guidance on the use of ultrasound and epidural catheterisation [2]. The natural progression from regional anaesthesia to pain medicine has seen the growing popularity of the use of ultrasound in modern pain management [17-19].

Ultimately, it will be up to practitioners themselves to satisfy not only clinical governance directives but also the rigours of appraisal and revalidation. This will almost certainly require the keeping of logbooks and competency curves. As time passes, more people will have completed their ultrasound training as part of basic anaesthetic training and the prospect of a more robust certification process can be realised as part of accreditation.

Curriculum for regional anaesthesia

Basic knowledge and skills

See pages 12-15.

Practice

Level 1 practice

- Superficial cervical plexus block
- Interscalene brachial plexus block
- Supraclavicular block
- Infraclavicular block
- Suprascapular block
- Axillary brachial plexus block
- Blockade of the terminal peripheral nerves of the arm
- Rectus sheath block
- Ilio-inguinal / iliohypogastric block
- Transversus abdominis plane (TAP) block
- Fascia iliaca block
- Femoral nerve block
- Obturator nerve block
- Saphenous nerve block
- Lateral cutaneous nerve of thigh block
- Sciatic (trans-gluteal, sub-gluteal, anterior or mid-thigh) nerve block
- Popliteal sciatic nerve block
- Ankle block
- Blockade of the terminal peripheral nerves of the leg
- Epidural – assessment of spinal level, epidural depth and direction
- Caudal
- Catheter techniques

Level 2 practice

- Lumbar plexus block
- Deep cervical plexus block (cervical nerve root)
- Paravertebral block / intercostal nerve block
- Real-time ultrasound-guided epidural puncture and spinal anaesthesia

Anatomy

Level 1 anatomy

Detailed knowledge of relevant sectional anatomy:

- Brachial plexus
- Lumbosacral plexus
- Terminal peripheral nerves of the arm and hand

Terminal peripheral nerves of the abdomen
Terminal peripheral nerves of the leg and foot

Level 2 anatomy

Additional knowledge of sectional anatomy:

Brachial plexus

Interscalene region
Supraclavicular region
Axillary region

Lumbosacral plexus

Posterior abdominal wall, lumbar plexus and psoas muscle
Femoral triangle and anterior thigh, including obturator nerve and saphenous nerve
Buttock and upper thigh
Popliteal fossa
Ankle and foot

Chest and anterior abdominal wall

Rib and intercostal space
Anterior abdominal wall: rectus sheath; internal and external oblique; and transversus abdominis
Inguinal region

Spine

Cervical spine, facet joints, cervical roots
Thoracic spine, facet joints and paravertebral space
Lumbar spine, facet joints, spinous process, interspinous space and intralaminar space
Cervical, thoracic, lumbar and caudal epidural space
Sacrum and sacral hiatus

Pathology

Regional anaesthesia is primarily the practical performance of standard techniques with the sole purpose of anaesthesia and analgesia for surgery and postoperative pain control. Specific associated pathologies, e.g. venous thrombosis and thyroid cysts, are not deliberately sought but may be noticed or detected by some clinicians.

Level 1 pathology

Understanding of the common anatomical variations of the brachial and lumbosacral plexuses.

Level 2 pathology

Knowledge of the common associated pathologies that may be seen with respect to peripheral nerves and the surrounding structures.

Pain

Specific and additional knowledge will be needed for the practice of pain medicine.

Competencies

The technical skills needed to perform any form of UGRA and pain medicine technique are the same independent of the overall level of training. The ability to see the nerve, control needle passage and observe the needle/nerve interface whilst injecting local anaesthetic are core to performing any block. The level of training is dependent on the technique used: some of these are easily learned with few complications (Level 1: axillary); others require improved scanning skills and knowledge (Level 2: paravertebral). The individual levels are arbitrary distinctions between those that will be required for CCT and those that can be achieved within a comprehensive training programme, and the distinctions should be viewed as guidance only. Level 1 training is deliberately minimalistic so that all trainees can achieve this level of training irrespective of the hospitals visited within their rotations.

Level 1 competencies

Patient

- Performance of gentle ultrasound examinations, provide appropriate sedation.
- Demonstration of proper patient selection.
- Use of appropriate monitoring to Association of Anaesthetists of Great Britain & Ireland (AAGBI) standards.
- Demonstration of proper nerve location techniques.
- Performance of effective and safe nerve block techniques.

Ultrasound knowledge

- Understanding of general principles of ultrasound physics.
- Understanding of benefits and limitations of UGRA techniques.
- Understanding of the differences between in-plane and out-of-plane needling techniques and their indications and limitations
- Understanding of key artefacts and pitfalls of UGRA.
- Development of an intimate knowledge of the 2D ultrasound anatomy of the major neurovascular structures of the upper and lower extremities.
- Understanding of common anatomical variations associated with the neurovascular and musculoskeletal structures of the upper and lower extremities.
- Understanding of the clinical applications and uses of colour Doppler in UGRA.
- Understanding of and be able to use ultrasound equipment.
- Demonstration of knowledge of sterility, infection control and equipment cleaning.
- Establishment of familiarity with the scientific literature pertaining to UGRA.
- Demonstration of knowledge and learning of commonly used UGRA techniques.

Interpersonal and communications skills

Sensitive and effective communication with patients and families.

Providing explanation of the procedure in terms that the patient can understand, outlining the benefits, risks and complications.

Demonstration of effective communication with anaesthetic colleagues, operating departmental practitioners (ODPs) and supporting nursing and ancillary staff.

Level 2

Professionalism and learning

Development of the skill to manage a regional anaesthetic service effectively.

Understanding of the costs relating to ultrasound regional anaesthetic service.

Remaining open to constructive criticism.

Awareness of the increasing literature relating to UGRA and its value.

Partaking in research and audit of UGRA practice.

Assessment checklist – regional anaesthesia

Demonstration of appropriate attitude and professional manner
Explanation of procedure, risks and complications to patient as appropriate
Checking patient's details and entering them into record and machine as appropriate
Confirmation of indication and checking of any supportive imaging
Positioning of patient and machine ergonomically
Selection of appropriate probe and optimisation of machine settings
Identification of nerve or plexus using a preliminary scan
Optimisation of the image by adjustment of gain, depth and focus
Demonstration of good needling technique with maintenance of the needle tip within the scan plane at all times
Confirmation of position of needle with respect to nerve
Identification of spread of local anaesthetic perineurally, NOT intravascular
Demonstration of spread of local anaesthetic around the nerve or nerves
Performance of technique safely and effectively
Attention to sterility with respect to procedure, patient and machine
Adequate documentation and storage of images and scans as appropriate
Provision of information to patient and reporting of findings where appropriate
Identification of whether a further scan or alternative imaging is indicated
Cleaning of equipment and storage to minimise damage

5. Vascular procedures

The use of ultrasound to guide vascular access is associated with a higher first-pass success and a reduced rate of complications. This led NICE to recommend that ultrasound guidance be the preferred method for insertion of central venous catheters (CVC) into the internal jugular vein and that ultrasound should be considered in most clinical circumstance where CVC insertion is necessary, either electively or in an emergency [1]. Following this guidance, the use of ultrasound to guide CVC placement has increased markedly in recent years as clinicians have realised its benefits in terms of ensuring the success of placement while minimising the risk of complications [20]. Many experienced clinicians now use ultrasound successfully to guide all CVC placements regardless of site or urgency such that it is becoming a standard of care. However, the safe use of ultrasound to guide CVC placement requires appropriate training and experience to achieve competence.

Some clinicians limit the use of ultrasound to confirm anatomy while they continue to perform a standard landmark technique when inserting the CVC. This approach is not recommended, as it does not allow the full benefits of ultrasound guidance to be realised. It is recommended that when ultrasound is used to assist CVC placement, it should be used to guide needle placement into the vein in real time.

There is a number of other areas of practice relevant to anaesthesia and intensive care in which vascular ultrasound may have a useful clinical role. These include the use of ultrasound to diagnose venous thrombosis, dynamic imaging of the inferior vena cava to assess circulating volume status and specialist applications such as transcranial Doppler. These are considered advanced areas of practice within anaesthesia and intensive care medicine in which clinicians with a special interest in ultrasound may wish to gain the necessary competencies.

Curriculum for vascular procedures

Basic knowledge and skills

See pages 12-15.

Practice

Level 1 practice

- Cannulation of internal jugular vein
- Cannulation of femoral vessels: vein and artery
- Cannulation of peripheral veins and arteries
- Insertion of peripheral inserted central catheter

Level 2 practice

- Cannulation of axillary and subclavian vein
- Assessment and diagnosis of venous thrombosis (upper and lower limb)
- Assessment of volume status from dynamic ultrasound imaging of inferior vena cava (see section on abdominal ultrasound)

Level 3 practice

- Specialist vascular examinations, e.g. transcranial Doppler, renal artery Doppler

Anatomy

Level 1 anatomy

Vascular access

- Cross-sectional and ultrasonographic anatomy of:
 - Neck (carotid artery and jugular vein)
 - Femoral vessels
 - Upper limb vessels
 - Common anatomical variations

Level 2 anatomy

- Axillary and subclavian vessels

Venous thrombosis

- Vascular sectional and ultrasound anatomy of the arms and legs including common anatomical variants

Pathology

Level 1 pathology

- Recognition of thrombosis and haematoma in major vessels, e.g. internal jugular and femoral veins.

Level 2 pathology

Ultrasonic appearance of peripheral venous thrombosis.

Competencies

Level 1 competencies

Identification of vein and artery in transverse and longitudinal scan.
Differentiation of the appearance of arteries and veins with 2D ultrasound.
Use of colour flow Doppler.
Identification of common anatomical variations.
Preparation of equipment to maintain sterility during ultrasound-guided cannulation.
Undertaking of ultrasound-guided cannulation in real time maintaining sterility.
Identification of needle tip with transverse and longitudinal views.
Identification of guide wire within vessel.
Insertion of appropriate sized cannula into vessel to correct length and secure fixation.

Level 2 competencies

Identification of deep veins in leg: common femoral, femoral and popliteal veins.
Assessment of lumen of veins in terms of diameter, echogenicity and compressibility.
Use of continuous wave Doppler to demonstrate arterial and venous waveforms.
Use of colour flow and pulsed wave Doppler to demonstrate patency of flow with phasic variation with respiration and augmentation of flow following distal compression.
Sequential scanning to demonstrate patency of common femoral, femoral into lower thigh and popliteal veins.
Identification of common pathology: venous thrombosis, haematoma.
Identification and assessment of external iliac veins.
Identification and assessment of upper limb veins.

Assessment checklist – vascular procedures

Demonstration of appropriate attitude and professional manner
Explanation of procedure, risks and complications to patient as appropriate
Checking patient's details/entry into machine as appropriate
Confirmation of indication and checking of any supportive imaging
Positioning of patient and machine ergonomically
Selection of appropriate probe and optimisation of machine settings
Identification of the vein and artery in transverse and longitudinal scan
Confirmation of patency and absence of thrombus or haematoma by compression, Doppler
Undertaking of ultrasound guided cannulation in real time maintaining sterility
Identification of needle tip using in-plane or out-of-plane technique
Identification of guide wire within vein
Insertion of appropriate sized cannula into vessel to correct length and secure
Performance of technique safely and effectively
Attention to sterility with respect to procedure, patient and machine
Adequate documentation and storage of images and scans as appropriate
Provision of information to patient and reporting of findings where appropriate
Identification of whether a further scan or alternative imaging is indicated
Cleaning of equipment and storage to minimise damage

6. Thoracic ultrasound

The use of point of care ultrasound for assessing and treating thoracic pathology in the intensive care environment has increased significantly in the last decade. Not only can it answer queries arising from standard chest radiographs, e.g. distinguishing effusion from consolidation from collapse, it can also be used to make primary diagnoses such as pneumothorax and pulmonary oedema or the interstitial syndrome. As well as a diagnostic tool, ultrasound is increasingly used to guide invasive procedures relating to the thorax, namely diagnostic thoracocentesis, chest drain insertion, pleural biopsy and percutaneous tracheostomy [21]. There is now an increased focus on the use of ultrasound to guide chest drain insertion for pleural fluid as a result of a rapid response report by the National Patient Safety Agency in 2008 [22], with subsequent guidelines issued by the British Thoracic Society [23-27].

As a technique, thoracic ultrasound is relatively straightforward to perform. However, it fosters a large number of acoustic artefacts. Some of these can aid and some can hinder diagnosis. Appropriate training is therefore mandatory in order to avoid serious interpretation errors. Level 1 training in thoracic ultrasound is not mandatory for the CCT in Anaesthetics and is not part of the RCoA curriculum.

Curriculum for thoracic ultrasound

Basic knowledge and skills

See pages 12–15.

Practice

Level 1 practice

- Systematic examination of the normal thorax
- Assessment and diagnosis of pleural effusions
- Ultrasound guided thoracocentesis and chest drain insertion
- Use of ultrasound to diagnose pneumothorax

Level 2 practice

- Assessment and diagnosis of pleural pathology
- Assessment and diagnosis of lung pathology
- Assessment of diaphragmatic function
- Ultrasound guided pleural and lung biopsy
- Ultrasound guided percutaneous tracheostomy and cricthyroidotomy
- Identification of the cricoid cartilage and extrathoracic tracheal rings
- Knowledge of the appearance of normal thyroid versus goitre and Doppler assessment of vascularity

Anatomy

Level 1 anatomy

Detailed knowledge of relevant sectional anatomy

- Right and left hemidiaphragm
- Chest wall layers
- Ribs and intercostal spaces
- Surface anatomy of pleural reflections
- Heart
- Liver, spleen and kidneys
- Thyroid

Level 2 anatomy

Additional knowledge of sectional anatomy

- Supraclavicular region
- Anterior and superior mediastinum
- Laryngeal cartilages and extrathoracic trachea
- Thyroid

Pathology

Level 1 pathology

- Pleural effusion
- Pleural thickening
- Pneumothorax
- Consolidated lung
- Atelectasis

Level 2 pathology

- Interstitial thickening
- Pulmonary mass/abscess
- Paralysed diaphragm
- Mediastinal and pleural masses
- Multinodular goitre

Competencies

Level 1 competencies

Performance of systematic examination of thorax identifying normal structures including diaphragm, liver and spleen.

Identification of ultrasound appearances of normal aerated lung including:

- Diaphragmatic movement
- Pleural line and gliding sign
- Normal aerated lung (including A-lines and B-lines artefacts).

Recognition of pleural fluid:

- Appearances suggesting transudate, exudate and loculation
- Assessment of size of effusion
- Differentiation between pleural thickening and effusion
- Distinguishing small or loculated pleural fluid from pleural thickening.

Recognition of consolidated lung:

- Distinguishing atelectasis from consolidation: with and without air bronchograms
- Recognition of signs of pneumothorax including lung point sign and appearance on M-mode.

Recognition of heart, liver and spleen.

Performance of ultrasound-guided (direct and indirect) thoracocentesis.

Performance of ultrasound-guided chest drain insertion and identification of when to use a direct or indirect approach.

Level 2 competencies

Differentiation between consolidated lung, abscess and pulmonary mass.

Differentiation of types of pleural thickening, e.g. pleural masses and plaques.

Use of colour/power Doppler to help distinguish between pleural and lung pathologies.

Familiarity with the altered artefact patterns seen with pulmonary oedema and interstitial syndrome.

Identification of the cricoid cartilage and extrathoracic tracheal rings.

Knowledge of the appearance of normal thyroid versus goitre and Doppler assessment of vascularity.

Performance of ultrasound-guided percutaneous tracheostomy or cricothyrotomy.

Assessment checklist – thoracic ultrasound

Demonstration of appropriate attitude and professional manner
Explanation of procedure, risks and complications to patient as appropriate
Checking patient's details/entry into machine as appropriate
Confirmation of indication and check any supportive imaging
Positioning of patient and machine ergonomically
Selection of appropriate probe and optimisation of machine settings
Correct identification of normal lung, pleural line and movement
Demonstration of pleural sliding in 2D and M mode
Identification of normal diaphragm, liver and spleen
Identification of pleural effusion
Differentiation of pleural effusion from intra-abdominal fluid (ascites)
Description of appearances of transudate and exudate
Demonstration of how volume of effusion may be estimated
Use of ultrasound to identify appropriate site for drainage of effusion
Demonstration of ultrasound guided thoracentesis
Identification of consolidation
Identification of atelectasis
Recognition of signs of pneumothorax including lung point sign, appearance in M mode
Demonstration of ultrasound guided chest drain insertion
Performance of technique safely and effectively
Attention to sterility with respect to procedure, patient and machine
Adequate documentation and storage of images and scans as appropriate
Informing patient and reporting findings where appropriate
Identification of whether a further scan or alternative imaging is indicated
Cleaning of equipment and storage to minimise damage

7. Abdominal ultrasound

The ability to detect free intraperitoneal fluid, assess the aortic diameter, assess the inferior vena cava (IVC), and measure bladder volume is extremely valuable. The finding of free fluid may have significance for patient management, especially following trauma. The purpose of ultrasound in the initial assessment of abdominal trauma is solely to document the presence of free intra-peritoneal fluid. In the context of abdominal trauma this is assumed to be blood. There is no attempt to identify specific organ injuries as ultrasound is not accurate in the early assessment of solid or hollow viscus injury. When abdominal scanning techniques are combined with basic cardiac scanning, the combination is known as ACES (Abdominal and Cardiac Evaluation with Sonography in shock). Fluid assessment is also known as FAST (Focused Assessment with Sonography in Trauma) if in a trauma setting. If one adds assessment of the upper pleura for pneumothorax, this is known as EFAST (Extended FAST) [28,29]. Level 1 training in abdominal ultrasound is not mandatory for a CCT in Anaesthetics and is not part of the RCoA curriculum.

Curriculum for abdominal ultrasound

Basic knowledge and skills

See pages 12–15.

Practice

Level 1 practice

- Detection of free intraperitoneal fluid
- Assessment of the abdominal aorta
- Assessment of the IVC including filling pressures
- Bladder volume assessment

Level 2 practice

- Assessment of the gall bladder
- Assessment of the kidneys

Level 3 practice

- Comprehensive abdominal scanning

Anatomy

Level 1 anatomy

- Aorta and IVC
- Liver
- Morrison pouch and right costophrenic pleural recess / splenorenal recess and left costophrenic pleural recess
- Rectovesical, vesico-uterine and recto-uterine pouches
- Bladder

Level 2 anatomy

- Kidney
- Liver (detailed)
- Spleen

Pathology

Level 1 pathology

- Intraperitoneal and pleural fluid
- Aortic aneurysm and rupture
- IVC collapse greater than 50%
- Pneumothorax

Level 2 pathology

Biliary disease including common bile duct obstruction, gallstones, gallbladder wall thickening and oedema, common bile duct dilatation. Mesenteric ischaemia.
Renal parenchymal disease, hydronephrosis, renal stones, renal tract obstruction.

Competencies

Level 1 competencies

Recognition of what is normal and abnormal in standard abdominal views.
Identification of the aorta and IVC in transverse and longitudinal sections.
Recognition of the main features of the aorta, and know how to measure it, i.e. antero-posterior diameter, outer anterior to outer posterior layer, distinction from the IVC.
Ability to carry out scanning in three planes.
Ability to use the machine to determine bladder volume.
Recognition of a catheter balloon within the bladder.
Knowledge of when to repeat the scan, and the value of repeat scans.

Level 2 competencies

Ability to assess the kidneys and recognise hydronephrosis.
Knowledge of how to image the gall bladder and measure wall thickness.
Assessment of the common bile duct for dilatation.
Assessment of the superior mesenteric artery for patency and flow.
Application of these findings to the clinical context appropriately.

Assessment checklist – abdominal ultrasound

Demonstration of appropriate attitude and professional manner
Explanation of procedure, risks and complications to patient as appropriate
Checking patient's details/entry into machine as appropriate
Confirmation of indication and checking any supportive imaging
Positioning of patient and machine ergonomically
Selection of appropriate probe and optimising machine settings: gain, depth and focus
Demonstration of Morrison's pouch and right costo-phrenic pleural recess
Demonstration of the spleno-renal interface and left costo-phrenic pleural recess
Identification of the bladder
Demonstration of potential fluid in the pelvis
Demonstration of pericardial views and cardiac motion
Application of examination in an Advanced Life Support (ALS) setting
Demonstration of the pleural space and can identify fluid
Performance of technique safely and effectively
Attention to sterility with respect to procedure, patient and machine
Adequate documentation and storage of images and scans as appropriate
Informing patient and reporting of findings where appropriate
Identification of whether a further scan or alternative imaging is indicated
Cleaning of equipment and storage to minimise damage

8. Echocardiography

The application of echocardiography (transthoracic and transoesophageal echocardiography – TTE and TOE) in the critical care arena has been well recognised for some time, expanding beyond cardiothoracic critical care to include diagnosis and monitoring on the general intensive care unit (ICU) [30]. When dealing with critically ill patients, two clinical scenarios need to be considered, which may be regarded as corresponding to Level 1 and Level 2 proficiency.

Level 1

In the peri-resuscitation setting, relatively simple information obtained using TTE may profoundly affect patient management. Here, a basic focused scan may be appropriate, which when performed during active resuscitation must be strictly ALS-compliant [31]. There is accumulating evidence in the literature that this can be achieved with appropriate training of novice practitioners [32, 33]. Several courses exist to train the novice practitioner to this level, including FEEL-UK, which is endorsed by the British Society of Echocardiography (BSE) and supported by the Resuscitation Council (UK) [34, 35]. Beyond peri-resuscitation echocardiography, the requirements for practitioners in different specialties begin to diverge. Practitioners already proficient in peri-resuscitation echocardiography may wish to develop their skills for use in trauma, emergency medicine or critical care, depending upon their base specialty [36], may do additional training to achieve accreditation in echocardiography (Level 2 – see below). For these and others keen to extend their skills, courses and training programmes such as FAST, FATE (Focused Assessment by Transthoracic Echo), CAUSE (Cardiac Arrest Ultra-Sound Examination) and FUSE (Focused Ultrasound and Echocardiography) provide a framework within which to achieve this in the UK [37- 40].

Level 2

As defined elsewhere, Level 2 training includes the ability to perform the complete range of echocardiographic examinations, recognise almost all cardiac pathology and to use echocardiography to guide interventional procedures. In the critically ill patient, Level 2 echocardiography can provide information about cardiac function and the causes of inadequate cardiac output, guide therapeutic interventions and monitor the effects of any treatment instigated [41- 43]. This may be focused or comprehensive, and require TTE or TOE depending upon the clinical question being asked. This level of practice is equivalent to accreditation in echocardiography, i.e. the most basic level at which a practitioner is judged to be capable of independent practice [35]. Echocardiography training is not mandatory for a CCT in Anaesthetics or General Internal Medicine, and is not part of the RCoA or Royal College of Physicians (RCP) curriculum.

Curriculum for echocardiography

Basic knowledge and skills

See pages 12-15.

Practice

Level 1 practice

Performance of a basic echocardiography examination of a normal heart.

Assessment and diagnosis of significant cardiac pathology including severe left ventricular dysfunction, right ventricular dysfunction (massive pulmonary embolus), pericardial effusion and tamponade, and hypovolaemia.

Performance of an ALS compliant examination when indicated.

Level 2 practice

Performance of focused or comprehensive echocardiography examinations in all relevant situations (emergency care, peri-operative and intensive care, high dependency unit and coronary care unit) as appropriate for the patient and clinical scenario.

Recognition of almost all cardiac pathologies.

Use of echocardiography to guide interventional procedures and monitor and assess the effects of interventions and therapies.

Anatomy

Level 1 anatomy

Basic anatomy of the heart, coronary arteries and great vessels.

Coronary anatomy and correlation with myocardial territories supplied (2D views).

Left and right ventricular anatomy and correlation with 2D views.

Basic heart valve anatomy and correlation with 2D views.

IVC anatomy and correlation with 2D views.

Normal changes in IVC dimensions in response to spontaneous respiration and ventilation.

Basic anatomy of the pericardium and normal pericardial space, including differentiation from pleural space.

Pathology

Level 1 pathology

Dilated left ventricle

Grossly underfilled left ventricle

Significantly impaired left ventricular systolic function

Severe wall motion abnormalities

Significant right ventricular dilatation
Features of pulmonary hypertension and massive acute pulmonary embolism
Features of significant hypovolaemia
Fixed, dilated IVC and its causes
Differentiation of pericardial collection and tamponade

Competencies

Level 1 competencies

Demonstration of the four basic echocardiography scan planes:

- Parasternal long axis view
- Parasternal short axis view including aortic valve, mitral valve and papillary muscles
- Apical 4-chamber view
- Subcostal view

Recognition of normal cardiac structures and important landmarks in all four scan plane: left atrium, right atrium, inter-atrial septum, left ventricle, right ventricle, inter-ventricular septum, aortic valve, ascending aorta, mitral valve, tricuspid valve, inferior vena cava, descending aorta, pericardium.

Understanding of and performance of measurements of global systolic function: eyeballing, MAPSE (mitral annular plane systolic excursion), TAPSE (tricuspid annular plane systolic excursion), fractional shortening and ejection fraction using Simpson's rule.

Recognition of a dilated left ventricle.

Recognition of a severely underfilled left ventricle, and differentiate from severe left ventricular hypertrophy.

Differentiation of normal from significantly impaired left ventricular systolic function and severe wall motion abnormalities.

Differentiation of normal from significantly impaired left ventricular systolic function.

Recognition of features of pulmonary hypertension.

Recognition of a significantly dilated right ventricle.

Recognition of significant right ventricular dysfunction.

Recognition of features of acute, massive pulmonary embolism.

Recognition of features of pulmonary hypertension.

Recognition of features of significant hypovolaemia.

Recognition of a fixed, dilated IVC.

Identification of a pericardial collection.

Differentiation of between pleural and pericardial collection.

Identification of right ventricular diastolic collapse.

Identification of swinging heart.

Technique of pericardiocentesis, including echo-guidance.
Ability to differentiate asystole from fine ventricular fibrillation.
Ability to differentiate pulseless electrical activity (PEA) from pseudo-PEA.

ALS peri-resuscitation competencies

Knowledge of current ALS algorithm and when to apply FEEL.
Ability to follow the steps required to perform FEEL during cardiopulmonary resuscitation in an ALS complaint manner.
Ability to follow the steps required if an inadequate echocardiography window is not obtained.
Ability to obtain cardiac images within 10 s.
Ability to interpret images in the context of a cardiac arrest scenario.
Ability to communicate findings clearly to resuscitation team leader.

Assessment checklist – echocardiography

Demonstration of appropriate attitude and professional manner
Explanation of procedure, risks and complications to patient as appropriate
Checking patient's details/entry into record as appropriate
Confirmation of indication and check any supportive imaging
Positioning of patient and machine ergonomically
Selection of appropriate probe and optimising machine settings
Demonstration of all four standard views:
• Parasternal long axis
• Parasternal short axis
• Apical four chamber
• Sub-costal
Recognition of normal cardiac structures and landmarks in all four major scan planes
Left ventricle – recognition of dilated or grossly under filled left ventricle and normal from significantly impaired function
Right ventricle – recognition of significant right ventricular dilatation and features of acute pulmonary hypertension
Inferior vena cava (IVC) – recognition of signs of significant hypovolaemia and detection of a fixed dilated IVC
Pericardium – recognition of a pericardial collection, distinguishing this from pleural effusion, recognition of right ventricular collapse and a 'swinging heart'
Performance of trans-thoracic ECHO in compliance with an ALS-algorithm
Performance of technique safely and effectively
Attention to sterility with respect to procedure, patient and machine
Adequate documentation and storage of images and scans as appropriate
Informing patient and reporting findings where appropriate
Identification of whether a further scan or alternative imaging is indicated
Cleaning of equipment and storage to minimise damage

Level 2 accreditation

A proportion of trainees may wish to extend their echocardiographic skills further to be competent to perform a comprehensive or focused study either on the ICU, or during general anaesthesia of the high-risk patient. Before 2010 the only accredited examination for transthoracic echocardiography in the UK was the 'Accreditation in Adult Echocardiography', administered and awarded by the BSE and for transoesophageal echocardiography, the 'ACTA/BSE TOE accreditation'. However, the BSE has been working together with key stakeholders and has now introduced an accreditation specifically for critical care. The development of this accreditation is analogous to those that were developed for cardiothoracic anaesthetists wishing to obtain TOE accreditation. As with other areas outlined in this document, Level 2 practice in echocardiography is likely to require a period of additional training and experience beyond that obtained during normal postgraduate specialist training [44].

9. References

1. National Institute for Health and Clinical Excellence. Guidance on the use of ultrasound locating devices for placing central venous catheters. http://www.nice.org.uk/nicemedia/pdf/Ultrasound_49_GUIDANCE.pdf (accessed 17/11/10).
2. National Institute for Health and Clinical Excellence IPG 249 Ultrasound guided catheterisation of the epidural space: Full guidance. <http://guidance.nice.org.uk/IPG249/Guidance/pdf/English> (accessed 17/11/10).
3. National Institute for Health and Clinical Excellence. IPG 285 Ultrasound-guide regional nerve block: guidance. <http://guidance.nice.org.uk/IPG285/NICEGuidance/pdf/English> (accessed 17/11/10).
4. Huang SJ, McLean AS. Do we need a critical care ultrasound certification program? Implications from an Australian medical-legal perspective. *Critical Care* 2010; **14**: 313.
5. Sites BD, Gallagher JD, Cravero J, Lundberg J, Bilke GT. The learning curve associated with a simulated ultrasound – guided interventional task by inexperienced anesthesia residents. *Regional Anesthesia and Pain Medicine* 2004; **29**: 544-8.
6. Sites BD, Spence BC, Gallagher JD, Wiley CW, Bertrand ML, Bilke GT. Characterizing novice behaviour associated with learning ultrasound-guided peripheral regional anesthesia. *Regional Anesthesia and Pain Medicine* 2007; **32**: 107-15.
7. Royal College of Radiologists. Ultrasound Training Recommendations for Medical and Surgical Specialties <http://www.rcr.ac.uk/publications.aspx?PageID=310&PublicationID=209> (accessed 17/11/10).
8. The European Federation of Societies for Ultrasound in Medicine and Biology. Guidelines and Recommendations. Minimal training for practice of medical ultrasound in Europe 2006. <http://www.efsumb.org/guidelines/guidelines01.asp>.
9. The College of Emergency Medicine. Medical Training Initiative. <http://www.collemergencymed.ac.uk/Training-Exams/Medical%20Training%20Initiative/default.asp> accessed 17/11/10).
10. Consortium for the Accreditation of Sonographic Education. Consortium for the Accreditation of Sonographic Education (CASE). <http://www.case-uk.org> (accessed 17/11/10).
11. Medical Specialty Training (England). The Gold Guide. <http://www.mmc.nhs.uk/pdf/Gold%20Guide%20--2009.pdf> (accessed 17/11/10).
12. De Oliveria Filho GR. The construction of learning curves for basic skills in anaesthetic procedures: an application for the cumulative sum method. *Anesthesia and Analgesia* 2002; **95**(2): 411-6.
13. De Oliveria Filho GR, Helayel PE, da Concelcao DB, Garzel IS, Pavel P, Ceccon MS. Learning curves and mathematical models for interventional ultrasound basic skills. *Anesthesia and Analgesia* 2008; **106**: 568-73.
14. Ali D, Rhodes S. Cusum Charts: A tool for assessing competency. *Anaesthesia* 2009; **64**: 1385-6.

15. The British Medical Ultrasound Society. Ultrasound Clinical Governance. www.bmus.org/policies-guides/ClinicalGovernanceInUltrasound-061108.pdf (accessed 17/11/10).
16. Sites BD, Chan VW, Neal JM, et al. The American Society of Regional Anesthesia and Pain Medicine and the European Society of Regional Anaesthesia and Pain Therapy joint committee recommendations for education and training in ultrasound-guided regional anesthesia. *Regional Anesthesia and Pain Medicine* 2009; **34**: 40-6.
17. Curatolo M, Eichenberger U. Ultrasound-guided blocks for the treatment of chronic pain. *Techniques in Regional Anesthesia & Pain Management* 2007; **11**: 95-102.
18. Gofeld M. Ultrasonography in pain medicine: a critical review. *Pain Practitioner* 2008; **8**: 226-40.
19. Peng PWH, Narouze S. Ultrasound-guided interventional procedures in pain medicine: a review of anatomy, sonoanatomy and procedures. *Regional Anesthesia and Pain Medicine* 2009; **34**: 458-78.
20. Karakistos D, Labropoulous N, De Groot E, et al. Real-time ultrasound guided catheterization of the internal jugular vein: a prospective comparison with the landmark technique in critical care patients. *Critical Care* 2006; **10**: R162.
21. Lichtenstein A. Whole body Ultrasonography in the Critically Ill, 1st edition. Heidelberg: Springer, 2010: 99-209.
22. National Patient Safety Agency. Chest drains: risks associated with the insertion of chest drains. <http://www.npsa.nhs.uk/nrls/alerts-and-directives/rapidrr/risks-of-chest-drain-insertion> (accessed 17/11/10).
23. Havelock T, Teoh R, Laws D, Gleeson F. Pleural procedures and thoracic ultrasound: British Thoracic Society pleural disease guideline 2010. *Thorax* 2010; **65**: i61-76.
24. Bouhemad B, Zhang M, Lu Q, Rouby J-J. Clinical review: bedside ultrasound in critical care practice. *Critical Care* 2007; **11**: 205.
25. Koh D-M, Burke S, Davies N, Padley S. Transthoracic US of the chest: clinical uses and application. *Radiographics* 2002; **22**: e1.
26. Lichtenstein DA, Menu Y. A bedside ultrasound sign ruling out pneumothorax in the critically ill. Lung sliding. *Chest* 1995; **108**: 1345-8.
27. Lichtenstein D, Meziere G, Biderman P, Gepner A, Barre O. The comet-tail artifact: an ultrasound sign of alveolar-interstitial syndrome. *American Journal of Respiratory Critical Care Medicine*. 1997; **156**: 1640-1646.
28. Yoshii H, Sato M, Yamamoto S, et al. Usefulness and limitations of ultrasonography in the initial evaluation of blunt abdominal trauma. *Journal of Trauma* 1998; **45**: 45-50.
29. Branney SW, Wolfe RE, Moore FE, et al. Quantitative sensitivity of ultrasound in detecting free intraperitoneal fluid. *Journal of Trauma* 1995; **39**: 375-80.
30. Cholley BP, Viellard-Baron A, Mebazza A. Echocardiography in the ICU: time for widespread use! *Intensive Care Medicine* 2006; **32**: 9-10.
31. Resuscitation Council (UK). Resuscitation guidelines 2010 p67. <http://www.resus.org.uk/pages/guide.htm> (accessed 17/11/10).

32. Niendorff D, Rassias A, Palac R, et al. Rapid cardiac ultrasound of inpatients suffering PEA arrest performed by non expert sonographers. *Resuscitation* 2005; **67**: 81-7.
33. Breitskreutz R, Walcher F, Seegar F. Focused echocardiographic evaluation in resuscitation management: concept of an advanced life support-conformed algorithm. *Critical Care Medicine* 2007; **35**: S150-161.
34. Breitskreutz R, Uddin S, Steiger H, et al. Focused echocardiography entry level: new concept of a 1-day training course. *Minerva Anestesiologica* 2009; **75**: 285-92.
35. Price S, Ilper H, Uddin S, et al., Peri-resuscitation echocardiography: Training the novice practitioner. *Resuscitation* 2010; **81**: 1534-9.
36. Neri L, Storti E, Lichtenstein D. Toward an ultrasound curriculum for critical care medicine. *Critical Care Medicine* 2007; **35**: S290-304.
37. Rose JS. Ultrasound in abdominal trauma. *Emergency Medicine Clinics North America* 2004; **22**: 581-99, vii.
38. Jensen MB, Sloth E, Larsen KM, Schmidt MB. Transthoracic echocardiography for cardiopulmonary monitoring in intensive care. *European Journal of Anaesthesiology* 2004; **21**: 700-7.
39. Hernandez C, Shuler K, Hannan H, et al. C.A.U.S.E.: Cardiac arrest ultra-sound exam – a better approach to managing patients in primary non-arrhythmogenic cardiac arrest. *Resuscitation* 2008; **76**: 198-206.
40. Morris C, Bennett S, Burn S, Russell C, Jarman R, Swanevelde J. Echocardiography in the intensive care unit: current position, future directions. *Journal of Intensive Care Society* 2010; **11**: 90-7.
41. Orme RM, Oram MP, McKinstry CE. Impact of echocardiology on patient management in the intensive care unit: an audit of district general hospital practice. *British Journal of Anaesthesia* 2009; **102**: 340-4.
42. Price S, Via G, Sloth E, et al. Echocardiography practice, training and accreditation in the intensive care: document for the World Interactive Network Focused on Critical Ultrasound (WINFOCUS). *Cardiovascular Ultrasound* 2008; **6**: 49.
43. ACC/AHA ASE 2003 guideline update for the clinical application of echocardiography: summary article. *Circulation* 2003; **108**: 1146.
44. British Society of Echocardiography. Accreditation in Adult Critical Care. <http://www.bsecho.org/index.php?option=content&task=category§ionid=13&id=31&Itemid=57> chocardiography [Information Pack] (accessed 17/11/10).

Appendix 1 RCoA Direct Observation of Procedural Skills [DOPS] Assessment Form

Please complete the question using a cross (x). Please use black ink and CAPITAL LETTERS

Trainee's surname		
Trainee's forename(s)		
GMC number		GMC NUMBER MUST BE COMPLETED

Observation	
Code number	

Observed by		
GMC number		GMC NUMBER MUST BE COMPLETED
Date		

Assessment:

	Practice was satisfactory	Assessor's Signature
	Practice was unsatisfactory	Assessors Signature

If the performance was judged to be unsatisfactory, you must tick the boxes on the reverse of this form to indicate which areas of performance you judged to be unsatisfactory.

Example of good practice were:

Areas of practice requiring improvement were:

Further learning and experience should focus on:

If you have rated the performance unsatisfactory please indicate which elements were unsatisfactory:

Did not understand the indications and contraindications to the procedure.		
Did not properly explain the procedure to the patient.		
Does not understand the relevant anatomy.		
Failed to prepare properly for the procedure.		
Did not communicate appropriately with the patient or staff.		
Aseptic precautions were inadequate.		
Did not perform the technical aspects of the procedure correctly.		
Failed to adapt to unexpected problems in the procedure.		
Failed to demonstrate adequate skill and practical fluency.		
Was unable to properly complete the procedure.		
Did not properly complete relevant documentation.		
Did not issue clear post-procedure instructions to patient and/or staff.		
Did not maintain an appropriate professional demeanor.		





THE ASSOCIATION OF ANAESTHETISTS
of Great Britain & Ireland



**The Royal College of
Anaesthetists**

 **intensive care
society**
care when it matters