

SPECIAL SUPPLEMENT
Aspen Symposium
during ESICM 2018

Imaging

Imaging and intensive care medicine: an evolving partnership, *A. McLean*

Whole-body ultrasound in the intensive care unit: bedside ultrasound of the whole body, *A. Denault et al.*

Clinical assessment of critically ill patients by whole-body ultrasonography, *R. Wiersema et al.*

Using ultrasound to prevent diaphragm dysfunction, *T. Schepens & E.C. Goligher*

Imaging and ICU: advice from a radiologist, *M. Sánchez*

Abdominal point-of-care ultrasound in critical care: the secrets of the abdomen, *J. Wilkinson et al.*

Multimodal neuromonitoring catheter insertion: secondary complications, *I. González & D. Santamarta*

Required and preferred scanner features for different ultrasound applications: executive summary, *ECRI Institute*

PLUS

Advances in monitoring expired CO₂ in critically ill patients, *M. Mezyd & JC Richard*

How to manage severe dengue infection, *S. Jog et al.*

Antifungal treatment in the ICU: best practice in managing fungal infections, *A. Cortegiani & M. Bassetti*

Interprofessional teamwork in the ICU: panacea or illusion? *A. Xyrichis*

Dr. Theodoros Kyprianou joins Editorial Board, *K. Theodoros*



Required and preferred scanner features for different ultrasound applications

Executive summary

Minimum requirements, preferred features, and other advantageous features are identified for ultrasound systems for common exam types.

Ultrasound is used for a wide variety of clinical applications, each requiring a somewhat different set of sonographic capabilities. A scanner's array of available features is a key factor in determining its appropriateness for a given application. Listed below are common ultrasound applications. For each one, we provide ECRI Institute's recommendations about the necessary transducer types, along with the following:

- Minimum requirements—the essential functions needed to perform the application
- Preferred features—highly desired capabilities that make scanning or image interpretation easier, make operation more convenient, or improve the use of the scanner for the application in some other significant way
- Other advantageous features—features that enhance the scanner's set of capabilities for the application but that are of lesser importance

Abdominal (comprehensive)

Imaging abdominal organs is one of the oldest and most common ultrasound procedures. Diagnoses of diseases, cysts, and tumours can be made from the anatomical information—such as size, texture, and location—provided by ultrasound scans. Biopsies of abdominal organs can be performed under ultrasound guidance. Colour Doppler

imaging (CDI) permits further diagnosis by providing information on blood flow. Comprehensive abdominal studies require a full-featured scanner typically used by experienced (credentialled) sonographers.

Transducer. Sector transducer (convex or vector; adult, 3 to 5 MHz; paediatric, >7 MHz)

Minimum requirements. Real-time 2D (B-mode) capability, CDI, DICOM compatibility, digital calipers, pulsed-wave (PW) Doppler

Preferred features. Power Doppler imaging (PDI), harmonic imaging, transducer needle-guide attachment

Other advantageous features. Cine-loop, elastography, extended field of view, frame averaging, frequency compounding, multiplanar reconstruction, multislice 3D, spatial compounding, volume rendering (either freehand 3D or real-time 3D [4D]), fusion imaging

Abdominal (limited)

Limited abdominal studies include detection of fluid collections caused by abdominal trauma (by means of a focused assessment with sonography for trauma, or FAST exam), gallstones, aortic aneurysms, and noncardiac studies of the thorax (e.g. pleural effusion). Studies can be performed with a system containing only basic features. The study is often performed at the point of care and is typically performed by a physician.

Transducers. Recommended minimum: any

sector transducer (3 to 5 MHz); acceptable: curved linear-array transducer (3 to 5 MHz)

Minimum requirements. Real-time 2D B-mode capability, digital calipers

Preferred features. Battery operation for portable studies, CDI (PDI also acceptable), image and video storage capability

Other advantageous features. PW Doppler, Wi-Fi connectivity

Cardiac (comprehensive)

Cardiac ultrasonography, or echocardiography, involves assessing the structure and function of the heart and imaging the cardiac valves and heart chambers to measure wall motion and wall thickness. Cardiac ultrasound can call on the full range of a scanner's Doppler capabilities to examine flow and turbulence throughout the heart and great vessels. Cardiac analysis packages measure and automatically calculate quantitative values to aid diagnosis. The unit normally produces an ECG to allow the images to be referenced to the cardiac cycle. A comprehensive cardiac study requires a full-featured scanner typically used by experienced (credentialled) echocardiographers. Examinations include comprehensive adult and paediatric echocardiography.

Transducers. Pedoff (continuous-wave [CW] Doppler, 1.5 to 3 MHz) transducer; small-footprint* sector transducer (phased-array, vector-array, or microconvex-array; adult, 2 to 4 MHz; paediatric, >7 MHz)

Minimum requirements. Real-time 2D

B-mode capability, cardiac analysis package, CDI, CW Doppler, DICOM compatibility, digital calipers, ECG, M-mode, PW Doppler, cine-loop

Preferred features. Contrast-specific imaging, transoesophageal echocardiography (TEE) transducer (single-plane), strain imaging, stress-echo calculation package

Other advantageous features. Multiplanar reconstruction, multislice 3D, stress echo, TEE transducer (biplane or multiplane), volume rendering (real-time 3D [4D]), intracardiac echocardiography (ICE) capability

Cardiac (limited)

A limited cardiac study includes assessment of basic cardiac activity as well as detection of pericardial effusion. A limited study can be performed with a system containing only basic features. A portable system could be used in a number of locations: a patient's bedside, the intensive care unit or cardiac care unit, the catheterisation lab, or an off-site clinic. The study is often performed at the point of care and is typically performed by a physician.

Transducer. Small-footprint sector transducer (phased-array, vector-array, or microconvex-array; 2 to 4 MHz)

Minimum requirement. Real-time 2D B-mode capability

Preferred features. Battery operation for portable studies, CDI, cine-loop, digital calipers, image and video storage capability

Intraoperative

Ultrasound is used for various intraoperative procedures such as laparoscopy and biopsy guidance. Some of these procedures require scanners that are designed and equipped for intraoperative applications. Because of the variety of intraoperative studies that may be performed, user assessment is very important when choosing features (mainly transducers) for these applications.

Transducer. Intraoperative transducer (application-specific)

Minimum requirement. Real-time 2D B-mode capability

Preferred features. CDI, PW Doppler

Other advantageous features. Fusion imaging capability, needle-guidance software, 3D/4D imaging capability

OB/GYN (comprehensive)

Gynaecologic ultrasonography is used to assess for a variety of gynaecologic abnormalities, including infertility. During a comprehensive obstetric study, ultrasonography is used to detect the presence and condition of the fetus, as well as to investigate the blood supply to the fetus and the fetus's growth throughout pregnancy. Ultrasonography is also useful in guiding amniocentesis and other invasive procedures. Obstetric analysis packages provide a variety of commonly used gestational age, fetal weight, and fetal growth calculation methods, and some are also capable of report generation. Endovaginal transducers are used with gynaecologic and early obstetric imaging. Comprehensive OB/GYN studies require a full-featured scanner typically used by experienced (credentialled) sonographers.

Transducers. Endovaginal transducer (>7 MHz); convex or sector transducer (3 to 5 MHz)

Minimum requirements. Real-time 2D B-mode capability, CDI, DICOM compatibility, digital calipers, M-mode, obstetric analysis package

Preferred features. Cine-loop, transducer needle-guide attachment

Other advantageous features. Extended field of view, multiplanar reconstruction, multislice 3D, volume rendering (either freehand 3D or real-time 3D [4D]), needle-enhancement software, automated measurement capabilities

OB/GYN (limited)

Limited obstetric and gynecologic studies may be used to determine the presence, position, and viability of the fetus, as well as to verify gestational age. Determining amniotic fluid levels and pelvic morphology and assessing for ectopic pregnancy are also possible. Limited OB/GYN studies can be performed with a system containing only basic features. The study is often performed at the point of care and is typically performed by a physician or nurse.

Transducers. Recommended minimum: convex sector transducer (3 to 5 MHz); acceptable: linear-array transducer (3 to 5 MHz); preferred: endovaginal transducer (>7 MHz)

Minimum requirement. Real-time 2D B-mode capability

Preferred features. Battery operation for portable studies, digital calipers, CDI or PDI

Other advantageous features. PW Doppler, Wi-Fi connectivity, image and video storage

Prostate

Endorectal transducers are available on some scanners for prostate screening and biopsy guidance. Prostate studies are typically performed by physicians or experienced (credentialled) sonographers.

Transducer. Endorectal transducer (>7 MHz)

Minimum requirements. Real-time 2D capability, CDI, DICOM compatibility, digital calipers, transducer needle-guide attachment

Preferred feature. PDI

Other advantageous features. Multiplanar reconstruction, multislice 3D, volume rendering (either freehand 3D or real-time 3D [4D])

Small parts

Some scanners are equipped with high-frequency (>7 MHz) transducers for use in thyroid, breast, scrotal, neonatal brain, and musculoskeletal imaging. Small-parts studies require a full-featured system typically used by experienced (credentialled) sonographers. Because of the variety of small-parts studies that may be performed, user assessment is very important when choosing features (e.g. transducers, needle guides) for these applications.

Transducers. Linear-array transducer for thyroid, breast, scrotal, and musculoskeletal imaging (>7 MHz); small-footprint sector transducer for neonatal brain studies (phased-array, vector-array, microconvex-array; >7 MHz); flat linear-array transducer for very superficial applications (e.g. to image the skin, subdermis, and some ligaments) (>10 MHz)

Minimum requirements. Real-time 2D capability, CDI, DICOM compatibility, digital calipers

Preferred features. PDI, harmonic imaging, transducer needle-guide attachment

Other advantageous features. Elastography for breast studies, extended field of view for thyroid and musculoskeletal studies,

frame averaging, frequency compounding, multiplanar reconstruction, multislice 3D, spatial compounding, volume rendering (either freehand 3D or real-time 3D [4D])

Transoesophageal echocardiography

In addition to its use in cardiology—see Cardiac (comprehensive), p.268—TEE is also occasionally used outside the cardiology department by anaesthesiologists for cardiac monitoring during surgical procedures.

Transducers. Single-plane TEE transducer; advantageous: biplane or multiplane TEE transducer

Minimum requirement. Real-time 2D capability

Vascular (comprehensive)

Vascular ultrasonography affords the clinician flow profiles of vessels throughout the body to diagnose arterial and venous abnormalities and identify their causes.

Comprehensive vascular studies include complete peripheral, cerebrovascular, and extracranial imaging with complete vascular analysis (2D and Doppler). Vascular analysis packages can make measurements and calculations automatically. A vascular study requires a full-featured scanner, typically used by experienced (credentialed) sonographers. Vascular studies are performed in a hospital department's radiology-based ultrasound lab, in a vascular surgery ultrasound lab, or in cardiology. These exams may be performed at the patient's bedside in general care areas and in the intensive care unit.

Transducers. Recommended minimum: linear-array transducer (>7 MHz); acceptable: vector-array transducer (>7 MHz); preferred: steered linear-array transducer (>7 MHz), curved linear array transducer (3 to 5 MHz)

Minimum requirements. Real-time 2D capability, CDI, PDI, DICOM compatibility, digital calipers, PW Doppler, vascular analysis package

Preferred features. Cine-loop, CW Doppler

Other advantageous features. Volume rendering (freehand 3D or real-time 3D [4D])

Vascular access

Vascular access is a special application that involves ultrasonic guidance for vascular surgical procedures, peripherally inserted

central catheter (PICC) line placement, and biopsies. Scanners are often dedicated to this application, and there is a growing list of related studies performed with these systems, including bedside deep-vein thrombosis exams, pseudoaneurysm repair guidance, vein mapping prior to harvest or dialysis fistula creation, and intraoperative arterial monitoring. Because of the variety of vascular access studies that may be performed, user assessment is very important when choos-

ing features (mainly transducers) for these applications. These procedures are typically performed at the point of care and are usually performed by physicians or nurses.

Transducers. Recommended minimum: linear-array transducer (>7 MHz); acceptable: convex-array transducer (>7 MHz)

Minimum requirement. Real-time 2D capability

Preferred features. Battery operation for portable studies, CDI or PDI, digital calipers ■

ECRIInstitute
The Discipline of Science. The Integrity of Independence.

ECRI Institute, a nonprofit organisation, dedicates itself to bringing the discipline of applied scientific research in healthcare to uncover the best approaches to improving patient care. As pioneers in this science for 50 years, ECRI Institute marries experience and independence with the objectivity of evidence-based research.

ECRI's focus is medical device technology, healthcare risk and quality management, and health technology assessment. It provides information services and technical assistance to more than 5,000 hospitals, healthcare organisations, ministries of health, government and planning agencies, voluntary sector organisations and accrediting agencies worldwide. Its databases (over 30), publications, information services and technical assistance services set the standard for the healthcare community.

More than 5,000 healthcare organisations worldwide rely on ECRI Institute's expertise in patient safety improvement, risk and quality management, healthcare processes, devices, procedures and drug technology. ECRI Institute is one of only a handful of organisations to have been designated as both a Collaborating Centre of the World Health Organization and an evidence-based practice centre by the US Agency for healthcare research and quality in Europe. For more information, visit ecri.org.uk