SELECTING AN ULTRASOUND IMAGING UNIT

If you or your organization is considering the purchase of an ultrasound imaging unit it is critical to assess your needs as well as investigate the many options available. Ultimately the goal is to match your needs to the various features available. Although highly sophisticated systems can provide you with extremely good quality images they may be an unnecessary expense particularly if you are not going to utilize many of their features (e.g. a color Doppler). An experienced operator can obtain a good quality image from a basic machine.

Beyond considering how your needs are to be met by a specific unit it is equally important to consider the company that you are purchasing the unit from, particularly their service record. Further the service contract, warranty and training that they offer.

Finally as many of the points of consideration require a basic understanding of the principles underlying ultrasound imaging it may be appropriate to either attend an introductory course on the topic or refer to one of many written resources;

- Whittaker JL, Teyhen DS, Elliot JM, Cook K, Langevin H, Dahl HH, Stokes MJ. Rehabilitative ultrasound imaging; understanding the technology and its applications. JOPST (in press).
- Whittaker, JL. *Ultrasound imaging for rehabilitation of the lumbopelvic region: A clinical approach*. Edinburgh UK: Elsevier Churchill Livingstone; 2007.
- Kremkau, FW. *Diagnostic Ultrasound: Principles and instruments*. 6th ed. Philadelphia PA: Saunders; 2002.
- Van Holsbeek, MT, Introcas JH. *Musculoskeletal Ultrasound*. Philadelphia PA: Mosby Press; 2001.
- Stokes, MH, J Nassiri, DK. Musculoskeletal ultrasound imaging: diagnostic and treatment aid in rehabilitation. *Physical Therapy Review.* 1997;2:73-92.

INTENDED USE

The first step is to determine if the unit is going to be used for *clinical* or *research* purposes. Establishing this will assist in determining the image quality, screen size, modes of display, degree of portability as well as the measurement and storage (still and/or real-time clips) features that are required.

- **Image quality** – From a medical diagnostic standpoint ultrasound imaging (USI) is used to assess tissue pathology and abnormalities, consequently high image resolution is preferred. However, a high degree of image resolution is excessive for the imaging applications associated with clinical rehabilitative USI. With that said, if one of your goals is to use the ultrasound unit to assess muscle density, which can change with age, disease and training, high image resolution is important. Furthermore, more accurate measurements can be obtained with higher resolution images. Consequently if the unit it intended for clinical use alone lower resolution is likely sufficient, if however the intended use is more research oriented than there is a need for higher image resolution.
- **Screen size** - if the unit is going to be used for biofeedback in a clinical setting it is important that the screen on the unit is of sufficient size. However, most ultrasound units have a port to which a TV monitor or LCD projector can be connected.
- **Modes of display**
  - **B (brightness of brilliance) mode** - displays the ultrasound echo as a cross-sectional grey scale image and is the mode of display most typically associated with USI. In

contrast to other modes of display (e.g. m–mode) the relatively large field of view available with b-mode combined with the real time nature of USI presents an opportunity to view several structures at once, and if warranted over a period of time. Consequently, it can be used to comment on the morphology (e.g. shape, size, composition and resting state) of a structure (muscle, nerve), the positional relationship of several structures (e.g. muscles, nerves, bone or an organ such as the bladder), as well as the characteristics (simultaneous vs. independent or, phasic vs. sustained increase in *thickness* of a muscle) and impact of a dynamic event (such as a muscle contraction) on structures within the field of view.

  - **M (motion) mode** - displays information collected from the midpoint of the probe as a continuous image over time. With time on the x-axis, and the depth of the underlying anatomical structure on the y-axis, the m-mode image represents changes in the depth of the structure over time and hence it is also referred to as time-motion mode. In addition to being a reliable method to measure muscle thickness m-mode provides an opportunity to assess the depth of a structure over time and allows for the calculation of the relative timing of muscular thickness changes
  - **Split screen** – can be useful for comparing sides or before and after images during biofeedback applications or, for different modes of display (e.g. b and m mode) at the same time.

- **Portability** – ultrasound imaging units vary from small hand-held battery operated machines to larger, heavier machines that require a trolley. Portable units are most appropriate for a clinical setting. In determining the portability of a unit it is important to consider its size, weight, the size of trolley required, its carrying case as well as if the unit is powered through an electrical cable or has the capacity to be battery operated.
- **Measurement features** – Electronic on-screen cursors are controlled by a, roller or tracker ball. Machine capabilities vary, with most having distance (linear) and ellipse measurement features. Others allow measurement of area, circumference, non-linear distance, ratios, angles and volume (if 3D).
- **Image storage features** – Generally ultrasound units have a feature which permits storage of still images (useful for immediate storage in patient's charts). An added feature is video storage (useful for biofeedback or teaching). It is important to establish the capabilities (still and/or video) as well as amount of storage available with any specific unit. Further considerations are the ease of transferring data to PC compatible CD ROM's or USB driven drives (necessary for the large amount of information for off line analysis associated with research and for reproducing high quality images or video clips for publication or presentation).
- **Peripherals** – consider if you have a need for.
  - Video outputs for displaying the ultrasound screen on a T.V., monitor or LCD projector or, for connecting to a digital video recorder.
  - Printer – for printing still images
  - Foot pedals – generally the function of the foot pedal can be programmed to meet the needs of the operator. Common applications include freeze, print etc.

MUSCLES OF INTEREST

Establishing which muscles are of interest will assist you in determining the type of transducer(s) you require.

Transducer available/compatible – The versatility of an ultrasound unit will depend on the range of transducers available. Specifically the frequency, shape and size (of footprint) of transducer(s).

- **Dual and multi-frequency transducers** – this refers to a single transducer which provides two or a range of frequencies. This reduces the number of probes needed and the associated cost.

- **Detachable transducers** – this is a feature that is required if more than one transducer is to be used. Non-detachable, one-probe scanners may be adequate for biofeedback of certain muscles but not for measuring muscles of different size/depth/shape that require a different shape/frequency of transducer.
- **Transducer ports and probe switching features**– having more than one port is advantageous as it facilitates the process of switching probes (e.g. saves the time required to turn off, change probes and rebooting the unit).

OTHER POINTS OF CONSIDERATION

Acoustic output settings – these features are commonly adjustable on larger machines and assist in allowing the operator to minimize any risk of safety however they tend to be fixed at a low level on portable scanners.

- **Thermal and mechanical indices (TI & MI) display** – This display allows the operator to monitor the acoustic output and hence tissue exposure. On low specification portable scanners, these indicators are not always displayed and have been pre-set at a low level.

Pre-programming – some ultrasound units allow certain settings and screen formatting to be pre-programmed e.g. the intensity or power output for safety reasons; for a specific muscle, the screen can be pre-set for various functions, such as focal zones and grey-scale settings, measurement functions, as well as indicating which probe to use.

Service contracts – it is important that the conditions of the contract provide comprehensive coverage beyond the standard electrical safety checks. Included within the coverage should be; output, intensity, thermal and mechanical safety checks specific to ultrasound; performance checks of unit's specifications; and calibration checks for accuracy of the unit's measurement calipers.

It is also important to consider how service to the unit will be performed. If the unit must be returned to the manufacturer's service department for the work to be done it is important to consider the logistics associated with shipping the unit within the country or across international borders, as well as the possibility of a replacement unit while your unit is undergoing service.

Warranty - there is significant variability in industry standards when it comes to warranty issues. Ensure that warranty and options for extended warranties are discussed and agreed upon.

Training – If an ultrasound manufacture indicates that basic training is included with the purchase of an ultrasound unit it is important to clarify if this is training specific to rehabilitative ultrasound imaging or to musculoskeletal (MSK) imaging in general as well as the qualifications of the individual that will provide the training. General MSK training by a sales representative may not be of much assistance for a physiotherapist wishing to use the tool for rehabilitative purposes.

It is recommended that assistance is sought when purchasing a scanner, to identify the appropriate specifications and carry out performance tests.

Adapted from Stokes, M. Ultrasound imaging of skeletal muscle: biofeedback and clinical assessment an introductory manual for physiotherapists. 1st ed. Southampton UK