ECMUS SAFETY COMMITTEE GUIDELINES FOR THE SAFE USE OF DOPPLER ULTRASOUND FOR CLINICAL APPLICATIONS

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Quantitative pulsed Doppler measurements involve stationary beams of high output levels (SPTA intensities may be 100 times those used in B-mode imaging). Colour flow imaging employs swept beams and lower acoustic outputs, which are intermediate between those of pulsed Doppler and B-mode imaging. Continuous wave Doppler devices use intensities that are sufficiently low to give minimum concern about potential heating effects. The differences between the various Doppler applications arise because high intensities are needed to obtain strong echoes from poorly reflecting blood cells for flow studies. Strongly reflecting moving structures, such as those found in the heart, return strong echoes from low intensity pulses.

These guidelines have been drawn up on the basis that there is the need to minimise any potential adverse thermal effects from Doppler applications. Although other effects (such as cavitation) may occur, it is considered that these do not give serious cause for concern in diagnostic equipment used clinically at present.

The absorption of ultrasound by different tissues varies greatly, with fully calcified bone absorbing most. Thus, the temperatures that result from exposure to a given ultrasound beam will vary according to the tissue type exposed. It should be borne in mind that tissues with low perfusion rates will experience higher temperatures than their well perfused counterparts. When considering the thermal implications of a given exposure, it is necessary not only to consider temperature increases within tissue structures lying in the path of the ultrasonic beam, but also their sensitivity to thermal damage.

On this basis, safe clinical practice, with regard to thermal effects, should be conducted according to the following guidelines:

Output conditions and exposure time

l. For each new patient investigation, set the machine output conditions to a minimum, and receiver settings to a maximum. This should ideally be achieved by a default (start-up) setting on the machine each time a new patient is examined. Where this is not available, the manufacturer should be consulted.

2. Keep Doppler exposure times and output levels to the minimum consistent with good clinical practice. Choose the region for Doppler interrogation using B-mode imaging. Where possible, set the Doppler gate to the required position under B-mode guidance before turning on the Doppler beam.

3. The user must know whether there is continued acoustic output when the image is frozen. If the acoustic output is not interrupted, then the probe should be removed from the patient during freeze frame conditions. Before it is replaced, its front surface temperature should be checked, since some transducers may self heat to unacceptable levels when operating in air. A hot transducer will cool when the pulsed Doppler is switched off.

Bone

4. Special care should be taken when bone falls within the pulsed Doppler field as rapid heating may result in biologically hazardous temperatures. Patients should be encouraged to report bone pain.

Paediatrics

5. In pediatric applications, where tissues that may be especially sensitive to temperature elevations lie very close to, or within, bone, extra care must be taken to minimise pulsed Doppler exposures. The tissue of most concern here is the neonatal brain lying adjacent to the skull. Care should also be exercised when pulsed Doppler exposures are undertaken in the vicinity of the epiphyses of growing bone.

Obstetrics

6. In view of the possibility of significant temperature elevation in tissues in the path of the pulsed Doppler beam, routine examination with Doppler ultrasound of the first trimester embryo is considered inadvisable at present. Investigations for which the embryo does not lie in the path of the pulsed Doppler beam, such as studies of the vessels of the uterine wall, may be undertaken.

7. Pulsed Doppler exposures become increasingly likely to produce biologically significant local heating as the pregnancy proceeds through the second and third trimesters because the acoustic absorption of fetal bone increases with its progressive mineralisation. This is of particular importance when brain or growing epiphyses lie in the path of the pulsed Doppler beam.

8. It should be remembered that sensitive structures lying in front of, or behind, the `measurement target' will also be in the pulsed

Doppler beam and thus will be exposed to ultrasound. This is of particular importance in obstetric applications.