Diagnostic ultrasound exposimetry using a tissue-mimicking liquid

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Accurate measurements of acoustic output parameters (e.g., PII, p_r , MI, TI) are necessary for ensuring the continued safety of diagnostic ultrasound. Under the current methodology, pressure waveforms are measured in water and derated to attempt to correct for the large difference in attenuation between water and tissue. Derating refers to multiplying each recorded pressure value by a factor equivalent to a pre-determined amount of attenuation of the sound field, viz. 0.30 dB cm $^{-1}$ MHz^{-1} . Because of nonlinear acoustic propagation effects, ultrasound propagation in water is not necessarily lossless, but can be accompanied by significant loss of signal. Derating does not consider this signal loss; thus, derated values of the acoustic output parameters may significantly underestimate *in situ* values.

The goals of this work are to produce a tissue-mimicking liquid that can be used as the propagation medium for acoustic output measurements and to compare parameter values obtained in this liquid to values obtained using the current methodology. Chapter 4 provides a description of the method used to create a TM liquid based on fat-free bovine milk concentrated by a factor of three and details the successful search for a satisfactory method of preservation. Chapter 5 describes the incorporation of this liquid into an apparatus designed to measure acoustic output parameters in this liquid or in water. Chapters 6 and 7 provide an in-depth accounting of results obtained with this system for forty-six configurations encompassing six diagnostic ultrasound scanners. The results indicate that values of several acoustic output parameters obtained through the derating procedure are generally less than those in tissue-mimicking liquid. Specifically, the pulse intensity integral is, on average, underestimated by a factor of about 2, the peak rarefactional pressure is underestimated by a factor of about 1.8 and the total power is underestimated by a factor of about 2.3. The use of a system incorporating tissue-mimicking liquid would eliminate the need to use derating and allow for direct measurements of acoustic output parameters.