Basic physics of ultrasonographic imaging

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PREFACE

Ultrasound as a tool for medical imaging evolved rapidly during the second half of the 20th century. Its value became established in those areas of imaging in which its unique features offer special advantages over other imaging modalities. It gained wide acceptance as a non ionizing form of energy which is applied non-invasively. The demand for basic as well as specialized ultrasound services has grown steadily, and continues to grow, with new horizons still being explored.

The development and expansion of basic ultrasound services is more readily achievable in comparison to other imaging technologies because it is less demanding in terms of the physical infrastructure required, and the costs of equipment and consumables. However, the same cannot be said in reference to personnel. The provision of reliable diagnostic ultrasound services requires well trained, highly skilled, resource persons. The training of personnel must therefore be regarded as a major responsibility on the part of those providing ultrasound services, whether basic or advanced. Some efforts have been made to prescribe the training requirements and qualifications of those wishing to practise diagnostic ultrasound. However, there has been no consensus on the subject. Some individual countries and professional organizations do provide regulatory guidelines, but generally the situation remains somewhat amorphous, and perhaps unsatisfactory. The difficulties in addressing this issue arise mainly from the wide diversity in the cadres of personnel who may be allowed to practice in different countries. In the developing countries, where usage of diagnostic ultrasound has been increasing quite rapidly, formal training courses and certification have been scarce.

Whereas the benefits of clinical ultrasound applied properly are widely acknowledged, it must be pointed out, indeed emphasized, that when the technology is left in the hands of the untrained, it impacts negatively on patient care.

Therefore the quest to promote ultrasound usage and make it more accessible to wider sectors of humanity must be accompanied by concerted efforts to train the personnel charged with the responsibility of providing the services to patients. This manual is intended to make a humble contribution towards these efforts in education and training.

Training in medical ultrasound is, of necessity, a multidisciplinary exercise. Besides medical knowledge and a good background in anatomy, one also needs to be well exposed to the physical principles underlying the use of ultrasound in imaging, and to the practical techniques of applying the technology. This text is dedicated to the basic physics of ultrasonic imaging.

Knowledge of the basic physics of ultrasound is essential as a foundation for the understanding of the nature and behaviour of ultrasound, the mechanisms by which it interacts with matter, the process of image formation, the choice of imaging parameters, the optimization of image characteristics, and the identification of artefacts. These topics are highlighted in this book. A good foundation in the fundamentals of imaging physics prepares practitioners to use their equipment more optimally in order to generate high quality images, and to make more critical evaluations of the images they produce. In turn, good practice leads to improved patient care.

Granted that some knowledge of physics is desirable, an important question arises: how much physics is the ultrasound practitioner expected to learn? The answers will vary, bearing in mind the variety of professional groups which may be considered as a pool for recruitment. Some of the professional cadres may have had only a rudimentary background in the physical sciences, while others may be regarding physics as a difficult and awesome subject. Therefore, while the need to impart some knowledge on the physical basis of ultrasonic imaging to all potential practitioners must be emphasized, the limitations among many of those targeted should also be acknowledged and appropriately addressed.