A HISTORY OF MEDICAL ULTRASOUND PHYSICS: PART II – INTRODUCTION

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Ultrasound scanning now probably contributes at least 30% of all medical imaging worldwide. By 2014, the year that the UK NHS stopped gathering imaging statistics, the number of ultrasound scans in England was approaching ten million, of a total imaging of 43 million, well exceeding the combined totals of CT and MRI. It is a technology that is used far beyond the confines of departments of imaging and radiology. The technology is so ubiquitous that it has been suggested as a replacement for the stethoscope for every junior doctor. How have we reached this astonishing position? First and foremost it is because ultrasound scanning is clinically useful. Many new medical technologies never emerge beyond the headline-grabbing launch phase, and others only find permanent homes in niche areas of medicine. Not only is ultrasound widely diagnostically valuable, it is cost-effective, safe, small-scale and, in particular, it is kind to the patient.

Earlier this year, we presented the first four articles of a history of medical ultrasound physics in a special supplement of Medical Physics International: http://www.mpijournal.org/pdf/2021-SI-05/MPI-2021-SI-05.pdf. These articles formed the first of a series intended to document the contributions of physicists and engineers to the application of ultrasound to clinical medicine. They are part of the broader initiative of the International Organisation of Medical Physics to document the history of medical physics in all its aspects. The first article documented the first fifty years of ultrasound up to 1950, during which time a few pioneers explored its destructive power, and the only serious established medical application was at the end of this period, for therapy. It was a time that encompassed the two world wars, both driving developments in ultrasound that were necessary before medical uses could follow. The remaining three articles in this first supplement cover a central function of most medical physicists, the measurement of radiation. From the earliest years it was necessary to quantify the acoustic power, acoustic intensity and acoustic pressure in the beams being generated by the new ultrasonic transducers. The methods that evolved in the laboratory, using thermometry, radiation force and hydrophones, were given impetus once medical applications emerged. They were used for the measurement of the ultrasonic properties of tissue, for the development and testing therapeutic ultrasound systems, for quantifying high intensities for surgery and finally to ensure safe output from diagnostic ultrasound equipment. These measurement techniques now underpin all medical uses of ultrasound. Manufacturers must ensure calibration and safety, set by international and national standards. National standards laboratories establish reference measurements, cross-calibration honing precision. Medical physicists make measurements to evaluate conformance and stability of output, and to educate clinical colleagues. Modern ultrasonic metrology is based on the slow evolution that is described in these articles.

This second supplement includes five more articles on medical ultrasound, which move the history towards its clinical exploitation. In the first, Norman McDicken and Carmel Moran give a succinct overview of some early developments, which emphasises the unique aspects that were recognised by the early pioneers, namely precise dimensional measurement, an inherent ability to create slice images with a high frame rate and the ability to track structural movements in real-time, all attributes that were challenging to achieve using x-ray imaging at the time. The next two articles take a more detailed look at the difficulties that faced engineers and commercial companies in translating this potential into financially successful equipment. Tony Whittingham gives a detailed historical account of the creation and development of the Diasonograph, a unique ultrasound B-scanner, designed and developed in Scotland, that established ultrasound imaging as an integral part of modern gynaecological and obstetric care. Tom Szabo brings his personal knowledge as a research engineer to the description of the creation of Hewlett Packard's phased array cardiac scanner. Both these accounts record the contributions of the many talented engineers whose design skills broke new ground and continued to innovate. Also, independently, both narratives address the enlightened management approach that created time and finance for an enterprise whose outcome was still uncertain. The fourth article, by Peter Hoskins, takes a look at the history of another aspect of ultrasound, the use of Doppler shift in evaluating haemodynamics in normal and diseased cardiovascular structures. At first separate from imaging, Doppler brought new diagnostic information in the audio Doppler-shifted spectrum, and eventually pulsed Doppler opened the door to colour Doppler imaging in which anatomical and physiological information merged. Finally, Gail ter Haar's article is a reminder that, during the same period of time that saw advances in ultrasound applications for diagnosis and for therapy, challenges were also being met and overcome for exploiting the destructive power of high intensity ultrasound for surgery and ablative therapy

You will find many details of the history of medical ultrasound in these articles that have not been documented elsewhere. Many histories start with the first arrival of an ultrasound instrument in the hands of a creative clinical user, and appropriately celebrate their achievements. Here, we look behind the scenes to those whose prior engineering skills and vision placed new tools in the hands of these clinicians.

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