A HISTORY OF MEDICAL ULTRASOUND PHYSICS – INTRODUCTION

Francis Duck
Formerly University of Bath and Royal United Hospital NHS Trust Bath UK

The four articles in this issue of Medical Physics International form 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. I would like to thank Slavik Tabakov most sincerely for his original invitation to participate in this project and his quiet guidance and support in reaching this stage.

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.

The articles selected for this issue do not describe the long, slow development of the techniques that are now part of modern clinical ultrasound, including Doppler imaging, elastography, harmonic imaging and all the rest. Articles covering some of these topics are planned or in preparation and will come later. Instead, first, we document the first fifty years of ultrasound up to 1950, during which 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. There were contributions of physicists from many nations during this period: Wilhelm Altberg, Paul Langevin, Robert Boyle, Frank Lloyd Hopwood, André Dognon, Robert Wood, Reimar Pohlman, Floyd Firestone and numerous others.

The remaining three articles in this issue 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.

Roland Blackwell (1943-2017) introduced me to ultrasound in 1966. We had both been appointed as junior medical physicists by John Clifton at the University College Hospital Medical Physics Department in London. My job was in nuclear medicine and his was in ultrasound, particularly to support the Diasonograph, the newly installed ultrasound scanner in the basement. Before solid-state electronics, I gave a hand when valves failed and needed replacing. We sneaked in after hours to scan my wife Di, expecting our first son Roger, in November 1967. I still have the Polaroid photograph, a starkly black-and-white image in which the head and thorax can just be made out. He arranged our visit to see Kit Hill at the Institute of Cancer Research, to use his balance to measure the power output for our MSc Doppler projects. Roland's central role as a leader and educator in the growth of ultrasound has not gained as much recognition as it should, and I am very pleased to dedicate these historical articles to his memory.