Out with the Old – in with the Nucleus
(Accelerator and Radioisotope Applications in Medicine)

E. Bezak
Department of Medical Physics, Royal Adelaide Hospital
School of Chemistry and Physics, University of Adelaide

X-rays were discovered in 1895 and radioactivity in 1898. Almost immediately it was observed that radiation impacted on growth of some tumours and from historical records it appears that the first cancer case was *cured* in 1898. These were mostly cures of superficial cancers. By 1913 radium was being mined in America and first X-ray tubes were manufactured by GE. Radiation therapy started to be applied to cancers of breast, head and neck, lymph nodes. In 1946, Robert R. Wilson made the first suggestion that energetic protons could be effective in cancer treatment. The first cobalt machines were produced in the early fifties and cost about US$30,000. This was followed by the production of the first X-ray medical linear accelerator in 1953. The Royal Adelaide Hospital purchased its first linear accelerator (linac) in 1957. The X-ray energies produced by linacs increased from 4 MV to 18 MV and linacs at currently represent the primary radiotherapy tool. The introduction of the computed tomography (CT) technology in the late seventies was a major breakthrough in treatment planning, enabling to visualize and delineate the extent of disease relative to normal tissue. In addition magnetic imaging resonance (1973) and positron emission tomography (1981) scanners were developed enhancing our ability to diagnose and target cancer and other diseases.

The probability of tumour control increases with radiation dose: the higher the dose, the more likely a biological effect (tumour cell death). There is documented evidence of improved treatment outcomes (cure) with radiation dose escalation in patients with prostate cancer. More radiation to the tumour, on the other hand, will result in more damage to the healthy tissues. As a result, the aim of radiotherapy is to deliver as high and as uniform radiation dose as possible to the target volume while minimising dose to healthy tissue. In order to achieve this, intensity modulated and image guided radiation therapy technologies were developed (based on new diagnostic advances) to target radiation dose with millimetre accuracy.

In addition to radiation therapy, nuclear medicine has developed as a specialty of medicine and medical imaging that uses radioactive isotopes (eg ^{67}Ga, ^{99m}Tc, ^{125}I, ^{131}I, ^{201}Tl, ^{177}Lu, ^{111}In, ^{64}Cu, ^{90}Y, ^{188}Re) and their decay to diagnose and treat. In general, radionuclides are bound to other chemical compounds or pharmaceuticals to form so-called radiopharmaceuticals. Their chemistry is such that a selective delivery of radiation to tumours or investigated organs can be achieved. Even for non-cancerous diseases such as thyrotoxicosis and arthritis radionuclide therapy is proven to be effective.

In summary, radiation and nuclear physics have changed the course of medicine. In line with medical applications, medical physics developed as a diverse scientific field where the knowledge gained in many areas of physics is applied to healing people. Medical physicists, as specialists with knowledge of the physical, mathematical and biological mechanisms of various radiation therapy processes, are vital in safe implementation of radiation physics into the clinical treatment of many diseases.