MEDICAL PHYSICS HISTORY, EDUCATION AND PROFESSIONAL TRAINING IN SWEDEN

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Abstract — **Sweden has a long tradition of using ionizing radiation within health care. In the span of more than 100 years, the applications within Medical Physics have grown to include many areas within diagnostics and treatment. Today, the usage of ionizing radiation is strictly governed by laws and the Hospital (or Medical) Physicist plays a central role within radiation safety. In order to work as a Hospital Physicist in Sweden, one has to undergo adequate training which leads to an MSc in Medical radiation physics and be legally entitled as a Hospital Physicist. The Swedish association of Hospital Physicists has for several years worked actively for a so-called specialist education, where Hospital Physicists have the opportunity to further educate themselves in the profession and after completing the education may call themselves a Specialist.**

Keywords— **Medical physics, ionizing radiation, training, education, Sweden**

I. Introduction – the legacy of swedish pioneers within medical radiation physics

Sweden has a long tradition when it comes to various applications of radiation within medicine and healthcare. Not least with regard to Rolf Sieverts' (1886-1966) pioneering efforts within dosimetry for measuring radiation doses in radiation treatment and diagnostics [1]. In addition, much of his later research focused on the biological effects of radiation and much of today's work in medical radiation physics bears traces of his spirit. His work is considered to have laid much of the foundation on which our modern radiation physics and protection stands. Despite Sievert's extensive work, he is not credited with all successes in Swedish radiation physics. The world's first successful radiation treatment was performed in Stockholm in 1899 by Thor Stenbeck, who is considered by many to be the Swedish father of X-ray technology [2]. He was also the first in Sweden to take an X-ray picture of a skull in 1896, the same year as Wilhelm Conrad Roentgen's great discovery of X-rays.

Radiation as a useful tool in healthcare grew rapidly during the first half of the 20th century, and medical applications were expanded and refined as radiation technology developed. In the wake of the growing field of radiation physics, the need for radiation protection grew and in 1941 Rolf Sievert's laboratory became the Department of Radiation Physics at Stockholm University, with a responsibility for national radiation protection. In parallel with this, the first radiation protection law in Sweden was adopted and Rolf Sievert's department was responsible for ensuring that this law was complied with until the National Institute for Radiation Protection was established in 1965. Departments of medical and academic radiation physics were also established at Lund University, the University of Gothenburg and the University of Umeå, and are still closely integrated with the clinical activities and applications of medical radiation physics [3]. With this development, the need for academic and clinical exchange within the profession increased, and the idea of a formal association emerged during the 50s. In 1954 The Swedish Hospital and Health Physicists' Association was formed and in 1961 it was split into The Swedish Association of Radio Physicists and The Swedish Association of Radio Physics. In 1976, the Swedish Hospital Physicists Association (SSFF) was formed as a section in the then Natural Scientists' Association.

II. Education and training

The usage of ionizing radiation in Sweden is strictly governed by laws and statutes, and in order to be able to legally practice the profession as a Hospital Physicist, one needs to have undergone adequate training and have applied for, and received the title of Hospital Physicist. The formal title of Hospital Physicist was recognized in Sweden as a credentialing profession in 1998, mainly as a result of the work that The Swedish Association of Radio Physicists put into the matter. The 5-year education leading to an MSc in Medical Radiation Physics, and thus the title as a Hospital Physicist, provides the student with the necessary theoretical and practical training needed to work in the profession. The education is currently offered at four universities and the content of the education is largely controlled by the Swedish National Board of Health and Welfare (Socialstyrelsen) together with professions in healthcare and universities. Even though the education can differ between the universities, the courses cover the same basic knowledge requirements required of a Hospital Physicist in Sweden today.

During the first years, the students will learn basic physics, mathematics and programming, as well as being trained in problem solving and laboratory work. The latter part of the education focuses on medical radiation physics and includes in-depth studies in, among other things,

radiation's interaction with tissue, How radiation detectors work, dosimetry, the basics of medicine and tumour biology, radiation biology, medical imaging and programming, ultrasound physics, x-ray physics, magnetic resonance physics as well as nuclear medicine and radiation therapy. Also, during the latter part of the education, typically shortly before the degree project, the student completes a clinical hospital internship where the student gets to learn how the Hospital Physicist works side by side with other professional categories in a hospital environment.

III. THE SWEDISH ASSOCIATION OF RADIATION PHYSICISTS

Today, The Swedish Association of Hospital Physicists (SSFF) is a professional association within The Swedish Association for Natural Scientists (SACO) and is a member of the European Federation of Organizations for Medical Physics (EFOMP). SSFF connects the country's Hospital Physicists in an organized way. Through the exchange of knowledge between Hospital Physicists, and further training, SSFF plays an important role in the Swedish Hospital Physicist society and the daily work of its members. SSFF should not be confused with the Swedish Association for Radio Physics, which is a section belonging to the medical society such as for doctors. But both associations cooperate in a wide range of matters concerning the development of professions working directly or indirectly with medical physics, radiation safety and dosimetry.

IV. THE PROFESSION AND FURTHER EDUCATION

The Swedish Hospital Physicists work at around 35 hospitals spread over the country, as well as at some private companies. Today there are roughly 7 trained physicists per 100,000 capita and there are over 600 trained physicists in Sweden. Most of the hospitals have nuclear medicine departments, whereas external radiation therapy only is given at 18 hospitals. There are diagnostic radiology departments in more than these 35 hospitals, and these are tended to by Hospital Physicists working in adjacent hospitals. There are seven on-site cyclotrons in Sweden, but PET/CT cameras in at least 12 hospitals and PET/MR cameras in four. The Swedish Hospital physicist may also work at other places where ionizing radiation can be found, such as nuclear power plants and withing the industry.

The Swedish Medical Physicists Association (SSFF) together with the Swedish Society of Radiation Physics together have a programme for Hospital Physicists to become specialists, corresponding to Medical Physics Experts (MPEs). To apply to this programme, one first must work clinically for two years and after that, together with practical work under supervision, attend several courses on advanced level. There are currently 216 graduates trained according to the programme. This programme is today not yet validated by the Swedish Government and Swedish National Board of Health and Welfare. There is a work in progress by the Swedish National Board of Health and Welfare to make the programme for becoming an MPE more similar to the physician's residency.

V. CONCLUSIONS

The field of medical physics, as well as dosimetry and radiation safety, is under constant development. There are a vast number of projects around the country, pushing applications further into the future. With this, a great responsibility lies with the health care system and hence the Swedish Hospital Physicist, to always stay up to date and educated within their fields. Therefore, there is a real and urgent need for the Specialists programme for Hospital Physicists to be accepted by the Swedish Government and the Swedish National Board of Health and Welfare.

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