MEDICAL PHYSICS EDUCATION AND TRAINING IN SOUTH AFRICA

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Abstract — **Six institutions offer academic training for medical physicists in South Africa, while seven institutions offer clinical training. A minimum of two years' of clinical training is required for registration by the Health Professions Council of South Africa. The medical physics association will celebrate its 60th birthday in 2020. The regulations defining the scope of the profession were published in 1988.**

Keywords — **education, medical physics, training**

I. Introduction

On 2 February 1960 eight medical physicists (with support from a ninth one who could not attend) founded the "SA Association of Medical Physicists", making it one of the older medical physics associations in the world. In 1968 the association expanded to include health physicists and became known as "The South African Association of Physicists in Medicine and Biology" (SAAPMB)[1]. The SAAPMB forms the umbrella body of three societies, namely the South African Medical Physics Society (SAMPS), the South African Radiation Protection Society (SARPS) and the South African Radiobiology Society (SARS).

The first Co-60 teletherapy unit in South Africa was installed in 1958, but radionuclides were imported in the late 1940's already. Specialization in medical physics began in the late 1950's, when physicists and engineers were appointed at some hospitals around South Africa.

II. Infrastructure

South Africa has large disparities between the public and private healthcare sectors. The private sector serves around 15 - 20 % of the population, while the public system is funded by the National Budget. There are efforts underway to introduce a National Health Insurance (NHI)[2,3], but this is not without controversy.

In 2015 an analysis of licensed diagnostic imaging equipment (not including Nuclear Medicine equipment) was published[4]. The regulator's database was analysed by modality, province and healthcare sector. They found that general X-ray units were the most equitably distributed and accessible resource (34.8/million). For fluoroscopy (6.6/million), mammography (4.96/million), computed tomography (5.0/million) and magnetic resonance imaging (2.9/million), there were at least 10-fold discrepancies between the least- and best-resourced provinces in South Africa and an average 13-fold discrepancy between the public and private sectors. Magnetic resonance imaging showed a 46-fold discrepancy between the public and private sectors. Only three of eleven provinces have the full spectrum of diagnostic imaging modalities in both the public and private sectors. A request to the regulator for an updated list in August 2019 was turned down.

A questionnaire was sent out to the public institutions that employ medical physicists to determine medical physics staffing and infrastructure levels.

Table 1 Medical Imaging and Radiotherapy Equipment at Public Institutions that Employ Medical Physicists

Equipment	Total
Linear Accelerator	32 (17 Elekta, 11 Varian, 4 Siemens)
Co-60 EBRT	2
HDR Brachytherapy	12
LDR Brachytherapy (eye, prostate)	1
CT in Radiotherapy	13
MR in Radiotherapy	1
SPECT/CT	16
SPECT	10
PET/CT	5
Dose calibrators	Between 1 and 7 per site
General X-Ray*	116
MRI*	14
CT*	27
Mammography*	13
Lodox*	13
Interventional*	27

*not all sites supplied data, number represents a lower limit

All sites do at least 2D and 3D radiotherapy, most sites do IMRT or VMAT treatments as well, some sites do SRS and TBI.

The private sector has 53 linear accelerators and one Gammaknife. All treatment techniques are offered in the private sector, including HDR and LDR brachytherapy.

The medical physicists of the one private hospital group deliver services to 58 hospitals and 106 primary care clinics, which include 44 interventional radiology units and the exposure monitoring of around 2100 radiation workers.

III. REGULATION OF MEDICAL PHYSICS

The regulatory framework in South Africa is well established.

The Hazardous Substances Act (No. 15 of 1973)[5] provides regulations for X-ray devices and radioactive substances. Regulation R 1332 of 1973[6] provides the framework concerning the control of electronic products and regulation R 690 of 1989[7] provides the regulations regarding the "licensing for the purpose of sale of listed electronic products". Regulation No. R.1302 of 1991[8] defines the schedule of listed electronic products.

Most importantly for medical physics, the scope of the profession was published under Government Notice R 310 in Regulation Gazette 4179 of 1988[9]. An upgrade to the scope of profession is waiting to be gazetted. This means that, in terms of the Health Professions Act 56 of 1974[10] (paragraph 33), all medical physicists must be registered by a professional board. Hence all medical physicists in South Africa must be registered with the Health Professions Council of South Africa (HPCSA).

The five main areas, according to the scope of profession, where medical physicists are required, are in:

(1) Radiation Protection
(2) Radiotherapy
(3) Nuclear Medicine
(4) Radiology
(5) Applied General Medical Physics,

all in areas where ionizing and non-ionizing radiation is used in medical practice.

The regulator recommends one full-time equivalent medical physicist per 600 patients receiving radiotherapy[11] and also insists that "a medical physicist must be appointed in writing to establish and implement an optimization program for Interventional Radiology procedures…" and that dose-area product data must be collected and submitted for the setting of diagnostic reference levels (DRLs)[12]. A number of DRL publications over the last few years confirm that there was some work done in this regard [13-22].

According to the HPCSA website there are 156 registered medical physicists, as well as 27 registered interns (last updated on 1 October 2018)[23]. However, this also includes retired medical physicists who are no longer practicing, but keeping their registration current. It also includes a handful of medical physicists outside of South Africa.

The replies from the public institutions are summarized in Table 3. A total of 59 full-time medical physicists and two part-time (5/8th) medical physicists are employed at the 13 facilities that responded, with two more smaller facilities that may or may not have medical physicists employed currently. Even though the majority of medical physicists are based in Radiotherapy, quite a few generally still render services to both Nuclear Medicine and Diagnostic Radiology. This is more likely the case in the smaller institutions.

Table 3 Distribution of registered medical physicists in the public sector in South Africa

Medical Physicists	Total
Radiotherapy	33 + 1 x 5/8th
Nuclear Medicine	10.5
Radiology	9.5 + 1 x 5/8th
University appointed	6
Total	59 + 2 x 5/8th

Table 3 represents the medical physicists currently employed in the public sector. A number of medical physicists employed in the public sector also work in the private sector, particularly in nuclear medicine.

Table 4: Distribution of registered medical physicists in the private sector and industry in South Africa

Medical Physicists	Total
Radiotherapy	51
Nuclear Medicine	2
Radiology	6
Metrology (SSDL)	3
Regulators	3
Industry and other	8
Total	73

IV. Education and training

It is not quite clear when medical physics education and training started in South Africa, but it seems to be in the 1950's, because regulations from 1956 required the registration of "hospital physicists" by the Atomic Energy Board. This required one year in-service training at a recognized hospital after an MSc degree in Physics, and two years after a BSc (Hons) degree[1]. Thus, South Africa became one of the first countries to regulate the profession.

The minimum academic training required to be allowed entry into a medical physics internship is a BSc (Hons) degree in medical physics. As a minimum, this includes "Physics of Radiotherapy", "Physics of Diagnostic Radiology", "Physics of Nuclear Medicine" and "Radiation Protection", on top of all the pure physics modules. Various universities offer additional compulsory or elective modules, which may include e.g. "Treatment Planning", "Radiobiology", "Digital Image Processing" or similar. One university starts their medical physics academic training at undergraduate level already.

There are 23 current MSc students in medical physics in South Africa, as well as 13 PhD students.

There are six universities that offer academic medical physics training, each with an affiliated teaching hospital that offers the clinical training component. Unfortunately, two of these academic programmes are currently suspended. One additional hospital can offer clinical training. There are currently a total of 44 full-time medical physicists and 2 part-time (5/8th) medical physicists appointed at these seven hospitals, including the academic appointments at only two universities (data included in Table 3). There another 13 full-time posts available on the various organograms, which are currently not filled, either due to budget constraints or vacancies waiting to be filled. Three of the seven "Head of Medical Physics" positions are currently filled with acting heads only. It has been an ongoing problem to fill these posts in the last five or so years and this needs urgent addressing.

The seven teaching hospitals are allowed to train up to 58 medical physics interns (intern = medical physicist undergoing clinical training), but only 28 interns are currently on training, with a large majority training without proper funding. This also needs urgent addressing at national level. Clinical training consists of a two-year long programme at an accredited training institution, with time spent in radiotherapy, nuclear medicine and diagnostic radiology, as defined by the HPCSA. After an oral exit assessment and the evaluation of intern portfolios of evidence by HPCSA appointed examiners, an intern may register as Medical Physicist (Independent Practice). It is not possible to register only in one area of expertise.

The SAAPMB, established in 1960, forms a vital component in the medical physics environment in South Africa. Membership currently stands at about 119 full members, with another 71 associate/ student/ institutional/ retired/ honorary members. Annual conferences are held, usually in combination with a school with invited international speakers. These meetings are popular to obtain continuous professional development (CPD) points / continuing education units (CEU), as required by the HPCSA, but also present a great networking opportunity and a perfect opportunity to deal with the logistics of an association and the attached societies (council meetings, AGMs, election of office bearers, etc.). Each of the three societies under the SAAPMB umbrella also has a representative to its respective international organization, namely the IOMP, IRPA and the IARR.

It was unfortunate that in South Africa very little medical physics training happened in the 1990's, which had the unwelcome side-effect that by the 2010's a lot of medical physicists had retired, leaving an almost 20-year void of experience to the next generation of medical physicists. Only one head and one acting head of medical physics currently have a PhD, which is concerning. This is being addressed, also through communication to the Department of Health through the association.

In addition, the regulator is severely understaffed and under-resourced. While an unprecedented 14 medical posts were advertised by the regulator in May 2019, the interviews are yet to happen.

V. Conclusion

Medical physics is well established, but very underrepresented, at many hospitals in South Africa. A regulatory framework guides the profession. There are six academic training sites in South Africa; unfortunately only four are currently offering the BSc (Hons) course, which is the minimum entrance requirement to an internship.

Less than half of the available clinical training posts are currently filled, with most interns doing their internship on minimal to no funding, just in order to register with the HPCSA. Private facilities are sponsoring interns to later employ these medical physicists.

There are some very worrying signs for medical physics on the horizon, but on the other hand there are also a number of young and enthusiastic medical physicists, who are very keen to take medical physics forward in South Africa.

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