Medical physics practice and training in Ghana

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1. Introduction

Medical physics activities in Ghana began in the 1970s when physicists were recruited and sponsored by the Government of Ghana and International Atomic Energy Agency (IAEA) to be trained in medical physics in developed countries. Population of Ghana then was about 8 million [1]. Ghana is situated along the Gulf of Guinea in the western part of Africa and is bounded by the countries Côte d’Ivoire, Burkina Faso and Togo. The country presently has a population of approximately 25 million [1] and has about forty fully trained medical physicists. Ghana has Accra as its capital city and also the most populous of all the cities in the country, with Kumasi as the second most populous city. Until the year 2004, Ghana’s medical physicists were all trained outside the country, mostly in Europe. The trained personnel offered services mainly to Ghana’s Radiotherapy and Nuclear Medicine programmes. Through an initiative of Ghana Atomic Energy Commission (GAEC), the Government of Ghana with support from IAEA established two state-owned radiotherapy centres and one nuclear medicine centre. These centres were established in Accra and Kumasi in 1998 and 2004, respectively. A third radiotherapy centre, which is privately owned, has also been established and operating in Accra. Diagnostic radiology also has seen tremendous growth in Ghana with the introduction of imaging systems such as computed tomography, computed radiography, digital radiography, magnetic resonance imaging, mammography and fluoroscopy.

In the quest to ensure sustainability to Ghana’s radiotherapy, nuclear medicine and diagnostic radiology programmes, training programmes were developed to locally train personnel who would feed into the nation’s radiological health centres. A two-year Mas-
ters degree programme (M.Phil) in Medical Physics was introduced by the University of Ghana (UG) in 2004. The programme was then run under the School of Allied Health Science (SAHS) of the University. Through a restructuring process in 2007, the Medical Physics programme was migrated and placed under the School of Nuclear and Allied Sciences (SNAS) of the same academic institution. The SNAS was established in 2006 by collaboration between GAEC and UG with key support from the IAEA, to promote post-graduate university education and training for preservation and enhancement of nuclear knowledge in Ghana and Africa [2,3]. To make the Medical Physics academic programme complete, Doctor of Philosophy (PhD) was introduced in 2008.

Over the years, the Medical Physics programme has grown from initially admitting local students to admitting foreign students from across Africa [4]. The Medical Physics Department at SNAS has become a hub of medical physics training in the sub-region, attracting a number of foreigners from the African countries. Presently, the department is the only one in Africa to be accredited by the IAEA as Regional Designated Centre for Academic Education in Medical Physics in Africa. This has contributed to recognition of the SNAS across Africa and has resulted in IAEA and governments of some African countries sponsoring students from across Africa to be trained in the programme.

2. Practices and infrastructure

The practice of Medical Physics in Ghana is impinged on international set guidelines and recommendations [5]. Clinical medical physicists are predominantly employed in radiation oncology facilities in the country and their responsibilities include performance of quality control and quality assurance checks, dosimetry, equipment specification, radiation safety and protection, treatment planning and commissioning of equipment. A good number of medical physicists are also involved in research at the Radiological and Medical Sciences Research Institute of the GAEC. Through collaboration between GAEC and some of the health facilities, selected medical physicists are seconded to offer clinical services in the nuclear medicine and radiotherapy facilities. This arrangement contributes to the overall improvement in healthcare delivery since the positives of research outcomes are applied in clinical practice. In academia, senior medical physicists actively engage in the education and training of students not only in medical physics but in other programmes such as radiology, radiography, oncology, nuclear science, health physics, radiation protection and biomedical engineering.

Infrastructure available for radiotherapy and medical imaging programmes in Ghana include:

- National Centre for Radiotherapy and Nuclear Medicine, Korle-Bu Teaching Hospital, Accra.
- Oncology Directorate, Komfo Anokye Teaching Hospital, Kumasi.
- Sweden-Ghana Medical Centre, Accra.
- 37 Military Hospital, Accra.

Several other diagnostic radiology centres, most of which are privately-owned, also contribute to the nation’s medical imaging programme. Equipment available in the medical facilities are presented in Table 1.

3. Education and training

3.1. Admission requirement

The minimum qualification to pursue Medical Physics Masters degree in Ghana (at the SNAS) is BSc degree with second class lower division in physics or related fields from approved universities. Prospective candidates for the PhD programme require a 2-year Masters degree in Medical Physics or other related disciplines to be considered for admission [6].

3.2. Academic and clinical training

The two-year Masters programme in Medical Physics comprises two semesters of didactic academic work in the first year and clinical training with research in the second year. Academic courses offered in the first year include: Anatomy and Physiology; Radiation Physics; Radiobiology and Radiation Protection; Electronics and Signal Analysis; Dosimetry for Photon and Electron Beams; Research Methodology and Scientific Communications; Professional and Medical Ethics; Ultrasonics and Instrumentation; Nuclear Magnetic Resonance Spectroscopy and Imaging; X-rays and Diagnostic Radiology; nuclear medicine; Radiotherapy; Applications of Computers in Medicine; and Nuclear Law and Legislation [6]. In order to ensure sustained credibility and international standards to the medical physics training in Ghana, IAEA’s harmonised Regional Syllabus for academic and clinical training of medical physicists in Africa has been adapted, and is being used for the training [7,8]. Additionally, IAEA’s publications on Education and Training of medical physicists such as the Technical Course Series (TCS 37, TCS 47, TCS 50, TCS 56) [9–12] are also used. The publications provide guidelines for academic and clinical training of medical physicists specialising in radiation oncology, diagnostic radiology and nuclear medicine. The two-year training is followed by a one year clinical internship for local graduates, a requirement by the medical physics professional association and the allied health regulatory body [13]. This arrangement ensures that clinically qualified medical physicists receive minimum of two years clinical training.

The PhD Medical Physics programme has since the 2013/2014 academic year been restructured to last a four year duration, comprising of one year didactic academic work and three years of research study [2]. Hitherto, the PhD programme was run for a period of three years and had no didactic academic component. A number of PhD candidates benefit from IAEA’s PhD Sandwich Programme, which ensures that candidates from less resourced countries and registered with local universities receive support to undertake their research studies in well resourced institutions, mostly in developed countries. Results from the studies are subsequently submitted to the local universities for the award of degrees.

Clinical training and research studies of the students in the Masters programme are undertaken through collaboration

### Table 1

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Equipment</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radiotherapy</td>
<td>Co-60 teletherapy unit</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Linear accelerator</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>LDR Cs-137 brachytherapy unit</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>MultSource HDR brachytherapy unit (with Co-60 source)</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>LDR I-125 prostate brachy system</td>
<td>1</td>
</tr>
<tr>
<td>Diagnostic radiology</td>
<td>Computed tomography</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Mamnography</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Fluoroscopy</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>General radiography</td>
<td>322</td>
</tr>
<tr>
<td>Nuclear medicine</td>
<td>Dental X-ray</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>SPECT system</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Laminar flow hood</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Dose calibrator and well counter</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Survey metre</td>
<td>4</td>
</tr>
</tbody>
</table>
between the SNAS and a number of health facilities in the country. Facilities for these purposes include the National Centre for Radiotherapy and Nuclear Medicine – Accra, Oncology Directorate – Kumasi, Sweden Ghana Medical Centre – Accra, 37 Military Hospital – Accra, and other diagnostic radiology centres. Facilities available in the health institutions for training and research studies include Cobalt-60 teletherapy units, linear accelerator, simulators, low dose rate brachytherapy units, high dose rate brachytherapy unit, computed tomography systems, magnetic resonance systems, mammography units, computed radiography systems and digital radiography systems. Facilities at GAEC such as secondary standards dosimetry laboratory (SSDL), Cobalt-60 gamma irradiator, research reactor, X-ray fluorescence, and gamma and beta spectrometry are also employed in practical training of students.

In addition to the research programmes of individual lecturers, GAEC’s Radiological and Medical Sciences Research Institute has an active medical physics research programme in place, from which students benefit. Some of the lecturers in the department double as clinical medical physicists in the Radiotherapy and Nuclear Medicine centres in the country. Such arrangement promotes efficiency in conducting clinical training with the lecturers having unrestricted access to training facilities.

3.3. Enrolment statistics

Enrolment statistics in the Medical Physics programme is presented in Table 2.

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
<th>M.Phil</th>
<th>PhD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Local students</td>
<td>IAEA fellowship</td>
<td>Other nationals</td>
<td>No. of Students</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>6</td>
<td>6</td>
<td>–</td>
<td>6</td>
<td>–</td>
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<tr>
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<td>–</td>
<td>3</td>
<td>–</td>
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<tr>
<td>2009</td>
<td>4</td>
<td>4</td>
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<tr>
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<td>7</td>
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<tr>
<td>2014</td>
<td>10</td>
<td>9</td>
<td>1</td>
<td>9</td>
<td>–</td>
</tr>
<tr>
<td>2015</td>
<td>9</td>
<td>6</td>
<td>3</td>
<td>8</td>
<td>–</td>
</tr>
</tbody>
</table>

3.4. Faculty

The Medical Physics Department has a well-resourced faculty comprising of professors, associate professors, senior lecturers and lecturers. In addition to faculty members from GAEC, UG and Kwame Nkrumah University of Science and Technology, adjunct professors, lecturers and consultants have been recruited from partner institutions in other IAEA Member States to co-supervise research studies of PhD candidates who are on IAEA sandwich programmes.

3.5. Accreditation

The National Accreditation Board (NAB) of Ghana [14] accredits the training programme. Assessment by NAB is carried out periodically at a frequency of once in every three years, using the services of international experts and consultants to ensure neutrality. Recommendations from the NAB are precisely applied to ensure that international standards are upheld.

4. The role of the Ghana Society for Medical Physics

Ghana Society for Medical Physics (GSMP) was formed in 2011 as a professional association to promote the application of physics to medicine, and to regulate activities of clinically practicing medical physicists [15]. Led by the Allied Health Professions Council (AHPC) of Ghana, GSMP together with other professional associations making up the Ghana Federation of Allied Health Professions (GFAHP), have successfully worked towards the passage of the
Health Professions Regulatory Bodies Act (Act 857 of 2013) [13] into law. The passage of Act 857 into law implies that medical physics among other allied health professions have legally gained recognition as professions in Ghana. This is in conformity with the classification of medical physics as a profession by the International Labour Organization (ILO) in 2011 [16]. The GSMP draws its inspiration from the International Organization for Medical Physics (IOMP) and it ensures that the roles and responsibilities of medical physicists are clearly adhered to [5]. The Society affiliates to IOMP and the Federation of African Medical Physics Organizations (FAMPO), and it annually partakes in the worldwide celebration of International Day of Medical Physics on November 7.

Ghana Society for Medical Physics has an executive committee in place to perform oversight functions of the association and medical physics activities in general. The Society ensures that minimum requirement for academic and clinical training of clinically qualified medical physicists in Ghana is in conformity with standards and recommendations of international agencies such as IAEA and FAMPO [7,8,12]. The training structure for clinically qualified medical physicists in Ghana is shown in Fig. 1. Recommendations on the Medical Physics Education and Training by the European Federation of Organisations for Medical Physics (EFOMP) [17] are also used as guides to shape the structure for training of clinically qualified medical physicists in Ghana.

Among other things, GSMP collaborates with the AHPC of Ghana to place graduate students on internships in the major hospitals offering radiotherapy, nuclear medicine and diagnostic radiology services. The 12-month clinical internship covers six months of radiotherapy, three months of nuclear medicine and three months of diagnostic radiology. Certification examination is conducted by the AHPC after the internship programme and successful candidates are licensed to practice clinically [13].

5. International partnerships

Ghana has received support and good will from a number of international agencies towards the development of medical physics. These agencies include IAEA, IOMP, FAMPO, International Centre for Theoretical Physics (ICTP), Argonne National Laboratory (ANL), World Health Organization (WHO) and University College London (UCL) paRTner Group. Through IAEA’s Technical Cooperation (TC) projects, medical physicists in Ghana have over the years benefitted from several short term training courses, long term fellowships, workshops, and conferences. Ghana presently participates in IAEA regional projects on medical physics in radiation oncology (RAF 6044) and medical imaging (RAF 6048). Through the two regional projects, Ghana adopted the IAEA harmonised syllabi on academic and clinical training for medical physicists [7,8]. Under the auspices of IAEA, a number of national TC projects on medical physics, radiation protection, radiation oncology and nuclear medicine are also ongoing. Notable among the national projects is GHA 6017, the national project which seeks to establish a Nuclear and Medical Imaging Centre at GAEC to aid in improved diagnosis and treatment of cancers and other degenerative diseases.

6. Summary

There have been several achievements made over the years towards addressing radiological health issues in Ghana. These include the establishment of nuclear medicine and radiotherapy centres, establishment of medical physics training programme locally leading to human resource development, recognition of the Medical Physics Department of the University of Ghana as Regional Designated Centre for Academic Education of Medical Physicists in Africa, and the passage of Act 857 which gives recognition to medical physics practice in Ghana.

Some challenges being faced include the non-adequacy of radiotherapy and medical imaging centres in the country. The three radiotherapy centres in Ghana altogether can treat not more than 5000 new cancer cases annually. With an annual cancer incidence of 0.25% per annum [18], Ghana is expected to record about 62,500 new cancer patients per annum. This leaves a huge shortfall which would have to be catered for, and hence a need to rapidly expand the nation’s radiotherapy and medical imaging facilities.

The way forward for proper sustainability of medical physics practice and training in Ghana is government’s continuous support for the training and development of the profession. An envisaged completion of some medical imaging facilities such as the Nuclear and Medical Imaging Centre at GAEC would tremendously improve healthcare delivery, research and student training in medical physics. The continual support from IAEA and other international agencies in terms of technical advice and logistics are also key for the sustainability of the Medical Physics programme.

7. Conclusion

Medical physics practice and training in Ghana has been relatively successful since its introduction. The practice has supported radiotherapy, nuclear medicine and diagnostic radiology services tremendously, while the training programme has grown internationally. The formation of GSMP has introduced checks and balances, helped to regulate activities of clinical medical physicists and given credibility to the practice.

Funding

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Conflict of interest

The authors hereby declare that there is no conflict of interest in the publication of this article.

Acknowledgements

The authors express profound gratitude to the Government of Ghana, IAEA, GAEC and the University of Ghana. Heartfelt appreciation goes to all radiotherapy and medical imaging centres where medical physics students undergo clinical training and internships.

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[4] Kyere AWK, Serfor-Armah Y, Amuasi JH, Sosu EK, Hasford F. Ten years of medical physics activities in general. The Society ensures that minimum requirement for academic and clinical training of clinically qualified medical physicists in Ghana is in conformity with standards and recommendations of international agencies such as IAEA and FAMPO [7,8,12]. The training structure for clinically qualified medical physicists in Ghana is shown in Fig. 1. Recommendations on the Medical Physics Education and Training by the European Federation of Organisations for Medical Physics (EFOMP) [17] are also used as guides to shape the structure for training of clinically qualified medical physicists in Ghana.

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