CAPACITY BUILDING OF MEDICAL PHYSICS IN GHANA AND AFRICA

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Abstract- **Medical physics activities in Ghana has seen tremendous growth in diverse fields. These include training of personnel, delivery of clinical services, research work, as well as international affiliations. The medical physics training program is well-structured and coordinated, adopting the International Atomic Energy Agency's (IAEA) harmonised Regional Syllabus for academic and clinical training. The program has since its inception trained 40 medical physicists who offer services in divergent fields. Upon its recognition by the IAEA and the African Regional Co-operative for Research, Development and Training related to Nuclear Science and Technology (AFRA) as Regional Designated Centre (RDC) for Academic Training of Medical Physicists in Africa, it has subsequently developed capacity to train IAEA fellows as well as students from other African countries. The Ghana Society for Medical Physics (GSMP), has in collaboration with the Allied Health Professions Council successfully worked towards the passage of a law backing the practice of the profession and continues to actively engage in activities that gives the profession the needed publicity necessary for growth and expansion. While these feats present formidable grounds for the furtherance of the nation's radiological health agenda, a number of challenges such as professional remuneration package, non-existence of medical physics department in major hospitals and most diagnostic centres is currently receiving redress by the appropriate authorities.**

Keywords: **capacity-building, infrastructure, imaging modality, challenges, regulatory-bodies**.

I. INTRODUCTION

The practice of medical physics in Ghana began in the 1970s when physicists were trained in developed countries (mostly in Europe) jointly through the support of the Government of Ghana (GoG) and International Atomic Energy Agency (IAEA) [1]. Upon the return of the trained medical physicists, majority of them worked with the Ghana Atomic Energy Commission (GAEC) where they contributed to the growth of the profession through education, training, clinical and research work [1, 2]. Their pioneering activities drew attention and interest to the medical physics profession, and subsequently influenced the establishment of two state owned radiation oncology centres and one nuclear medicine centre, with support from the IAEA. These centres were sited in Kumasi and Accra to respectively serve patients from the northern and southern sectors of the country. Subsequently, a third radiation oncology centre which is privately owned has been built in Accra [1].

Presently, there are forty (40) trained medical physicists practicing in various fields in Ghana. The distribution of medical physics practitioners in the various sectors of practice is presented in Figure 1 [3].

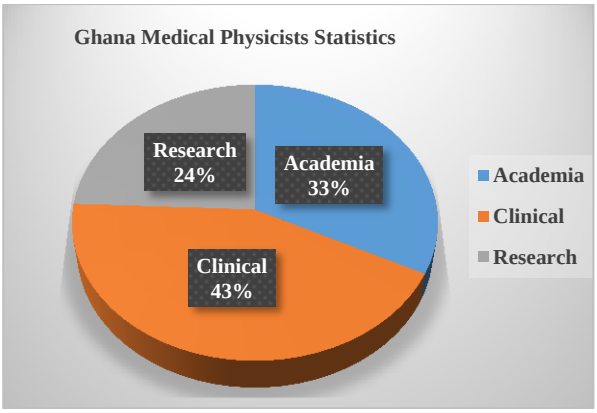

Fig. 1. Distribution of medical physicists in various sectors of practice [3]

Diagnostic radiological services has seen tremendous growth in Ghana, with the introduction of more imaging modality systems such as computed tomography, magnetic resonance imaging, mammography, conventional X-ray, dental X-ray, dual energy X-ray absorptiometry and fluoroscopy. Many diagnostic imaging centres have also migrated from film-screen radiography to computed and full digital radiology.

With Ghana's fast growing economy (presently, lower middle income status) and improvement in diverse sectors especially healthcare, it is projected that by 2019 each major (teaching, regional, district, etc.) hospital offering diagnostic radiological services would have at least 2 resident medical physicists.

The aim of this paper is to outline the various capacity building initiatives of medical physics in Ghana and Africa. The challenges of medical physics practice are discussed.

II. EDUCATION AND TRAINING OF MEDICAL PHYSICISTS IN GHANA AND AFRICA

The increase in awareness of the medical physics profession in Ghana and the urgent need for qualified personnel to support the nation's expanding radiological health program necessitated the development of capacity locally to train professionals. In 2004, a two year postgraduate course in medical physics education and training started in Ghana with 6 students. The program was hosted by the School of Allied Health Science (SAHS), College of Health Sciences, University of Ghana (UG) [1, 2]. The intensions of promoting post graduate education and training for preservation and enhancement of nuclear knowledge in Ghana and the rest of Africa saw the establishment of the Graduate School of Nuclear and Allied Sciences (SNAS) in 2006, jointly by GAEC and UG with support from the IAEA. Subsequently, the medical physics program was migrated from the SAHS and placed under the department of medical physics, SNAS, UG which is the only educational facility for the training of medical physicists in Ghana. In 2009, doctor of philosophy (PhD) programme in medical physics was also introduced and currently has duration of four (4) years.

In 2014, the department of medical physics, SNAS, was recognised as Regional Designated Centre (RDC) for Academic Education in Medical Physics by the IAEA and the African Regional Co-operative for Research, Development and Training related to Nuclear Science and Technology (AFRA).

Until 2009, the medical physics program was run as a biennial model. A total number of 74 students have successfully graduated at the master's level since the inception of the program. Eleven (11) IAEA fellows as well as 4 other foreign students have benefitted from the program. At the PhD level, the program has produced 4 PhD holders [1].

The Medical Physics Department is well resourced with professors, associate professors, and lecturers. The academic programme is interspersed with structured clinical training regimes at the three radiotherapy centres and other medical imaging facilities. Some of the lecturers double as clinical training supervisors, making the medical physics programme well harmonized and coordinated. Adjunct professors, lecturers and consultants have also been recruited from partner institutions from other IAEA member states to co-supervise research studies of PhD candidates who are on sandwich programs [1].

Local students undergo one year clinical internship after the master's programme, after which they are eligible to sit for a certification exam conducted by the Allied Health Professions Council (AHPC) of Ghana. Successful candidates are then certified and could undergo state registration and practice.

In Ghana, the pathway to training clinical medical physicists is presented in Fig 2.

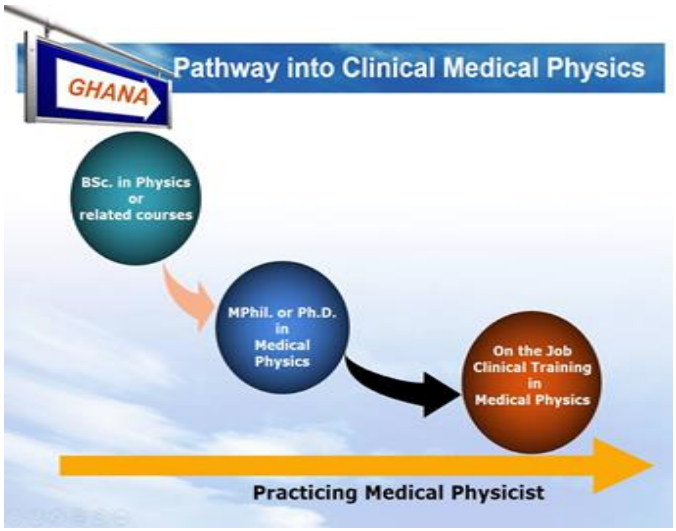

Fig. 2. Pathway to training a clinical medical physicist in Ghana [3]

Infrastructure available for education and training in the medical physics programme 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.

In addition, there are several other diagnostic radiology centres in both public and private hospitals which are contributing to the nation's medical imaging programme [4].

Accreditation of the training programme is done by the National Accreditation Board of Ghana through a standardised accreditation format [5]. The IAEA also undertakes frequent audits of the programme. Both institutions use the services of international experts and consultants to ensure neutrality and maintenance of high academic standards

III. GHANA SOCIETY FOR MEDICAL PHYSICS (GSMP)

The Ghana Society for Medical Physics (GSMP) was established in 2011 with an ultimate aim of promoting the application of physics to medicine [6]. The Society serves as checks and balances on the activities of professional medical physicists and contributes to the training of medical physics students in Ghana. With the passage of the Health Professions Regulatory Bodies Act 2013 (Act 857) [7], GSMP is mandated to regulate activities of medical physicists. Internationally, GSMP is affiliated to the Federation of African Medical Physics Organizations (FAMPO) and the International Organization for Medical Physics (IOMP). GSMP operates with a Constitution, Code of Ethics and Practice Standards, and achieves its objective by:

- Encouraging advancing and disseminating technical information, theory and practice of medical physics and related fields.
- Promoting a high level of ethical practice among medical physicists.
- Ensuring that medical physicists are engaged in technical procedures, which form part of patient care and treatment and
- Ensuring that medical physicists undergo certification examination and award of license to practice.

IV. ROLE OF REGULATORY AGENCIES

A. ALLIED HEALTH PROFESSIONS COUNCIL (AHPC)

The AHPC is the body established by an Act of Parliament (Act 857, 2013) to regulate the training and practice of allied health professions in Ghana [7]. This Act gives legal and professional recognition to the practice of medical physics in Ghana. This is in conformity with the classification of medical physics as a profession by the International Labour Organization (ILO) [8]. As part of its mandate, the Council is responsible for granting professional accreditation for all allied health programmes including medial physics. The Council is responsible for ensuring the highest standard in the practice of allied health profession in Ghana. The functions of the AHPC include the following;

1. Regulating the standard of services for the practice of allied health professions;
2. Ensuring that standards of study and training in recognised institutions are improved;
3. Setting practice standards of proficiency and conduct for allied health professionals;
4. Registering practitioners;
5. Monitoring and inspecting allied health facilities in collaboration with the health facilities regulatory agency;
6. Facilitating continuing professional development of practitioners;
7. Determining, in consultation with the appropriate educational institutions, courses of instruction and practical training for allied health professionals;
8. Determining and implementing post registration continuing education and continuing professionals development programmes for practitioners;
9. Ensuring that education and training of allied health practitioners and other allied health care providers are carried out at approved educational institutions;
10. Advising the Minister of Health on matters relating to allied health practice;
11. Conducting licensure examination for the registration of allied health professionals; and
12. Performing any other functions that are ancillary to the object of the Council

The AHPC has formulated a technical draft Legislative Instrument (LI) for allied health professions' regulatory bodies in accordance with the Health Professions Regulatory Bodies Act, 2013 (Act 857) [7]. All recognized allied health professions captured in the Health Professions Regulatory Bodies Act 857 (2013), including medical physics, have been given the opportunity to make an input into the LI.

B. NUCLEAR REGULATORY AUTHORITY (NRA)

There has been an enactment of a new independent "Nuclear Regulatory Authority (NRA) Act", Act 895 of 2015 to regulate the peaceful uses of ionizing radiation in Ghana [9]. Before the NRA came into being, the Radiation Protection Board of GAEC was the national competent authority for authorization and inspection of practices and activities involving radiation sources [10, 11]. The NRA took the regulatory functions of GAEC to enable GAEC focus on its core functions of research and training. It is anticipated that the NRA will seek to establish high standards of safety, security and safeguards in accordance with international best practices and in line with the IAEA Basic Safety Standards (BSS). The BSS used by Member States of the IAEA range in scope from engineering safety, operational safety and radiation, radioactive and nuclear material transport, and waste safety. The new Act addresses nuclear liability in accordance with IAEA conventions on liability.

V. CAPACITY BUILDING PROGRAMMES PROJECTS

A. NORWEGIAN PARTNERSHIP PROGRAMME FOR GLOBAL ACADEMIC COOPERATION (NORPART-2016/10470): GHANA-NORWAY COLLABORATION IN MEDICAL PHYSICS AND RADIOGRAPHY EDUCATION:

The main goal of the Norwegian Partnership Programme for Global Academic Cooperation (NORPART) project is to establish a partnership for education and research between institutions in Ghana and Norway within the fields of Medical Physics, Radiation Protection and Radiography. The main partners in the NORPART project are the Norwegian University of Science and Technology (through its Department of Physics) and the School of Nuclear and Allied Sciences, University of Ghana (through its Medical Physics Department). In addition, there are other network institutions both from Norway and Ghana of which GSMP is one. The objectives of NORPART are as follows;

1. Partnership for education and research in Medical Physics, Radiation Protection and Radiography.
2. Increased mobility of Medical Physics and Radiography students between the partner institutions.
3. Increased contact between and mobility of academic staff at the partner institutions

4. Increased quality and internationalization at the level of master and PhD study programs in Medical Physics and Radiography at the partner institutions

B. UNIVERSITY COLLEGE LONDON (UCL) PARTNER PROJECT

GSMP and SNAS have also been involved in a partnership on radiotherapy with the University College London under a project code named *paRTner*. This project involves medical physicists, and the objectives include; training of personnel, development of techniques and protocols, and increasing capacity of equipment.

In order to achieve the said objectives, the scope of the *paRTner* project encompasses the following;

a. Provision of resource in terms of training, teaching, personnel and equipment
b. Location of funding for training support, and assistance to help Ghanaian radiotherapy departments secure funding internally
c. Practical training course tailored to local needs
d. University collaborations, both in the UK and Ghana, and between Ghanaian universities and hospital departments.
e. Development of medical physics profession in West Africa through setting up an African radiotherapy consortium, a local training scheme and formalizing a career structure.

There has been some donation of radiotherapy equipment from the paRTner project to Ghana for clinical use and training.

C. IAEA RESEARCH PROJECTS

Under the auspices of the IAEA, a number of national Technical Cooperation (TC) projects on medical physics, radiation protection, radiation oncology, diagnostic radiology and nuclear medicine are currently ongoing. Ghana is involved in the following IAEA TC projects;

a. RAF6048: Strengthening Medical Physicists' Capacities to Ensure Safety in Medical Imaging, with an Emphasis on Paediatric Imaging Safety
b. RAF9033: Strengthening Radiological Protection of the Patient and Medical Exposure Control
c. RAF6044: Strengthening Medical Physics in Support of Cancer Management II.
d. GHA6017: Establishing a Nuclear Medicine, Medical Imaging and Radiotherapy Centre for Cancer Prevention, Treatment, Research and Development.
e. RAF9048: IAEA Regional Post-Graduate Education Course on Radiation Protection and Safety of Radiation Sources
f. RAF-057-9002-1: Strengthening National Capabilities on Occupational Radiation Protection in Compliance with Requirements of the New International Basic Safety Standards
g. RAF9053: Strengthening Member States' Technical Capabilities in Medical Radiation Protection in compliance with requirements of the new International Basic Safety Standards (BSS).

D. INTERNATIONAL DAY OF MEDICAL PHYSICS (IDMP) CELEBRATION- GSMP

Celebration of International Day of Medical Physics (IDMP) throughout the world has involved organizing seminars, symposia and public lectures among a host of other activities to draw gatherings and for practitioners and the general public to receive in-depth information about the medical physics profession. GSMP has actively celebrated the IDMP in Ghana on 7th November each year since its institution by the IOMP in 2013. This has given the medical physics profession a huge publicity in Ghana. Based on the theme for each year, the Society selects appropriate speakers for its celebrations. A list of speakers and their topics reflecting IOMP's theme for the year is presented in Table 1 below.

Table 1: Symposia for International Day of Medical Physics (IDMP) Celebration in Ghana for 2013-2016

Year	IOMP Theme	Speakers / Topic
2013	Radiation Exposure from Medical Procedures: Ask the Medical Physicist	Prof. C. Schandorf: Radiation Exposure from Medical Procedures - Ask the Medical Physicist
2014	Looking into the body – Advancement in imaging through Medical Physics	Mr. Eric Kotei Addison: Role of Medical Physics in Ultrasound Imaging Dr. Mumuni Abdul Nashirudeen: Role of Medical Physics in MRI Applications Dr. Alfred Ankrah: Nuclear Applications in Medicine (Nuclear Medicine) Dr. Samuel Asiamah: Computed Tomography Applications in Medicine
2015	Better Medical Physics = Better Cancer Care in Radiation Oncology	Dr. Joel Yarney: Better Cancer Care: Radiation Oncologist Perspective Ms. Clothida Muronda: General Cancer Care in Radiation Oncology Dr. Joseph Kwabena Amoako: The Role of the Regulator in the Advancement of Cancer Management Mr Eric Kotei Addison: Role of Medical Physicist in Better Cancer Care Management
2016	Education in Medical Physics: The Key to Success	Dr. Stephen Inkoom: Norwegian Partnership Programme for Global Academic Cooperation (NORPART) on Ghana-Norway Collaboration in Medical Physics and Radiography Education Dr. Mercy Afadzie: Sharing of Experiences as a Student in Norway Prof. Catharina de Lange Davies: Education and Training in Medical Physics: The Norwegian Experience

a. IMPORTANT MILESTONES AND FUTURE PROJECTIONS

Over the years, some key milestones have been achieved in the field of Medical Physics by key actors and stakeholders in the country, based on which some future projections are made:

b. The SNAS has since its establishment become a centre of excellence in Africa, and has consequently been accredited by the IAEA as a RDC by AFRA for Academic Education in Medical Physics in Africa [1, 2]. Through this, the IAEA as well as Governments of other African countries send students to be trained in this program. Every year, a number of well-trained medical physicists are churned out who feed into the growing national and African radiological health program

c. In 2011, the GSMP was formed as a professional association to promote the application of physics to medicine and to regulate the activities of clinical medical physicists [1, 7]. Led by the AHPC of Ghana, GSMP together with other professional associations making up the Ghana Federation of Allied Health Professions, have successfully worked towards the passage of the Health Professions Regulatory Bodies Act (Act 857 of 2013) [7]. The passage of the Act backs the practice of the profession and gives it the professional recognition it deserves. This is in conformity with the classification of medical physics as a profession by the ILO [8]. The GSMP draws inspiration from the IOMP and ensures that the roles and responsibilities of medical physicists are clearly adhered to [12].

d. The GSMP in collaboration with the Radiological and Medical Science Research Institute (RAMSRI) of the GAEC successfully implemented the National Project on Quality Assurance Audit of Radiotherapy Facilities in November 2016. The exercise which was based on the recommendations of the IAEA served purposes of giving credence to the quality of radiotherapy services being offered to patients who patronize these facilities. Owing to the success of this activity, there are plans to undertake similar missions for Quality Assurance Audit of Diagnostic Radiology and Nuclear Medicine Facilities in 2017 [1].

e. In December 2016, RAMSRI through the GAEC, IAEA, the World Health Organization's Regional Office for Africa and the International Agency for Research on Cancer, hosted a 5-day Workshop on the establishment of Cancer Registries to intensify Cancer Control. The workshop brought together participants, health authorities and cancer control experts from 20 different Anglophone countries. Cancer registries compile and provide information on the number of new cancer cases, in addition to the total number of cancer cases, as well as death and survival rates. With this data, policymakers can more effectively plan services, from prevention campaigns to treatment for cancer patients. The GSMP was well represented through this workshop as it presented credible roadmaps in the management of cancer in Ghana [13].

VI. CHALLENGES OF MEDICAL PHYSICS PRACTICE IN GHANA

A. *PLACEMENT OF MEDICAL PHYSICISTS IN THE HEALTH SERVICE SALARY STRUCTURE*

Currently, medical physicists are not captured on the salary structure of Ghana's Health Ministry. The GSMP has therefore petitioned the Ministry of Health to consider the medical physics profession as a Medical Occupation (Health Professional) in the Health Structure. The petition is humbly seeking to address non-existence of the medical physics profession in the health structure as a clinical specialty although the Health Professions Regulatory Bodies Act 857 of 2013 legally recognizes the Medical Physics profession as an Allied Health Profession [7].

Other challenges are the non-existence of medical physics departments in the major hospitals and the non-availability of resident medical physicists at most diagnostic imaging centres. However, these challenges are being addressed by the regulatory agencies. There are also challenges with unavailability of some selected advanced phantoms and dosimetry equipment for students' clinical training and research studies.

VII. THE WAY FORWARD

The future of medical physics in Ghana is bright. The implementation of Act 857 and the passage of the NRA Act 895 will see more employment opportunities for medical physicists. It is equally anticipated that the full recognition of the profession will come with well deserving conditions of employment. The acquisition of more equipment (two linear accelerators presently under installation), especially in the two public oncology centres proffer greater advantages to boost student experiences during clinical rotations. With admission into the 2-year master's program becoming keener and keener largely due to increasing number of applications from both locals and foreign students, it is suggestive, that the number of qualified medical physicists in Ghana will increase in the very near future which casts a bright shadow on the sustenance of our radiological health program.

There are also proposals to establish Ghana College of Allied Health in the near future. A technical committee has been put in place and is working on establishing the framework for the College. Once established, the College will offer training to allied health professionals in specialized areas and to become consultants who would handle complex medical conditions with great success.

This will reduce the over reliance of training consultant medical professionals outside the country.

VIII. CONCLUSION

Medical physics training and practice in Ghana has been fairly successful since it begun. Clinical medical physicists have over the years played central roles in imaging, therapy and nuclear medicine procedures. As the GSMP continues to grow in numbers (qualified medical physicists), there is an anticipated sustainability in both training and practice of radiological procedures in the country. The profession can therefore look confidently into the future and hope to offer significant contributions in healthcare.

IX. ACKNOWLEDGEMENT

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X. CONFLICT OFINTEREST

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

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