MEDICAL PHYSICS AND RADIOGRAPHY TRAINING MODEL TAILORED FOR RESOURCE LIMITED SETTINGS

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***Abstract*— Medical Physics and Radiography training require a tailored, practical-focused curriculum deployed in well-resourced facilities. However, resource limited settings in low- and middle- income countries are faced with challenges of low expertise, brain drain, and lack of adequate medical equipment to optimize healthcare services in these regions. Various training models have been implemented for specific professionals, which can be modified to develop a framework for a structured practical training for Medical Physicists and Radiographers practicing in these regions. This paper presents a modified Teach-Try-Use approach to training of Medical Physicists and Radiographers in resource limited settings. The aim of such a program is to optimize the limited resources, both human and equipment, to meet the training needs of professionals in resource limited settings. Recommendations are made on how the model can be sustained and strengthened over time. It is expected that there will be challenges in the initial stages of its implementation, but these challenges should present opportunities to even make it better in future rounds of the implementation process.**

***Keywords*— Medial Physics, Radiography, low- and middle- income countries, curriculum, education**

I. INTRODUCTION

Medical Physics and Radiography services have become the core of healthcare systems in developed nations. In many of such jurisdictions, there are even healthcare personnel specialized in sub-disciplines of Medical Physics and Radiography. The situation of low- and middle- income countries (LMICs) is very different in terms of the availability of equipment, expertise and support systems [1,2] to enable full implementation of Medical Physics and Radiography practice. The consequence of this situation is often brain drain of the few experts to the developed settings, poor maintenance of equipment due to lack of effective quality control programs in most health facilities, and overall high cost of Medical Physics and Radiography services to the general population, where such services are available.

Pragmatic steps are therefore needed to adequately train, retain and equip the current cadre of professionals and yet-to-be inducted professionals of Medical Physics and Radiography in such resource limited settings. This would not only strengthen the practice of these very critical healthcare professions, but would ensure equitable provision of adequate and quality healthcare services in these regions. The broader effect would then be a significant step toward achieving universal health coverage by 2030/2035.

The ideal order of steps to narrow the yawning gap in Medical Physics and Radiography services between the developed and developing nations would involve training of professionals, establishment of active professional networks of these professionals across borders, and provision of the relevant equipment in health facilities to support their practice. The nature and burden of diseases are becoming complex and, in some cases, could become global pandemics such as COVID. Preventive measures therefore are crucial in curbing the impacts of such pandemics. Medical Physicists and Radiographers have important roles to play in this regard.

Based on a number of existing models in other specialties (such as Radiology [3], MRI technology [4], Artificial Intelligence [5], and Medicine [6]), this paper proposes a structured model within which various curricular could be harmonized to train and upskill the expertise of Medical Physicists and Radiographers practicing in LMICs where most healthcare facilities are resource limited in terms of both expertise and equipment. The training model is relevant for all specialties of Medical Physics and Radiography and could be curated for any setting.

II. IMPLEMENTATION OF THE MODEL

A. NEEDS ASSESSMENT SURVEY

There is clearly a need for a structured, tailored, and sustainable Medical Physics and Radiography training in regions such as Africa, Latin America and South-East Asia. However, rather than using a one-size-fits-all approach to this, there should be a needs assessment using the same tool in all regions. This will provide information about the nature and scope of the needs of practitioners in these regions as well as available training resources, so that the appropriate training methods and content can be tailored to the needs of the experts in each region. Where necessary, steps should be taken to identify training facilities to support the practical components of the training.

Leadership of regional Medical Physics and Radiography professional bodies should collaborate in this in order to coordinate the process through targeting their members. Experts in the design and analysis of appropriate tools for needs assessment could be engaged to assist the professional bodies in this regard. Not less than a response rate of 70 % to the needs assessment questionnaire should be targeted in each region. This would ensure that the multiplicity of challenges and professional needs of their members are well captured to influence the content of the training curriculum.

B. CURRICULUM DESIGN STRATEGY

Based on the needs assessment, a call should be made to invite curriculum design and educational content development experts to participate in the curriculum design process. All of them do not necessarily need to be Medical Physicists and Radiographers, particularly when there is the need for the group to work on developing the content and deploying them through various media platforms.

Generally, the curriculum for both professionals must have both theoretical and practical components, specific to each specialization. The theoretical component should cover all the basics required in the subspecialty of each field. For example, Medical Physicists in Radiation Protection do not need to go through the basics of Diagnostic Imaging Physics, if those topics are not relevant to their practice. Of course, specific imaging modalities that are based on ionizing radiation (such as computed tomographic and X-ray imaging) could be covered, but not in much detail as would be covered for those in Diagnostic Imaging Physics. Radiography professionals, on the hand, will be taken through all imaging modalities, but with limited physics content. Such fine adjustments will enable the content to be tailored to all professionals, regardless of their levels in the profession.

There should be more focus on the practical components of the curriculum. The needs assessment should have elements to enable the creation of a database of possible (private and public) training facilities at universities, hospitals, medical equipment vending companies, and research units. Both local and international experts (researchers, clinicians, equipment vendors, etc.) willing to form the faculty to provide training should be contacted both directly and indirectly by invitations. There should be minimum practical training hours to be achieved by all participants which would ensure that they acquire the requisite skillset for their specific practice.

The curriculum design phase should include pooling all these expertise and equipment together in readiness to implement all aspects of the training. An example of this strategy is currently being implemented by the Scottish Imaging Network: A Platform for Scientific Excellence (SINAPSE) [7]. SINAPSE is a collaboration of experts with medical imaging resources pooled from seven universities in partnership with the National Health Service and industry within Scotland, to support research and training in Imaging Sciences. The goal of the consortium is to develop novel imaging methodologies and the next generation of scientists to apply these methodologies in addressing healthcare needs of the population in Scotland.

C. THE TRAINING MODEL

The tailored curriculum in the respective regions can be delivered using a modified approach of the Teach-Try-Use model previously implemented in Artificial Intelligence training [8,9]. The specific modifications of the model, incorporating other models, for Medical Physics and Radiography training are described as follows.

The *Instructive* component of the model will involve teaching participants the basics about the relevant themes related to their practice over a planned period of time. This can be a combination of live virtual and recorded lectures delivered by experts in various fields. In some cases, face-to-face or virtual tutorial sessions and seminars can be planned at the local sites of the training to provide further opportunities for participants to properly understand the concepts. Short quizzes could be used to assess the depth of their appreciation of the content delivered, whereas the interactive tutorial sessions will offer them an opportunity to have their challenging questions answered.

The *Try* component of the model will involve practical demonstrations of concepts by experts to participants either in face-to-face sessions (for those with access to the equipment) or in live video demonstrations, recorded versions of which can be accessed online by participants any time after the sessions. This component of the training should immediately follow each specific instructional session on the practical topic so that participants can easily relate the two for better appreciation of the concepts.

The *Use* component of the model will involve participants using the theoretical and practical knowledge gained to solve a number of practical real-life problems in their respective disciplines. Well-planned problems will be presented to them in teams, so that in a peer-to-peer interaction [3], they share knowledge and experiences in a problem-based learning fashion [6]. The topics to be considered here could range from optimization of quality control protocols, imaging techniques, patient safety issues, acceptance tests, etc. Solutions could be simulated with the aid of various simulation/virtual software and platforms and reports presented as project seminars to be assessed. The team leaders here will later become permanent facilitators for the program in their respective countries, whereas the team members will be added into a database to create an academy of trained experts who can always be contacted at any time as experts to train their peers.

Figure 1 shows the summary of the model, Figure 2 shows the organogram of the model implementation team and Table 1 shows the roles of the team members.

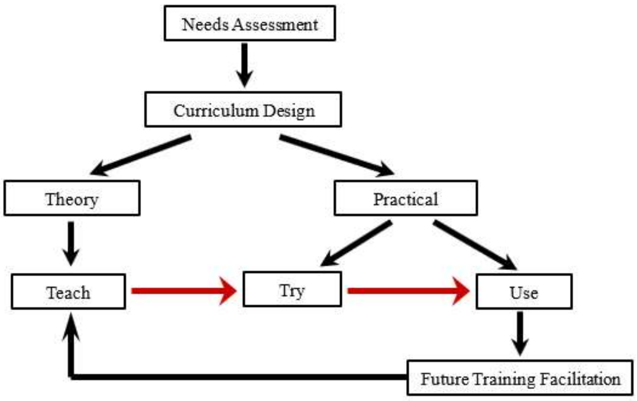

Fig 1 Structure of the training model

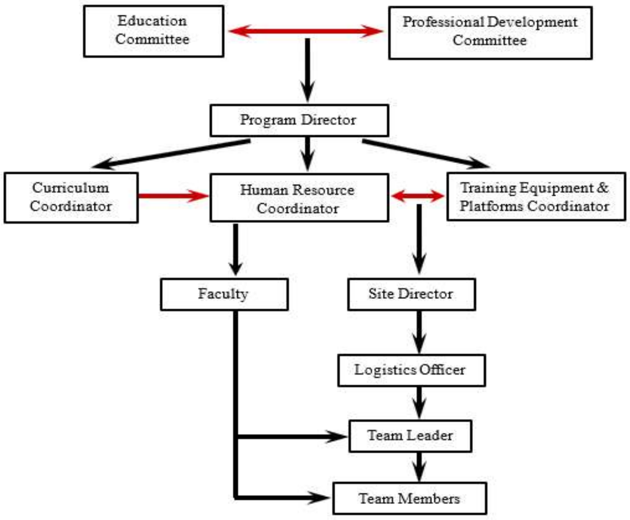

Fig 2 Organogram of the team to implement the training model

Table 1 Functions of the various team members to implement the training model

Team Member	Function in the model
Education Committee	Develops and revises the needs assessment tools and presents a synopsis of the curriculum to the Curriculum Coordinator to develop it further. Oversees the effective implementation of all aspects of the program
Professional Development Committee	Develops and maintains a database of accredited training facilities and available equipment for the practical component of the training. Responsible for continuous professional development program planning, and providing avenues for inter-regional interactions through conferences, seminars, summer schools, etc.
Program Director	Collaborates with the Education and Professional Development Committees to recruit and coordinate the functions of the Curriculum, Human Resource, and Training Equipment and Platforms Coordinators.
Curriculum Coordinator	Puts a team together through the support of the Education Committee to develop a tailored curriculum based on needs assessment outcomes. Reports to the Human Resource Coordinator the list of expertise or specialties of faculty required to teach various aspects of the curriculum
Human Resource Coordinator	Identifies, contacts, recruits and maintains a database of all experts who will serve as faculty or trainers in the program. In addition, provides and monitors the code of conduct of all stakeholders in the program. Responsible for coordinating a team to select applicants for the program based on established eligibility criteria.
Training Equipment and Platforms Coordinator	Coordinates with the Human Resource Coordinator to identify and recommend platforms, software and general resources needed by the faculty to teach. At the same time, sends a list of required resources to the Site Director.
Site Director	Recruits a Logistics Officer at their site to assist them with making arrangements for logistics support for the training at their local site. Ensures that an effective platform and environment are available for the smooth interaction between faculty and trainees
Logistics Officer	Ensures availability of functional equipment and other resources to support a smooth deployment of the training content to trainees
Faculty	Various experts including researchers, university teachers, clinicians, equipment vendors, etc. who will be teaching various aspects of the program content
Team Leader	This usually will be the seniormost member (in rank and expertise) of the team of trainees who will conduct tutorials for the team, and at the same time will receive mentorship on aspects of the training curriculum. Evolves to become a permanent facilitator to train others in their region.
Team Members	Each team will comprise of a maximum of ten members, excluding the Team Leader. They will receive the training over a planned period, and are therefore the target beneficiaries of the program. They later become academy members as team of experts to rely on as trainers of their peers in the future.

D. PROGRAM SUSTAINABILITY

The training model can be established and maintained if the following recommendations are taken into consideration:

- *Education Committee*

Each regional professional body must have an education committee whose membership should take on the roles discussed in Table 1. The function of this committee will, among others, include taking steps to revise the training curriculum as frequently as necessary to include new and emerging themes/topics and best practices for the respective specialties; they will also conduct participant satisfaction and skillset upgrade surveys in respect of whether their expectations and needs were met after every round of completion of training session. The outcomes of such surveys will inform the revisions to the curriculum.

- *Professional Development Committee*

There must also be a professional development committee (Figure 2) in each regional society. Their function will be to identify and create a database of accredited facilities that will be ready and willing to support the practical component of the training. The committee should engage international societies they are affiliated to, in order to gain access to a wider scope of facilities and equipment vending companies. Involvement of vendors in this aspect of the training could offer such facilities firsthand access to the vending companies for support in areas of appropriate contract terms, equipment upgrades and troubleshooting, and site-specific training opportunities. In addition, the committee must design a structured credit scoring system to award professionals points toward their annual professional PIN renewal. Lastly, in collaboration with the education committee, the professional committee should organize inter-regional seminars, summer schools, and establish collaborations to enable exchange of ideas, networking, and offer platforms for presentation of common challenges and progress under the training program.

- *Center of Excellence*

Steps should be taken to either use the SINAPSE model of resource pooling [7] or establish regional centers of excellence for Medical Physics and Radiography training. Exchange programs, internships, and visiting lectureship arrangements could be made among such centers in the training process. The centers should be ultimately resourced and accredited over time to provide structured academic and continuous professional training toward certification. At the centers of excellence, steps should be taken to eliminate language barrier in the deployment of the curriculum by engaging other trainers who can speak the languages of trainers, where applicable.

- *Training College*

There should be an established collaboration between academic institutions, industry and the managers of the program in such a way that the relationship could evolve into an established training college with both virtual and physical space coverage within each region. Mounting the training model in such an establishment could make it easier to consider structured and accredited postgraduate training as well, to eliminate the barriers to postgraduate scholarships and opportunities for Medical Physicists and Researchers who may wish to join academic institutions. There are limited opportunities for postgraduate education in these two areas in most LMICs; this program could therefore evolve to provide such opportunities.

- *Funding*

A funding scheme for the program can be established and sustained through contributions of participating universities in terms of teaching, supervision, fee waivers, and equipment. The regional bodies could as well provide some funding support, through annual dues, to supplement other sources of funding for the program. Partnerships with vending companies and global healthcare bodies could offer opportunities to access funds to sustain the budget for the program. Indeed, academic training toward postgraduate certification should be charged to raise funds for the program, but significant fee waivers should be considered for applicants from LMICs.

- *Motivated Trainees*

Finally, participants must willingly apply to participate in the program and must show evidence of a need and motivation to engage in the program. Participants must have specific compulsory deliverables at every stage of the training, before they progress to the next stage. This is to ensure their active participation throughout the training process. Continuous professional training programs should be free, subject to trainees being in good standing with their professional societies. Postgraduate training on the other hand should be charged at high rates of fee waivers.

III. CONCLUSIONS

Medical Physics and Radiography training require the deployment of a tailored curriculum in well-resourced facilities. In the absence of such facilities, there is a need to develop and deploy innovative curriculum in a way that should meet the needs and expectations of all trainees. The refined Teach-Try-Use model is one effective means of meeting this requirement in resource limited settings. Challenges to be encountered in its implementation could provide avenues to perfecting the model in specific settings.

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