MEDICAL PHYSICS STATUS IN CUBA. CURRENT SITUATION AND FUTURE DEVELOPMENT.

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Abstract— **During the last decade cancer in Cuba has become in a special care issue, due to the impact that disease has played in the Cuban society. The demanded technologies to deal with this disease imply accounting with qualified personnel. Medical physics provides the physical basis for understanding and implementing such technologies. Accounting with the adequate academic program ensures the continue education. In this paper an analysis of the Medical Physics status in Cuba was performed, regarding the academic programs available till 2014 and their future strengthening projection. The evaluation of the future personnel necessity in this field was done as function of the projected acquisition technologies program.**

Keywords— **academic program, Medical Physics, future necessity.**

I. Introduction

During the recent years, cancer mortality has increased in the Cuban society (Fig. 1), which in 2013 was integrated for 11210064 habitants [1]. Since 2012 cancer has become in the first cause of mortality in Cuba, reaching the number of 22655 deaths in 2012 and 22868 deaths in 2013 as is showed in the Figure 1.

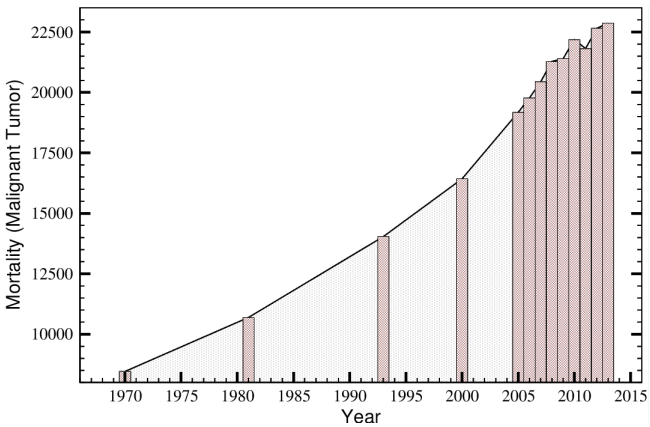

Fig.1.Cancer incidence in Cuba [1, 2]

The development of new technologies has caused that the Clinically Qualified Medical Physicist (CQMP) demand has increased significantly, not only quantitatively, but the demand for their academic and professional preparation. The increase of the complexity in dose calculations in patients, medical imaging processing algorithms, together with the necessity of performing measurements with equipment of a high level of complexity, leads to the necessity of personal with a theoretical and practical basis as to competences and skills in the Medical Physics (MP) field.

MP provides the physical basis for many therapeutic techniques and the scientific basis for understanding, implementation and development of the technologies that are revolutionizing medical diagnosis, and establishes the criteria for the correct use of physical agents applied in medicine

II. Radiation Medicine Equipment in Cuba

Health authorities in Cuba have made significant investments in recent years to provide the radiation medicine specialties with state of art equipment (linear accelerators capable IMRT, IGRT and IORT; HDR units, multi-slice CT scanners, hybrid nuclear medicine scanners, such as SPECT-CT and PET-CT, etc.), in recognition of the need to strengthen the quality of diagnosis and treatment with ionizing radiation, in turn increasing the number of patients with access to these technologies.

Table 1. Main Radiation Medicine equipment in Cuba. First column shows the available equipment, second column includes equipment commissioned in 2014 and/or purchased in 2015.

Equipment	Existing 2014	2014-2015 Acquisition/ commissioning	2016-2017 Acquisition (projected)
Radiotherapy			
Linear Accelerator	6	2	2
Co – 60 Teletherapy	11	1	2
HDR Brachytherapy	3	2	1
Superficial Radiotherapy	-	3	4
CT Simulator	-	-	7
TPS	17	2	3
Nuclear Medicine			
SPECT	7	14	-
SPECT - CT	-	-	1
Therapy	2	-	-
PET - CT	0	2	1
Ciclotron	-	-	1
Diagnostic Radiology			
Conventional Radiography	1000	53	-
CT	39	1	-
Mammography	26	5	-

Ultrasound	500	35	-
Digital Radiography Equipment	10	17	-

Although Cuba is a middle income country, in 2014 the country accounted with the main technologies that supplies the radiotherapy treatment and also the diagnostic radiology and nuclear medicine fields. Table 1 shows a summary of available and projected main radiation medicine equipment.

As shown, the amount and complexity of equipment means that the demand of medical physicists is continuously increasing. Additionally, the training requirements of medical physics must take into account also the traditional provision of technical support to other countries (at the moment of redaction of this report, 7 medical physicists are deployed in mid-term missions in Algeria, Ecuador and Surinam).

III. Staffing

The introduction of new technologies in Cuba, has progressively increased the demand of Clinically Qualified Medical Physicist (CQMP) in hospitals. Taking into account the national program for acquisition of equipment and the traditional international cooperation, an estimation of staffing requirements is shown in the Figure 2.

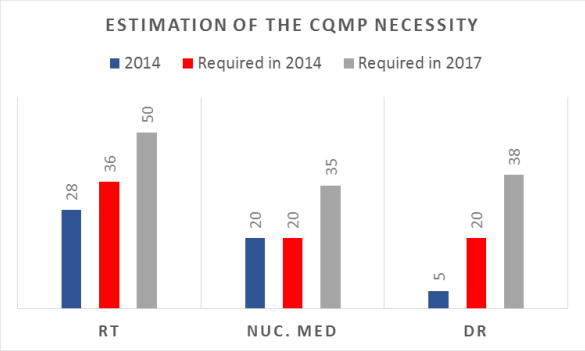

Fig. 2. Medical physicist requirements in 2014 and near future (based on indexes proposed in [3]).

The IAEA has recommended in the Human Health Report # 1 [3] that education and training of CQMP should be structured in 3 main professional academic elements:

1. university degree: BS in Physics, or equivalent,
2. postgraduate specialization degree (courses, formal programs, seminars and practical work in MP) with minimum of 1-2 years,
3. supervised clinical training, that means, program for acquisition of skills and competencies for independent performance in any of the areas of MP with minimum of 1-2 years.

As the health system in Cuba is all public, since early 80's all the NM and RT services had the Ministry of Health mandate of hiring medical physicists as part of their staff. This measure implied that the amount of physicists working in hospitals increased significantly, in comparison with other Latin-american countries. The difference is still very pronounced in the field of Nuclear Medicine, where the availability of CQMP is relatively much higher than most of the low/middle income countries (LMIC). The main source of professionals entering the hospital were graduated of nuclear related undergraduate programs: bachelor in Nuclear Physics or Nuclear Engineering, graduated locally or in former European socialist countries, so they had a very strong background in Radiation Physics, nuclear instruments and so. These conditions allowed the establishment of a critical mass of teachers and trainers that conducted to setting up academic programs in Medical Physics nationally.

In Cuba during more than a decade, there have been several academic training modalities of MP, taking into account the guidelines recommended by the IAEA and also the national requirements for licensing in-hospital MP in Radiotherapy [4] and in Nuclear Medicine [5] established by the national nuclear regulatory body (CNSN). To become in a CQMP in Radiotherapy (RT), Nuclear Medicine (NM), or Diagnostic Radiology field the candidate should has a diploma in Physics, Nuclear Physics, Nuclear Engineering or any other related field, a specialization in MP and Radiological Protection, and has at least 6 months working in one of those fields, under supervision of a licensed medical physicist.

The Cuban Master in MP Program (MMPP) covers the 4 main field that are requested by the regulatory authorities. The National Center of Nuclear Security (CNSN) has accredited the MMPP and the Diploma Programs as the academic training to provide individual medical physicist license in these specialties.

However, the figure of CQMP has not been officially recognized by the health authorities, reason why in the country does not exist yet a system of professional certification of the CQMP. Their clinical training is still conducted in a heterogeneous way, without following guidelines duly authorized or accredited by professional bodies programs.

Moreover, the time required by the CNSN experience in the specialties of Radiotherapy and Nuclear Medicine to provide individual medical physicist license is much lower than recommended by international organizations [6, 7, 8].

Neither there are credit based continuing education programs in MP, even though every year courses, seminars, conferences, symposia, and workshops are organized, at national and international level, which eventually involve CQMPs.

The institution which has traditionally focused and promoted academic training of the CQMP has been the

Higher Institute of Technologies and Applied Sciences (InSTEC). The analytical program of the InSTEC's Master in MP is already 14 years old and is being updated, both in content and in the teaching staff. The undergraduate programs of InSTEC such as Nuclear Engineering and Nuclear Physics started offering electives subjects in MP, increasing the interest in undergraduate students in MP, with many of them developing their diploma thesis in this field. InSTEC is also promoting national and international cooperation projects in order to enhance and strengthen the education and training of medical physicists in Cuba. A national project has been approved by the Ministry of Sciences, Technology and Environment (CITMA), which main goal is to establish a comprehensive methodology for education and training in MP in Cuba, applicable to other LMICs. A new Technical Cooperation project with the IAEA (CUB2014004) is in the final design phase, with one output devoted to strengthening the structure for the academic education of nuclear medicine physicians, radiation oncologists and CQMP in those fields.

Currently, most of the CQMP in Cuba are linked to RT or NM departments, in an amount that is quantitatively close to the requirements, not so qualitatively. In the field of Diagnostic Radiology the number of CQMP is extremely low, as there are not yet local regulations demanding this profession in those areas. There is a strong but small group of medical physicists working in the Cuban Medical Equipment and Drugs regulatory agency (CECMED), who are in charge of performing acceptance testing, commissioning and routine quality controls of most of the X-ray based imaging devices, such as mammography, CT scanners, equipment for interventional radiology and X-ray units used for treatment planning purposes in RT. This group is also responsible of performing the external audits of RT and NM services, ensuring traceability and uniformity in the dosimetry and QA protocols, working together with the Cuban Secondary Standard Dosimetry Laboratory. Finally, there are smaller groups of physicists working in research and education linked to Medicine, supporting the educational programs in MP, mentoring students and promoting continuous education courses and workshop, as the biannually performed WONP/NURT (www.wonp-nurt.cu).

IV. Conclusions

To deal with the advanced Radiation Medicine technologies it is a must the improvement in quantitative and qualitative training of CQMP in Cuba. To achieve that goal, a comprehensive education program for CQMP, from undergraduate to clinical training is being designed, in the framework of a national and an IAEA´s technical cooperation projects. One of the main challenges to face will be the implementation of supervised, competence-based clinical training programs for MP in the 3 main specialties of Radiation Medicine: RT, DR and NM, following IAEA guidelines [6, 7, 8]. That should leads to the enhancement of the academic and clinical training of MP at university level. Recognition of the role of the MP in the health system, homologation of their academic and clinical training level will be of great help in the future advance of the profession.

Acknowledgment

The support of international organizations, such as IAEA, PAHO, ICTP, IOMP, ALFIM and AAPM in providing education and training to many Cuban medical physicists, has been crucial for reaching the current level of development of the profession of Medical Physics in Cuba.

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