# THE PROFESSIONAL MASTER'S DEGREE PROGRAM ON MEDICAL PHYSICS IN BRAZIL - A NOVEL EXPERIENCE

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*Abstract*— **It is indeed highly commendable the efforts made by national and international organization such as, IOMP, IAEA and WHO to provide recommendations regarding the curriculum of the Medical Physics educational program. However, the particularities and the needs of each country and the financial opportunities that arise make it very difficult to follow precisely those guidelines. This program was created to attend a critical demand generated by a massive Linac acquisition program made by the Ministry of Health to fill part of the existing lack of radiation oncology centres in Brazil. The content and number of hours of the course have followed very closely the international recommendations and specifically the requirements established by the Brazilian Society of Medical Physics to prepare the emerging students to be eligible for Board Certification, a process that exists since 1979. As result, the Universidade do Estado do Rio de Janeiro (UERJ) and the Cancer Foundation (CF) decided to create a professional Master's degree in Medical Physics, a novel experience, to adequately train physicists to be prepared to work as a professional in radiation oncology centres. The result was excellent, all 22 students were able to complete successfully all the requirements and now they all are working in the field.**

*Keywords*— **Brazil, Master's degree, Medical Physics.**

## I. INTRODUCTION

The present population in Brazil is about 220 million people, distributed unevenly in a continental area. The number of new cancer cases in the present year estimated by the National Cancer Institute (NCI) is of about 600,000 disregarding the non-melanoma skin cases. As a result, 60% will need radiation therapy at some point of their treatment.

There are 265 cancer centres with 320 machines, mostly linear accelerators, and a few Cobalt units, though a significant portion of machines are lacking the most recent technology to allow intensity modulated radiotherapy (IMRT) and hypofractionation treatment schemes.

This small number of machines results in about 40,000 people without access to this treatment option as reported in the study of the stereotactic body radiotherapy (SBRT).

In 2012, The Ministry of Health decided to launch the National Expansion Plan in Radiotherapy which included the acquisition of 100 linear accelerators to be installed in different regions of the country in new centres or replacing old machines or enhancing the capabilities of some regional centres.

Now, more than half have been being installed and are functioning and installation is in progress for the other half but with some delay due to the need for having extensive building construction, especially in the new sites.

As expected, a demand for instance of qualified medical physicists for this program was higher than what the established training centres were able to provide.

The Cancer Foundation, in association with the State University of Rio de Janeiro, and funded by the Ministry of Health decided to offer an extensive training program of 1,200 hours for training new radiation technologists, several up-dated short courses for the medical physicists, radiation oncologists, nurses working in radiation therapy and to create a Professional Master's Degree Program in Medical Physics.

The main objective of this paper in to describe and share the experience with the design, implementation and the results of the Professional Master's Degree Program in Medical Physics, designed in a moment where there was an expectation of a shortage of 100 medical physicists in the country – number that will not be fulfilled by the existing program.

Since 1979 in Brazil, for medical physicists to become responsible for activities in radiation oncology centres, they must be Board certified by the Brazilian Association of Medical Physics or have an equivalent certification recognized by the Licensing Authority. In both cases, several hours of clinical training under the supervision of a Board-Certified Medical Physicist is required to be eligible for the Board Examination or to be recognized as such.

At present, there are several BSc. in Medical Physics programs which function as an introduction into Medical Physics. There are several academic oriented Master and D.Sc. programs in Medical Physics which are more research oriented with insufficient clinical experience, and several residency programs, mostly clinically oriented with unsatisfactory academic content.

## II. PROJECT DESIGN

This project was designed as a final goal to train medical physics students or to allow working medical physicists to upgrade their expertise specifically in radiation oncology.

The main motivation to create the Professional Master's Degree in Medical Physics was to offer a training program that would harmonize both aspects, the academic and the clinical training. The program was designed and conducted in seven complementary modules, totalling 91 weeks with 60 hrs/weeks.

The first module began with 611 hours of intensive solid academic content, including practical classes providing sufficient information to allow the students to follow the coming activities on the designated cancer centres where the clinical training took place (Figure 1). A treatment planning system (TPS) CAT-3D with a non-clinical license was installed on each computer and a set of typical clinical cases were used for their initial training.

Figure 1a: Exercise on how to make moulds and masks

Figure 1b: The TPS being used under proper supervision

The following modules started with a minicourse of 40 hours and then 8 weeks of clinical training. During each phase of the clinical training, they were free to follow the routine defined by the preceptor and in addition the central coordination requested to concentrate and fully register the treatment planning and QA locally used for some of the most prevalent types of tumours such as prostate, breast, lung, colon rectum, lymphoma, head and neck cases.

After each clinical training module, all students came back to the Cancer Foundation headquarters and the first week was dedicated to the individual presentation of at least one case planned and treated in each place where there was exchange of different experiences and approaches by each student.

During the following week, all students participated in a hands-on 40-hour theory and experimental exercise in one of the minicourses below:

- The IAEA TRS 398 Dosimetry Code of Practice
- Machine commissioning
- Data acquisition, modelling and TPS validation
- Quality assurance of IMRT and VMAT
- Dosimetry of small fields

The number of hours of the six modules amounts to 611 hours of theory and 4,739 hours of clinical work, 5 specific mini courses of 40 hours each.

The short courses were also open to 20 medical physicists already working in public radiation oncology centres. After each module, a written examination was applied covering topics previously planned for each module.

The final stage (two weeks) of the program was dedicated for each student to present before a committee their mini projects developed under the supervision of local preceptors.

The number of hours (5,350 hours) is considered sufficient for the students to be eligible for the Board examination by Brazilian Association of Medical Physics (ABFM) and/or professionally be accredited and recognized by the Licensing authority, the Brazilian Nuclear Energy Commission (CNEN). Figure 2 is an overview of the course structure.

To undertake such a project, the Cancer Foundation (CF) in collaboration with the State University of Rio de Janeiro involving several regional radiation oncology centres submitted a Grant Request to the Ministry of Health, which was approved within the framework of the PRONON, which allows the CF to gather financial support from several companies.

**Staff involved:**

Eight Ph.D., four MSc., one PMO, one M.Sc. in education, twenty-five invited lecturers, five staff clerical workers, two TI and twenty-two preceptors all Board certified in Medical Physics.

**Financial Aspects:**

During the course duration of 24 months a fellowship was provided, the transportation costs and as well as a token grant to each institution to cover the costs incurred by the students. The training grant also covered the administrative costs and a token fee for each invited speaker.

**The Students Selection Procedures:**

- Priority was given to the new sites designated by the Ministry of Health project
- Letter of recommendations from Radio Oncologist and Medical Physicist
- Analysis of the curriculum vitae
- Online interview by Skype carried out before 3 staff members
- Medical record
- English proficiency (reading & understanding)
- Institutional indication of their desire to hire the student upon return.

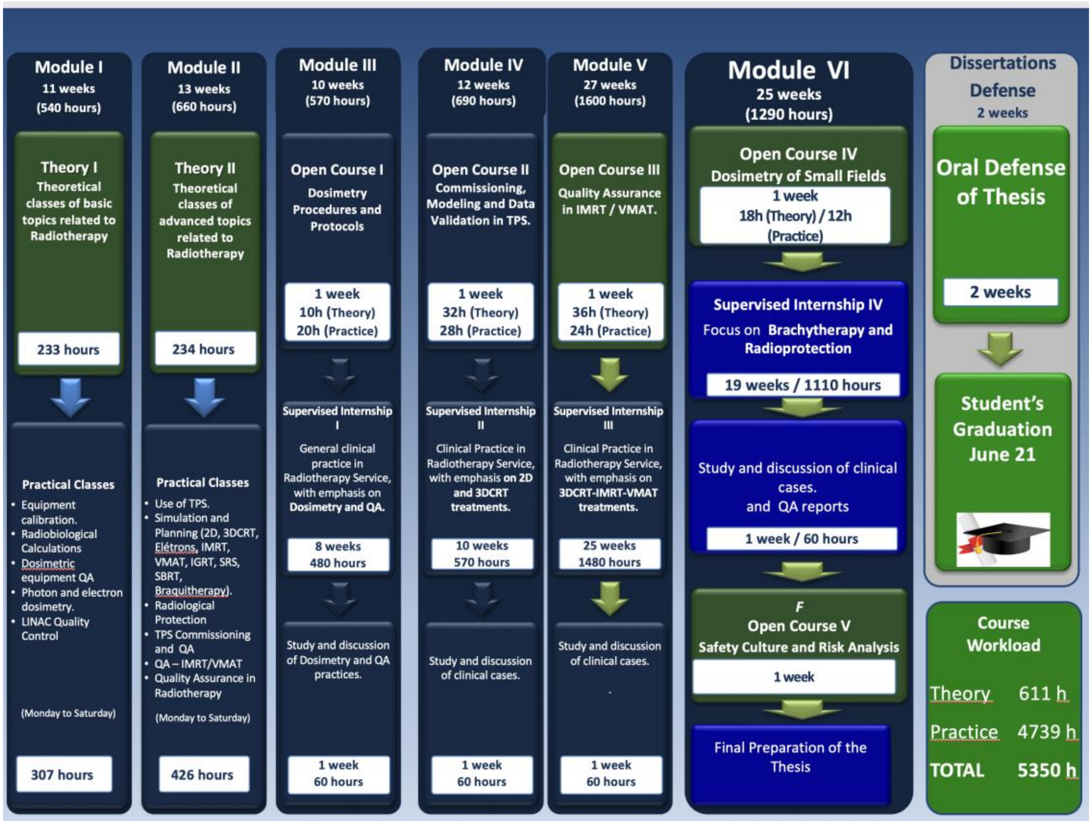

Figure 2. An overview of the course structure

In the selection process, 27 students were initially selected out of 32 applicants to finally result in 22 students from 12 different states (Figure 3).

Figure 3. Students initially selected into the program

## III. METHODOLOGY

To manage so many areas involved in the project, a software named Tandle (Teach and Learn) was developed to manage all areas of the project.

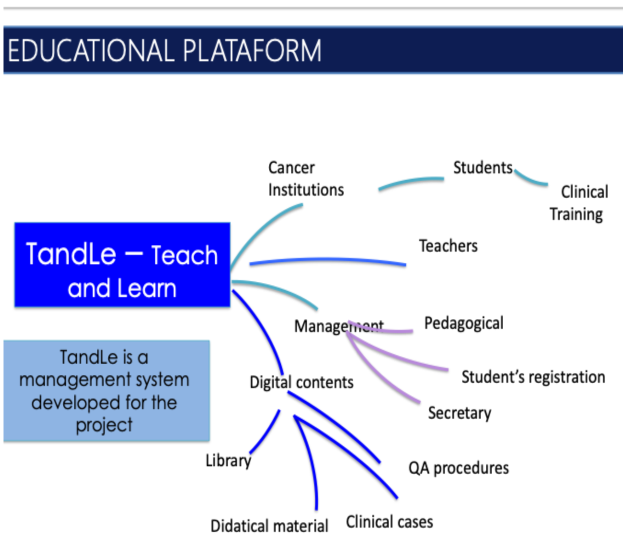

Figure 4. A broad view of the education platform developed to manage the project

Each student received a laptop with an individual password to access the Tandle since all activities described below were registered online.

The Tandle was then used to:

- register the student's grades.
- record all lectures with open access after they were delivered during the duration of the project.
- access the bibliography.
- register the results of the experimental lab reports as well as the ones developed during the clinical training.
- maintain contact with the preceptors and follow the ongoing performance of the student.
- register the selected clinical cases developed in each clinical training.
- register all administrative procedures.

All the didactic materials were made available to the students.

**The Clinical Training Sites and the Research Project**

Several clinical sites were approached and invited to be part of the project and at the end 22 were selected. The criteria to select the clinical training sites were based on the availability of modern treatment equipment, including at least one 6 MV Linac with three-dimensional (3D) and IMRT treatments, active brachytherapy with high dose rate (HDR) $^{192}$Ir, radiosurgery procedures and the availability of computed tomography (CT) and magnetic resonance imaging (MRI), though in some cases positron emission tomography (PET-CT) was also available. It was required to provide a set of dosimetry systems sufficient to allow high-quality quality assurance (QA) and quality control (QC) procedures according to published recommendations.

The experience of the preceptors and the willingness of each centre to welcome the students and as well to supervise the research project was a strong point for the final consideration used in the process.


**Figure 5.** The participating institutions were selected from different states in Brazil except one which was in Cordoba-Argentina

## IV. DISCUSSION:

The classes and the practical disciplines of modules I and II have proved to be sufficient to qualify the student to move forward to the supervised clinical training.

The clinical training was successfully conducted under the supervision of a Board qualified physicist, following the requirements of the Brazilian Medical Physics Society.

The number of hours in each module was carefully planned and executed in harmony with the pre-requisites to apply for the Board Certification by the Brazilian Society of Medical Physics and the Licensing Authority (CNEN).

In each module, a main theme of increasing complexity was proposed as a guide to the preceptor to cover all aspects and to make the monthly reports of the students' progress very objective.

This methodology has proven to be efficient in following the students' performance and their ability to face the subsequent module.

The research project developed by each student during the clinical training and presented before a Board was also a requirement to obtain the degree.

## V. CONCLUSIONS:

As a result, 22 students have successfully completed the program, 20 are working as medical physicists in radiotherapy centres and two are working as product specialist for Varian and PTW.

It was clearly demonstrated and proven that when a well-designed project and the resources are available with the promptly accepted participation of several colleagues and renowned institutions the result is worth the efforts.

The MSc. program is carried on, now covering also the diagnostic radiology area.

## VI. ACKNOWLEDGMENTS

It is necessary to register our recognition to the amazing efforts made by the whole staff directly involved in the project, the institutions that have agreed to provide the clinical training, the professional societies involved (SBRT and CONTER), the fantastic work done by the preceptors, the speakers, the grant donors, the manufactures, the support of the National Cancer Institute (INCa) and CNEN.

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