

## MEDICAL PHYSICS IN SPAIN: CURRENT STATUS AND CHALLENGES

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**Abstract**— Medical Physics is officially recognized as a healthcare specialty in Spain with the same status to that of other medical specialties. Regulation at national level together with the activity of organizations such as the SEFM (Spanish Society of Medical Physics) and the work of medical physicists have brought the profession to a high level of qualification. This paper describes the current situation of Medical Physics in Spain and summarizes the challenges it is currently facing: the need to update and expand the official teaching programme and the accreditation criteria for hospital training units, to promote research activity and to increase the social visibility of Medical Physics.

**Keywords**— Medical Physics, Spain, SEFM, training programme.

### I. INTRODUCTION

The first medical physicists in Spain, mostly women, began working in the hospital setting in the early 1960s because of the need to ensure the safe and controlled use of ionizing radiation in health care.

Throughout the 80s and 90s, a series of events took place that marked the development of our profession. In 1980, the Nuclear Safety Council (CSN) was created as the sole regulatory body in the field of Radiation Protection. Subsequently, in 1982 and in accordance with Directive 80/836/EURATOM [1], the role of the Qualified Expert in Radiation Protection (RPE), called “Head of Radiation Protection Department”, appeared in the first regulation on health protection against ionizing radiation.

In the 1990s, Radiation Protection Services (SPR) were created in large hospitals of the public network of the National Health Institute of the Ministry of Health, while CSN started to require that such departments be organized in some hospitals with Radiotherapy, Nuclear Medicine and Diagnostic Radiology facilities.

A milestone towards specialization/regulation of training and accreditation was the first call for medical physics residents in 1993. Finally, Royal Decree 220/1997 [2] of 14 February, created and regulated the official title of Specialist in Radiophysics (Medical Physics Expert, MPE), based on regulated three-year theoretical-practical residency.

With this Royal Decree, physicists and physicians were given the same status as specialists.

Medical Physics is currently a health profession in Spain, regulated along with the rest of the health professions by Law 44/2003 [3] and Royal Decree 183/2008 [4], and for whose professional practice it is required to be in possession of the corresponding official title of specialist in Medical Physics.

The MPE degree in Spain qualifies the holder to work in the field of ionizing radiation in any hospital setting. The activity is mainly clinical, including the areas of therapy, both in radiotherapy and nuclear medicine, diagnostic imaging, interventional radiology and radiation protection.

In addition, teaching and research are regular activities of Medical Physics departments, although, due to the clinical workload, the latter must often be reduced.

Regarding institutions, there are currently more than 100 centres in Spain, both public and private, where more than 650 MPEs work. According to a survey conducted by the Spanish Society of Medical Physics in 2016 [5], the average number of MPEs in public centres was 5.2, and 2.5 in private ones. Although these numbers have certainly increased, it can be said that Spain is a country with a wide network of centres with relatively small MPE teams.

The historical ratio of men to women was approximately 2, but this value has been balanced to approximately 1.5, according to data on new residents in the last decade.

### II. SEFM

The Spanish Society of Medical Physics (SEFM) was born in 1974 from the dissolution of the Spanish Society of Medical Radiology and Electrology (SEREM), which combined Electrology, Radiotherapy, Physiotherapy and Radiology. SEREM, created in 1930, had only physicians as full members, although it admitted physicists, manufacturers and others, but without voting rights.

The development and specialization of the discipline of Medical Physics in Spain, boosted by the creation of national societies of Medical Physics by IOMP (International Organization for Medical Physics), eventually led to the founding of SEFM. In this context, the nearly twenty medical physicists who were spread all over the country, in either universities or hospitals, were linked through a society with its own statutes, dependent on the Spanish Ministry of the Interior.

The number of members of SEFM, which started with only two women and two men in 1974, has progressively increased to the current 960 members, of which 600 (67%) are MPEs.

Its development has been driven by the organization of 23 congresses, which have been held since 1977 on a biennial basis until the last one held in 2021, this one completely virtual due to COVID-19 restrictions. The last 7 congresses have been held jointly with the Spanish Society of Radiological Protection. It should be noted that the 1993 congress in Tenerife coincided with the 2<sup>nd</sup> EFOMP congress, which demonstrated the support that Spanish Medical Physics received from the international community.

The aim of the SEFM is the development and promotion of Medical Physics in scientific and professional aspects, with training activities and working groups. An accredited training course (12 ECTS, European Credit Transfer System) in Fundamentals of Medical Physics (Baeza Course) is given annually to provide a common theoretical basis to most of the medical physicists in training (it is not mandatory, but most attend). It is a blended course, with a six-month online phase (but requiring 4-5 hours per week) and a three-week face-to-face phase, although in 2020 it was online-only due to COVID-19 restrictions.

Continuing Professional Development of medical physicists is another of the SEFM's strategic objectives for which there is a permanent commission with a wide range of accredited courses covering all areas of the specialty. This activity has been strongly affected by COVID-19 and SEFM has had to reorient its teaching activity to online mode, which has been a great challenge. It is likely that the training will continue to have an online component allowing for greater flexibility.

Among the different activities in which SEFM is working through its members and working groups, two projects in particular should be highlighted: GAIN (Support Group for New Researchers), aimed at enhancing the research role of medical physicists in Spain with the support and collaboration of colleagues with consolidated research experience, and the REM project (Network of Spaniards in the World), which will put in contact all Spaniards who carry out activities outside our borders to create a network of support and feedback that strengthens our work, both individually and as a professional group.

Since the year 2000, SEFM has been publishing periodically a journal, the yellow journal, which is currently in the process of being indexed.

At present, it continues its scientific development in close collaboration with other Spanish Societies, such as Radiation Protection (SEPR), Radiation Oncology (SEOR), Nuclear Medicine and Molecular Imaging (SEMNUM) and Medical Radiology (SERAM).

SEFM is also involved in all aspects of Medical Physics through its representation in relevant national organizations, such as the National Commission of the Specialty, the Spanish Professional Association of Physicists, the Forum of the Nuclear Safety Council and the Spanish Society of

Radiological Protection, as well as in international organizations, namely, EFOMP, IOMP and ESTRO.

All information about SEFM can be found at <https://sefm.es/>.

### III. MEDICAL PHYSICS EDUCATION AT UNIVERSITY

Until 2007, Physics was a licentiate's degree (5 years), equivalent to a master's degree. To apply for the 3-year Medical Physics residency programme, a Licentiate degree in Physics or other scientific-technological degrees were required.

After joining the European Higher Education Area, aimed at homogenizing university degrees in Europe, the old licentiate's degrees disappeared and the Physics degree was reduced to a 4-year graduate's degree, equivalent to 240 ECTS credits.

A Physics degree (240 ECTS) is taught by 24 universities in Spain and 8 (33.3%) offer a specific subject of Medical Physics as an elective (mostly of 6 ECTS). Two more universities (8.3%) offer a subject related to the applications of radioactivity, touching on some topics of Medical Physics, such as radiation protection or radiological equipment.

In summary, less than 50% of universities offer content related to Medical Physics. Students are required to do an internship (6 ECTS) in companies or institutions related to Physics degrees. Some students choose a Medical Physics department of a hospital to carry it out and, in this way, establish a first contact with this field.

A Master in Medical Physics (determining a total of 300 ECTS, EFQ7) is not required to become a MPE, but it provides the basic background to prepare for the national exam to apply for the residency programme. It is also a valuable profile for some companies looking for a profile related to Medical Physics (application specialists, sales representatives, research, etc.). Only 3 out of 24 universities offer a specific Master's degree in Medical Physics.

As for the PhD, only one university offers a specific programme on Medical Physics. However, topics in this matter are included in different programmes, such as Nuclear Physics, Applied Physics, Medicine, Biophysics or Engineering. PhD students must have a master's degree or, failing that, the second year of residency in Medical Physics.

The PhD degree is a prerequisite for directing a research project and it is often taken into account for career promotion. There are some well-established research groups on Medical Physics in Spain, especially in brachytherapy, functional imaging, in-vivo dosimetry, Monte Carlo or IORT, whose work is often published. Most of them are composed of medical physicists working in hospitals and researchers from universities or other public institutions, such as IFIMED (Valencia), CIEMAT (Madrid), CSIC, i3M (Valencia), Complutense University of Madrid, UNED, University of Granada, University of Barcelona, University of Santiago, etc.

Finally, it is worth mentioning that there are different centres dedicated to the calibration and traceability of ionizing radiation measurements, such as Ionizing Radiation Metrology Laboratory- CIEMAT (Madrid), Institute of Energy Techniques (Barcelona), National Dosimetry Center (Valencia) or the Radiophysics Laboratory (Santiago).

#### IV. SPECIALISED HEALTH TRAINING

As mentioned above, the specialty of Medical Physics is recognized as a specialty in Health Sciences by Royal Decree 183/2008 [4]. Therefore, the specialized training in Medical Physics (Fig. 1) is regulated and governed by the same rules of access, structure, monitoring and evaluation as the rest of the healthcare specialties, as established by the Law 44/2003 [3].

Training in Medical Physics is carried out in accredited institutions through a residency system that follows an official 3-year teaching programme. The training framework foresees the provision of paid professional services by the medical physicists in training, while they acquire the competences of the specialty through the professional practice programmed and supervised by the tutor and the collaborators of the teaching unit.

Access to the training system is by means of a national examination, held annually along with the rest of the health specialties. This exam consists of a test-type exercise mainly on physics and to a lesser extent, in mathematics.

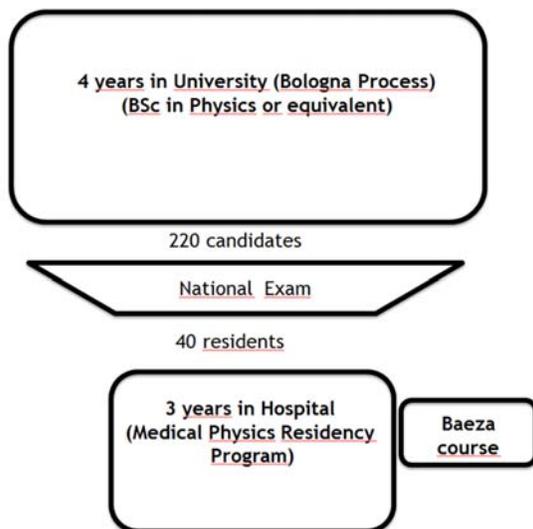


Fig. 1. Scheme of Spanish system of specialized training in Medical Physics. Data for 2020-2021 Spanish Ministry of Health [6].

The number of applicants varies over the years but usually hovers around 200. According to a study conducted

between 2015 and 2019, approximately 95% of the candidates had studied Physics and of the remaining 5%, most had studied Industrial Engineering.

There are currently 40 accredited teaching units in Spain that could offer a total of 43 training positions, although the number offered annually by the Ministry of Health varies according to the proposals of the Spanish Autonomous Communities, which have healthcare competencies. In the last 5 years the number of positions offered has increased (Fig. 2) due to the 7 new teaching units accredited in recent years and the need for a greater number of MPEs to cover the latest investments in radiotherapy in Spain.

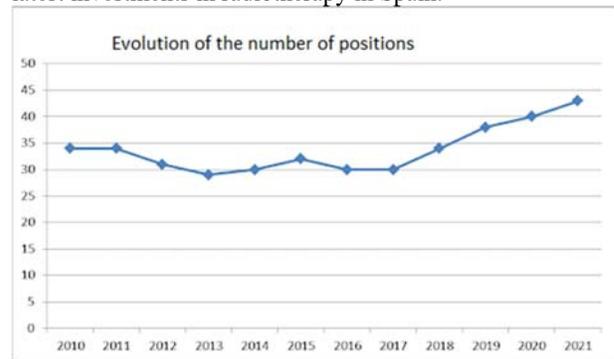


Fig. 2. Evolution of the number of training positions offered in recent years.

The Ministry of Health is advised by the National Commission of the Specialty, which issues a justified report recommending the number of positions appropriate to the current need for MPE.

The National Commission is made up of 11 members with specialist degrees, representing the Ministry of Education and Professional Training, the Human Resources Commission of the National Health System, the national scientific societies SEFM and SEPR, the Spanish Professional Association of Physicists and the specialist in training. Its main functions, as an advisory body on specialized training, are to draw up the training programme and the evaluation criteria, to propose the creation of specific training areas and to establish the criteria for accreditation of teaching units.

Summarizing, specialized training in Medical Physics in Spain follows a training programme drawn up by the National Commission of the Specialty, informed by the regulatory authority for Radiological Protection (Nuclear Safety Council, CSN) and approved by the Ministries of Health and Education.

The current official training programme was approved in 1996 when the specialty was created. It established the teaching objectives, the specific theoretical and practical content and the recommended time to be dedicated to each area: Radiotherapy (18 months), Diagnostic Imaging (12 months) and other uses of radiation and Radiation Protection (6 months). Activities such as teaching and research were also taken into account. The National Commission has been

working on updating this programme and has proposed to the Ministry of Health to extend the training period from 3 to 4 years in order to: i) adequately develop the responsibilities established for MPEs and RPEs referred to in Directive 2013/59 EURATOM of 5 December 2013 [7], ii) incorporate the recommendations expressed in the “European Guidelines on Medical Physics Experts (MPE)”, published by the European Commission in 2014 [8], which include competencies that reflect the updating of new technologies and clinical procedures in the field of Medical Physics.

## V. CHALLENGES

The scientific challenges of Medical Physics in Spain are linked to those of the community worldwide in this field. Spanish MP and research groups related to this discipline contribute and participate in the evolution of Medical Physics. This is the result of individual efforts but also of the existing infrastructure at the clinical, administrative and research level.

The official recognition of Medical Physics as a healthcare specialty by the national authorities is a fundamental step for its consolidation and development. This goal, together with the existence of a regulated training system that guarantees the competence of professionals and researchers, are two of the main objectives of our profession in all countries. Both milestones were accomplished in the last decade of the last century in Spain [2].

Over time, these foundations have allowed the consolidation of an important scientific community dedicated to Medical Physics in Spain. SEFM has been key in this evolution as an integrating element of the different needs and initiatives. It is also worth mentioning the contribution of the administration through the creation of bodies such as the National Commission of the Specialty [4]. In addition to them, the Spanish Professional Association of Physicists also plays a major role for legal matters concerning professional issues.

Despite the achievements made, major structural challenges that Medical Physics in Spain must face in order to continue growing:

- The current official training programme is in urgent need of updating, as it has become obsolete both in content and in duration. Since its approval 25 years ago, there have been important advances in clinical procedures that have been accompanied by an increasing complexity of technologies in the therapeutic and imaging fields. In addition, new legislation has established new responsibilities and new specific roles for MPEs. Consequently, the competencies to be acquired have increased significantly in both number and complexity.
- The harmonization of accredited programmes in hospitals requires a constant effort on the part of those in charge. Special attention needs to be paid to the existence of new techniques and technological

advances, due to the impossibility of their existence in all training centres. To make up for this, stays are organized during the training process in those centres that have the latest developments.

- Special attention should be paid to the figure of tutor. Tutoring is a voluntary activity that is not recognized in salaries. The recognition and training of tutors must be a constant challenge, as they are a fundamental part of achieving quality training.
- The requirements for access to Medical Physics training should be modified. Firstly, it should be limited to those with a solid background in physics and mathematics. Secondly, the required university education should be increased to a minimum of 300 ECTS, which is the equivalent level of education to that required prior to the entry into force of Royal Decree 183/2008 [4]. These rules would guarantee the appropriate level of knowledge of the applicants, as well as equal opportunities for specialists in the field of free exchange of professionals in the EU.
- To increase the research participation of MPEs, especially in clinical trials where they have very limited participation. Although there are several competitive research groups in Spain, there are few commitments with clinical trials and the participation of MPEs in clinical trials is residual and mostly related to quality assurance. One way to increase the inclusion of MPEs in clinical trials could be to improve the collaboration with clinical societies (SEOR, SEMN, SERAM, EORTC and ESTRO).
- The presentation in October 2021 of the ESTRO-EFOMP Core Curriculum for Medical Physics Experts in Radiotherapy [9, 10] will represent a new challenge consisting of the incorporation of its new features into the official training programme for Spanish medical physicists.

We would also like to stress the importance of the improvements in the integration and participation of the SEFM in the EFOMP and IOMP, as a natural framework for development in the future of Medical Physics in Spain.

In conclusion, Medical Physics in Spain is in good health but requires some actions to maintain its positive evolution over time. Particularly, it is worth noting that there is a growing concern among medical physicists about the still poor social outreach of our profession in Spain. This is not only a matter of social recognition, but rather a strategic issue that would help to resolve some of the pending challenges already mentioned in this paper. SEFM should lead this initiative.

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## REFERENCES

1. Council Directive 80/836/Euratom of 15 July 1980 amending the Directives laying down the basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation. <http://data.europa.eu/eli/dir/1980/836/oj>
2. Real Decreto 220/1997, de 14 de febrero, por el que se crea y regula la obtención del título oficial de Especialista en radiofísica Hospitalaria. <https://www.bos.es/eli7es7rd71997/02/14/220>
3. Ley 44/2003, de 21 de noviembre. De ordenación de las profesiones sanitarias. <https://www.boe.es/eli/es/1/2003/11/21/44/con>
4. Real Decreto 183/2008, de 8 de febrero, por el que se determinan y clasifican las especialidades en Ciencias de la Salud y se desarrollan determinados aspectos de formación sanitaria especializada. <https://www.boe.es/eli/es/rd/2008/02/08/183>
5. Recursos humanos en los Servicios de radiofísica y Protección Radiofísica. Informe del grupo de trabajo de la SEFM. <http://revistadefisicamedica.es/index.php/rfm/article/view/235>
6. <https://fse.mscbs.gob.es/fseweb/view/public/datosanteriores/resumenGeneral/listadosResumen.xhtml>
7. Council Directive 2013/59/Euratom laying down basic safety standards for protection against the dangers arising from exposure to ionizing radiation. <https://eur-lex.europa.eu/eli/dir/2013/59/oj>
8. European Commission. European Guidelines on Medical Physics Experts. Radiation Protection No 174; 2014.
9. Garibaldi, C., Essers, M., Heijmen, B., Bertholet, J., Koutsouveli, E., Maas, A. J., ... & Jorret, N. (2021). Towards an updated ESTRO-EFOMP core curriculum for education and training of medical physics experts in radiotherapy–A survey of current education and training practice in Europe. *Physica Medica*, 84, 65-71.
10. ESTRO - EFOMP Core Curriculum for Medical Physics Experts in Radiotherapy. Submitted to publication.

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