MEDICAL PHYSICS
International

IOMP

The Journal of the International Organization for Medical Physics

Volume 3, Number 1, May 2015

MPI

MEDICAL PHYSICS INTERNATIONAL

THE JOURNAL OF

THE INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS

Volume 3, Number 1, May 2015

MEDICAL PHYSICS INTERNATIONAL

The Journal of the International Organization for Medical Physics

Aims and Coverage:
Medical Physics International (MPI) is the official IOMP journal. The journal provides a new platform for medical physicists to share their experience, ideas and new information generated from their work of scientific, educational and professional nature. The e- journal is available free of charge to IOMP members.

MPI web address: www.mpijournal.org

Published by: The International Organization for Medical Physics (IOMP), web address: www.iomp.org ; post address: IOMP c/o IPEM, 230 Tadcaster Road, York YO24 1ES, UK.

ISSN 2306 - 4609

CONTENTS

Contents

EDITORIALS

EDITORIAL

Perry Sprawls, Co-Editor

A major goal of this journal, Medical Physics International, is to introduce and connect medical physicists in all countries to available educational resources that can be used for their continuing education, professional development, and as references for improving their medical physics activities especially as it relates to new developments in applied clinical physics. This edition gives special emphasis to that with highlighted articles describing the extensive resources provided by the American Association of Physicists in Medicine (AAPM) that are available online.

The AAPM Virtual Library is an extensive collection of the educational presentations at the Annual Meetings, Summer Schools, a variety of other conferences, and the AAPM Reports on a variety of topics. The article, The AAPM's Resources for Medical Physics Education Wherever You Are, describes these materials and how they can be used. A special feature is that medical physicists in the developing countries can apply to the AAPM to become an Education Associate and have access to the complete Virtual Library at no cost.

The article, History and Publication Space of the Journal of Applied Clinical Medical Physics (JACMP), describes a major innovation in medical physics publishing with the creation of the first international medical physics journal with completely open and free access for both readers and authors. The great value of the JACMP is its publication of reports that apply to and support practical clinical physics activities. It is a collaborating journal of this journal, Medical Physics International, and provides publishing opportunities for manuscripts that are not within the scope of topics published here.

As a medical physicist, wherever you are in the world, you will gain much by reading these articles and then following the links to the websites where the extensive resources can be found.

EDITORIAL

Slavik Tabakov, Co-Editor

The increased growth of the profession during the past 2 decades (c. 4000 specialists per decade – about double the growth compared with the previous decades) was underpinned by increased development of education and training activities. Naturally more and more colleagues were directing their activities towards the development of new education and training materials in medical physics. The number of University courses in the profession (and most importantly the number of countries delivering such courses) increased manyfold. This was reflected in the number of education/training/professional presentations at the World Congresses of Medical Physics and Biomedical Engineering (about 30-40 during WC2000 and WC2003, later about 70-80 during WC2012 and WC2015).

The early development of e-learning materials and activities in medical physics was one of the pillars of this trend (presented in this issue with the abstract of the e-book "The Pioneering of e-Learning in Medical Physics"). This resulted in the publication of one of the world's top-three e-learning materials with ISBN numbers, a number of original web sites with educational materials, unique Multilingual e-Dictionary and e-Encyclopaedia - all currently used by thousands of colleagues around the world. This particular issue also includes information about the IAEA SAFRON project and on-line information, as well as the continued educational activities of the ICTP.

The Journal Medical Physics International was initiated in 2012 exactly with the aim to support this increased demand for exchange of information related to educational and professional issues. This is very important especially for e-learning use, which is imperative for a dynamic profession as medical physics, but at the same time has relatively short useful cycle, what requires quick exchange of information. This is one of the reasons for the continued interest in this Journal – keeping from its first issue (April 2013) its steady number of online readers (close to 5000 per month). The Editorial team is grateful to all colleagues submitting papers with new educational/training and professional activities and invites more such papers in its future issues.

COLLABORATING JOURNALS

HISTORY AND PUBLICATION SPACE OF THE JOURNAL OF APPLIED CLINICAL MEDICAL PHYSICS (JACMP)

Michael D. Mills[1]

[1] Editor-in-Chief and Founder, Journal of Applied Clinical Medical Physics (JACMP), www.jacmp.org

Abstract— **A short article from the Editor-in-Chief and Founder of the Journal of Applied Clinical Medical Physics (JACMP)**

Keywords— **Journal of Applied Clinical Medical Physics (JACMP)**

I. WHAT IS THE JACMP AND WHAT IS ITS SIGNIFICANCE?

The Journal of Applied Clinical Medical Physics (JACMP) is the clinical medical physics academic journal of the American Association of Physicists in Medicine (AAPM). The JACMP was founded in the year 2000 by the now defunct American College of Medical Physics (ACMP). When ACMP operations were folded into the AAPM in 2012, the AAPM assumed JACMP management. Along with the AAPM, the Canadian Organization of Medical Physicists and the International Organization of Medical Physics are sponsoring organizations of the JACMP. The JACMP was the first open-access journal for any medical specialty, being initially published in February of 2000. The first open access medical journal was the Journal of Medical Internet Research, initially published in August of 1999.

The JACMP has employed a Gold open access model from its inception. The JACMP is currently free to submit, free to publish and free to access. The author retains the copyright for all articles published in the JACMP. Over 1000 articles have been published under this model.

II. MEANING OF THE JACMP INNOVATIONS WITHIN THE OPEN ACCESS REVOLUTION

Beginning in 2000 and culminating in 2003, the open access community met in several conferences resulting in declarations from the cities of Budapest, Bethesda, and Berlin. Although the white papers from these conferences had minor variances respecting one another, there was essential agreement on the major points. Open access publication is intended to:

- Increase the velocity of information
- Review, edit and publish faster
- Eliminate print
- Remove barriers for access
- Reduce transaction costs
- Establish the author as the owner of the copyright

Platform	Choice		Operation	Choice
Computer Server	Intel Workstation		Operating System	Linux
Operating System	Linux	Independent from	Application Software	PHP, MySQL, PKP*
Application Software	PHP, MySQL, PKP		Publishing Partner	Multimed
Publishing Partner	Multimed		Intellectual Property	Authors
Intellectual Property	Authors		Commercial or Society Interests	

Table 1 Platforms and choices for the JACMP operational model

*PHP is a free scripting language, MySQL is a free database software platform, and PKP is the free Public Knowledge Project journal management and publishing platform

III. BRIEF HISTORY OF THE JACMP

The ACMP formed an exploratory committee in November of 1997 to envision a new type of journal. It would be published only online and maintain a low cost publishing model. The members were:

- Michael Mills, Committee Chair and Founder, JACMP
- Bruce Curran, Chair of the AAPM Electronic Media Coordinating Subcommittee
- Jeff Fairbanks
- John Glover
- Kenneth Hogstrom, elected AAPM President-elect in 1998
- Colin Orton, Editor of Medical Physics
- John Pacyniak
- Alex Turner, Chair of ACMP

The following individuals have served as Editor-in-Chief of the JACMP:

- Peter Almond – 2000 – 2002
- Ed McCullough – 2003
- Michael Mills – 2004 – 2007
- George Starkschall – 2008 – 2012
- Michael Mills – 2013 - present

IV. THE CURRENT MISSION AND OPERATIONAL MODEL OF THE JACMP

The Journal of Applied Clinical Medical Physics (JACMP) is an applied journal, which publishes papers that will help clinical medical physicists perform their responsibilities more effectively and efficiently for the increased benefit of the patient. The journal was established in 2000 and is an open access journal published bi-monthly.

Anyone with Web access may register with the JACMP web URL: http://www.jacmp.org. Find Register in the top banner and follow the instructions. Then, under User Home, find My Account; Edit My Profile. Under Roles, check the boxes for Reader, Author and Reviewer. Return to User Home. You will find you have an Author identity. Look to the right and you will find “New Submission”. Follow the Submission Guidelines on the top of the home page that tells you how to prepare your submission.

A submission from an Author will be assigned to an appropriate Section Editor for selection of Reviewers. Two Reviewers will offer comments and suggestions to the Author, which must be addressed to the satisfaction of the Section Editor. This process may be repeated at the request of the Reviewer or Section Editor. After acceptance, the contribution will be copy-edited and sent back to the Author for final proofreading. The Editor-in-Chief will review the paper and make a final decision for inclusion in the JACMP.

This journal provides open access to all of its content on the principle that making research freely available to the public supports a greater global exchange of knowledge. Such access is associated with increased readership and increased citation of an author’s work. For more information on this approach, see the Public Knowledge Project (https://pkp.sfu.ca/), which has designed this system to improve the scholarly and public quality of research, and which freely distributes the journal system as well as other software to support the open access publishing of scholarly resources. See Table 1 for some perspective on the ideal operational model for an open access journal.

The Board of Editors of the JACMP is organized according to the following categories:

- 1 Editor-in-Chief
- 2 Associate Editors-in-Chief
- 64 Associate Editors in Radiation Oncology Physics
- 11 Associate Editors in Imaging Physics
- 2 Associate Editors in Radiation Protection
- 2 Associate Editors in Management & Professional Topics
- 1 Associate Editor in Radiation Measurements
- 1 Associate Editor in Non-Ionizing Topics

In 2014, the JACMP published 184 articles from approximately 400 submissions; it currently has 190 articles under review. As of April 7, 2015, the JACMP recorded the following activities:

- The JACMP database has 6029 registered readers, authors, reviewers and editors.
- The JACMP recorded 261,793 sessions from 152,826 unique IP addresses in 2014.
- We estimate the JACMP has about 50,000 users
- JACMP Peer Review is Double-Blind
- Typically there are 180 days or less from submission until final disposition of the manuscript
- Submissions are about 30% from the United States, 10% from Canada and 60% from the rest of the world
- JACMP is published on the Public Knowledge Project Open Journal Systems platform
- The JACMP utilizes Canadian copyeditors, layout editors and proofreaders

JACMP Current website access and download activity:

- Total Articles Accessed 2000 - present
    - o 2000 – 2004 (.pdf estimated) 250,000
    - o 2005 – present (.pdf) 2,380,440
    - o Total (.pdf estimated) 2,600,000
- Total Articles Access in 2014 324,733
- Total Articles Accessed in Q1, 2015 94,129
- One year after publication, the median JACMP .pdf article has been accessed ~700 times
- Three years after publication, the median JACMP .pdf article has been accessed ~1,500 times
- Ten years after publication, the median JACMP.pdf article has been accessed ~3,000 times

Table 2 below present the Top-four accessed JACMP .pdf articles in the past five years (2010 – 2014); as of April 7, 2015.

With a free to submit, free to publish and free to access model and over 15 years of continuous publication, the JACMP likely represents the limit of academic journal penetration into the worldwide medical physics community. It has become the world leader for clinical medical physics academic community.

Article	Number of .pdf accesses as of 4/7/15
Vol 12 # 2 Dose tolerance limits and dose volume histogram evaluation for stereotactic body radiotherapy (2011)	12,399
Vol 14 # 2 Dosimetric characterization and use of GAFCHROMIC EBT3 film for IMRT dose verification (2013)	10,168
Vol 12 # 2 Computed tomography dose index and dose length product for cone-beam CT: Monte Carlo simulations (2011)	8,997
Vol 13 # 3 Clinical commissioning and use of the Novalis Tx linear accelerator for SRS and SBRT (2012)	8,950

Table 2 Top JACMP articles and number of .pdf accesses as of April 7, 2015

V. Final thoughts

The JACMP provides benefit to the patient and dissemination of scholarly work without restrictions to a worldwide audience. This has not come without a lot of volunteer effort and personal sacrifice. All reviewer and section editor work is volunteered. The JACMP is only as good as its authors, reviewers and section editors. My thanks to all of these extraordinary individuals that have created the success the JACMP enjoys today.

Contacts of the corresponding author:

Author: Michael D. Mills, PhD
Institute: Department of Radiation Oncology, Brown Cancer Center, University of Louisville
629 South Jackson Street, Louisville, Kentucky, USA
Email: michael.mills@louisville.edu

PROFESSIONAL ISSUES

APPROPRIATE TECHNOLOGIES IN RADIATION MEDICINE

Kin Yin Cheung[1,2],

[1]President, IOMP
[2]Medical Physics & Research Department, Hong Kong Sanatorium & Hospital, Hong Kong

Abstract— **The paper discusses appropriate diagnostic and therapeutic radiology technologies in resource limited countries.**

Keywords— **diagnostic and therapeutic radiology technologies, developing countries**

I. INTRODUCTION

Radiation medicine may be classified under two major categories of medical specialties, i.e. diagnosis of diseases or disorders and treatment of such diseases. The quality of these clinical services relies heavily on equipment technologies to make a diagnosis or deliver a radiation treatment. In the case of diagnostic radiology, a wide range of imaging equipment are available in the market which are designed for acquiring anatomical images of patients for diagnosis of diseases by assessing anatomical abnormalities in patients. General imaging equipment such as general radiography unit, fluoroscopy unit, mammography unit, tomography unit, general CT unit, general MRI, gamma camera, and dental X-ray unit are becoming basic and essential diagnostic imaging facilities in hospitals and clinics. In addition, a range of specialized imaging equipment is also available for diagnosis of specific types of disease with better accuracy and specificity. Advanced and specialized but expensive imaging technologies are also commercially available, which include MDCT, high field MRI, Cardiovascular and angiographic digital subtraction units, SPECT, PET-CT, and PET-MRI. These high-tech equipment have special clinical tools and functionalities for acquisition of additional information which help the diagnosis of a specific disease or improve the accuracy and specificity of a disease diagnosis, which in turn can help improving the quality of patient management procedures. Likewise, advanced but expensive radiation therapy technologies such as the latest generation of computer controlled linear accelerator with advanced on-board IGRT system and VMAT capability, robotic linear accelerator, helical tomotherapy unit, and particle therapy system are currently available. Such equipment are capable of delivering high quality radiation treatment that better meet specific clinical needs than conventional radiotherapy equipment.

In order to be able to meet all clinical needs, an adequate number of the latest generation of diagnostic and therapeutic radiology equipment is essentially required. This would be difficult to achieve in resources limited countries for a number of reasons as discussed below. A system of priority based on optimization of resources and cost effectiveness for healthcare services is often adopted in these countries. There is no simple solution to prioritization of healthcare technology as this is country specific. Different countries have different healthcare policy and priority on healthcare technology. The important consideration is how best healthcare resources can be put to optimum use.

II. APPROPRIATE HEALTHCARE TECHNOLOGY

According to a WHO discussion paper [1], there is no country in this world has yet been able to guarantee everyone immediate access to all the services that might maintain or improve their health and every country faces resource constraints of one type or another, although these are most critical in low-income countries. As different countries face different degree of resource constraints, the amount and pattern of investment and priorities in healthcare services are different between countries. Optimization on use healthcare resources is often necessary, including use of appropriate healthcare technologies in every country.

The provision of appropriate medical devices for clinical service is an important consideration in healthcare planning, particularly in resources limited countries, where medical services are mainly provided by the government. Planning and acquisition of expensive medical devices such as radiotherapy and imaging equipment should be considered based on a set of country specific criteria. The criteria used in planning the acquisition of medical technologies may include following.

(1) Compatibility with national clinical needs

Equipment technologies should be compatible with national clinical needs. Taking radiation therapy in management of cancer patients as an example, a simple equation is that the number of therapeutic equipment needed in a country depends on the number of cancer patients required to be treated. The recommendation by IAEA on the basic machine to cancer patient ratio can be considered as a starting point [2]. In reality, a more complex equation is needed in order to be able to give a good estimate on the actual clinical requirement in a country. The type and amount of treatment and associated equipment required and the national geographical distribution of such equipment is depended on such information as national and regional cancer incidence, disease type and pattern, and staging of diseases at the time of diagnosis. These clinical data should be readily available from the national cancer registry.

(2) Cost effectiveness of equipment in patient management

Cost effectiveness is an important consideration in equipment acquisition. In countries with good primary healthcare services, a higher percentage of cancer patients can be diagnosed at earlier stages. These patients are normally treated with curative intent. Treatments of this sort are more sophisticated and the use of advanced technologies will have definite long and short term clinical advantages to the patients. In this situation, a higher proportion of radiotherapy equipment should be capable of delivery sophisticated high quality radical treatments. On the contrary, in countries with less satisfactory primary healthcare patients are often diagnosed at late stage and patients are more appropriately treated with palliative intent. Such treatments are less sophisticated and can be delivered with less complex and cheaper radiotherapy equipment. In such situation, it would be more cost effective to acquire a larger number of simple and low cost equipment to meet the case load. To what proportion between high technology and high cost equipment to simple low cost equipment should be invested would depend on case mix, case load and financial constraints of the country.

(3) Availability of staff who can be trained to make full use of the equipment

The simple formula discussed in (1) above did not take into account if qualified or appropriately trained medical doctors, medical physicists, radiation therapists and related supporting staff are available with sufficient number. One cannot take advantage or make use of the advanced features of high-tech equipment if he does not have the knowledge to use it properly. In addition, inappropriate or incorrect use of such equipment can do more harm than benefit to the patient. Healthcare planners and decision makers will have to take into account the number of staff required to operate the equipment, their qualification, competence and training requirement in the formulation for equipment acquisition.

(4) Compatibility with the local clinical operational conditions

Clinical services in hospitals are operated on an interdependent manner that aims for efficient and effective patient flow between clinical management procedures and between medical specialties. Individual services should therefore be compatible with each other in every aspect, including consistency in standard and quality between clinical procedures such that all treatment procedures are appropriate supported by other specialties, including diagnostic imaging and pathological and laboratory testing.

(5) Compatibility with local facility infrastructure

An important consideration in acquisition of medical equipment technology is the building and building services requirements for installation and operation of radiological equipment. For instance, advanced radiotherapy equipment require the availability of reliable three-phase AC power supply, air-conditioning system, coolant water and other machine specific requirements for operation. Some of them, especially high energy linear accelerators require appropriate access route for delivery to installation sites. Some of them may have special structural requirement for its delivery and installation. Provision of these building and building services can be expensive and may not even be possible in some countries or some regions of a country. On the contrary, low cost and less sophisticated radiotherapy equipment, such as Co-60 teletherapy unit and low energy linear accelerator are much less demanding in building and building services requirements hence lower installation cost.

(6) Compatibility and connectivity

For reliable and efficient operation, all medical equipment, particularly advanced radiology equipment should be electronically connected through computer network. Achieving such connectivity in healthcare system can be a challenge in medical institutions, especially in facilities where analogue equipment are dominantly in use. The existing technological status and the long term and short term solutions for network connectivity should be considered when planning new technology for the facility.

(7) Maintaining the quality and functionality of equipment

Quality assurance is an essential measure taken by every radiotherapy centre to ensure proper and safe operation of every piece of radiotherapy equipment. Maintaining the proper operation and functionality of advanced and high cost radiology equipment can be financially and technically very demanding. Investment on manpower, expertise, appropriate test equipment and radiotherapy machine time are required to perform quality assurance testing of radiation therapy equipment. Investment of this sort is much higher on sophisticated equipment such as the latest generation of multi-modality linear accelerators as compared with that on QA of conventional radiotherapy equipment such as Co-60 teletherapy unit and single modality low energy linear accelerator.

(8) Maintenance, upgrade and replacement

Maintenance of medical equipment can be financially demanding. The typical post-warranty contract maintenance cost for an advanced radiotherapy equipment is around 10% of its capital cost. Cost cutting by in-house maintenance of complex equipment is no longer viable due to technical and proprietary limitations and high costs for replacement parts. On the other hand, contract maintenance by non-local vendor engineers on equipment installed in some developing countries, especially those in remote areas can be problematic due to difficulty for engineers and spare parts in reaching the installation sites. Furthermore, current generation of advanced medical technologies has shorter life-cycle then that of analogue equipment. This may be partly due to unavailability of key proprietary spare parts, particularly computer hardware and software. Obsolescent of modern technologies begins at around 10 years after leaving the factory. Analogue equipment with electro-mechanical control systems do not have such problems. They can be maintained by in-house engineers for a much longer life-cycle as spare parts are normally readily available from different sources. Maintenance engineers can attend to equipment fault calls without delay. When planning equipment acquisition programme, consideration should be made to balance between sophistication, quality, functionality and maintainability of high cost equipment. For developing countries with high demand for palliative treatments and limited budget, use of low cost and less sophisticated radiotherapy equipment that can be maintained by in-house engineers may be a better option.

(9) Alternative options available

In acquisition of healthcare technologies, healthcare planners and relevant healthcare professionals should consider all technology options available. They should also consider other treatment options available other than radiation therapy that may be more appropriate and effective in patient management.

III. A POSSIBLE APPROACH IN TECHNOLOGY ACQUISITION IN RADIATION MEDICINE

The above technology planning criteria and associated parameters used in assessing them are country specific and they change with time as healthcare services evolve. Hence, the formulation and policy on acquisition of equipment technologies should be reviewed regularly. To ensure that appropriate technologies are acquired that best meeting national or regional requirements in cancer treatment, a possible approach is to establish national or regional technology acquisition committee or advisory group to provide professional advice and recommendation to government on acquisition of major radiotherapy technologies. The same principle could be applied to an institutional system. The role of the expert group is to advice on all matters related to technology acquisition, including the following.

- Appropriate technologies for radiation therapy (could include technologies for diagnostic radiology)
- Implementation programme and budgetary planning
- Procurement mechanism
- Manpower and training needs
- Building and building services provisions
- Utilization monitoring and audit
- Equipment maintenance, replacement, and upgrade policy

Membership of the advisory group should include medical physicist, radiation oncologist, radiologist, radiation therapist/technologist, architect, IT expert, and representatives responsible for healthcare services and finance. Medical physicists have good knowledge on the physics and engineering principles of this type of medical devices. They are familiar with the functionality, performance, quality, limitation, connectivity and safety of such devices of different brands and models. They can contribute to the strategic planning and acquisition of such major medical devices.

IV. CONCLUSION

In resource limited countries, particularly those with low-income, acquisition of appropriate and cost effective medical technologies is an important measure in optimization of national resources for healthcare services. To achieve optimization in healthcare resource investment on high cost equipment such as therapeutic and diagnostic radiology equipment, consideration should be made on a number of country specific criteria. These include patient load, disease type, pattern and staging, standard of healthcare, treatment technique and intention, professional knowledge and competence of the operational staff, and financial status of the country. Correct acquisition of appropriate and cost effective medical technologies is a complex process which requires the support of professional experts of different disciplines. Medical physicists, who are familiar with the physics and engineering principles of radiological equipment, the functionality, performance and limitation of different equipment brands and models, can play a key role in the acquisition or advice others on acquisition of such equipment.

REFERENCES

1 World Health Organization, "Health care cost containment policies in high-income countries: how successful are monetary incentives?" Discussion paper, Number 2/2002, WHO, Geneva, Switzerland, 2010.

2 International Atomic Energy Agency, "Setting up a Radiotherapy Programme: Clinical, Medical Physics, Radiation Protection and Safety Aspects", IAEA, Vienna, Austria, 2008.

Contacts of the corresponding author:

Author: Kin Yin Cheung, PhD
Medical Physics & Research Department,
Hong Kong Sanatorium & Hospital,
Hong Kong
Email: kycheung@hksh.com

INITIAL RESULTS ON THE NUMBER OF FEMALE MEDICAL PHYSICISTS BASED ON AN INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS (IOMP) SURVEY (*ABSTRACT FROM EUROPEAN JOURNAL OF MEDICAL PHYSICS*)

Virginia Tsapaki[1], Madan M Rehani[2]

[1] Medical Physics Unit, Konstantopoulio General Hospital, Agias Olgas 3-5, 14233 Nea Ionia, Greece,
[2] Medical School and Massachusetts General Hospital, Boston, USA

Extended abstract

The International Organization for Medical Physics (IOMP) has just published a paper on the percentage of female medical physicists (MPs) [1]. The survey was triggered due to the need to find out the gender composition of MPs around the world. It was expected that the survey would provide information on gender imbalance, if it existed, and provide a basis for establishment of a Task Group (TG). Further, it would provide an opportunity for countries and IOMP for more in-depth analysis.

For this reason, a simple online questionnaire was created asking the country, the total number of MPs, the number of female MPs and finally the gender of the person providing the data. The questionnaire was sent to six regional member organizations of IOMP and a major country, the USA. The regional organizations were asked to distribute it among national member organizations (NMOs) and even to non-IOMP member countries. Due to the fact that many years of communication with countries are required before they become members of IOMP, a communication line is maintained with non-member countries too.

It must be emphasized that this is the first time ever that almost global data on the percentage of females in the field of medical physics is being presented. The number of countries that responded was 66 in total. Fifty-two percent of respondents were females. The analysis of data showed that total number of MPs in these 66 countries is 17024. Overall 28 % of MPs were found to be female (4807). Furthermore, there is a substantial variation in the values reported. Median values of percentages of females range from 21 % in USA to 50 % in the Middle East region with Europe having 47 %, Asia 35 %, Africa 33 % and Latin America 24 %. Specifically for Europe, the European Commission, in 1999, adopted a Communication to develop a coherent approach towards promoting women in research with the aim of significantly increasing the number of women involved in research during the period of the Fifth Framework Programme. The Commission's stated aim was to achieve at least a 40 % representation of women in all groups, panels, committees and projects of the European Commission [2, 3]. This target is subject to regular monitoring in order to ensure that the current levels of female participation are raised. Due to the continuous and large efforts of the EC [4, 5], the percentage of women in the field has met the initial target of 40 % but is still less than 50 %, with 10 out of 16 countries reporting values below 48 %. It must be noted that, according to the European Commission's policy on women in science, "achieving equal and full participation of women in all scientific disciplines at all levels in the scientific job market" is a fundamental part of its mission. It is quite interesting that countries such as Germany (female MPs: 20 %), Netherlands (female MPs: 21 %) and Spain (female MPs: 29 %) are far away from the initial target of 40 % set by the European Commission. On the other hand, there are quite a number of countries around the world with a so-called tradition of biases against women entrenched in their history and culture (such as those in the Middle East or Asia) where today the female MPs actually outnumber males. Our data show that these countries seem to follow the change in attitude in medical physics as also quoted by van Arensbergen et al [6]. On the other hand, despite perception otherwise, data do not reflect positively about developed countries.

There are a number of limitations such as: 1) the survey was conducted as a first level information of existing situation rather than a scientific study; 2) data were based on numbers provided by national member societies but in some of these countries personnel may include professions other than MPs such as radiation oncologists, radiotherapists, technologists, dosimetrists, etc. (The large variation in different countries on "who is MP?" creates serious difficulty and for the purpose of this paper leaving it to each member country organization to decide what was accepted as being adequate.); 3) there are countries that tend to cite lower numbers in membership because this helps in payment of lower dues; 4) a number of countries may have given speculative numbers. Another important limitation is the number of countries that participated in the survey. This is particularly important for Europe (16 countries participated in the survey). According to the European Federation of Organizations for Medical Physics (EFOMP), which is the regional organization of IOMP within Europe, there are 35 European countries within Europe that are members of EFOMP. Also, the absence of Canada, Australia and New Zealand is significant as regards the Asia-Pacific region. Given the importance of the data and the results of the survey, a more detailed study is needed. Unfortunately, also, developed regions of the world such as the USA that may be expected to have higher percentage of women, actually have a lower percentage as compared to many developed countries, despite the fact that they have the highest number of MPs in the world.

Our data will serve as a baseline for future actions around the world in pursuit of the objective of gender equality in science. It provides opportunity for deeper analysis, in cooperation with national societies, for the inequalities between women and men in medical physics and their evolution over time. In view of importance of the subject, a more in-depth study needs to be undertaken in near future.

References

1 Tsapaki V, Rehani MM. Female medical physicists: The results of a survey carried out by the International Organization for Medical Physics. Phys Med. 2015 Jun;31(4):368-73. doi: 10.1016/j.ejmp.2015.02.009. Epub 2015 Mar 17.

2 Communication from the Commission COM(1999) 76 Final of 17.02.1999

3http://ec.europa.eu/research/science-society/index.cfm?fuseaction=public.topic&id=1282&lang=1,last accessed 5 May 2015.

4 European Commission (2003c) She Figures 2003 – Women and Science – Statistics and Indicators. Directorate-General for Research, Science and Society.

5 European Commission (2006a) She Figures 2006 – Women and Science – Statistics and Indicators. Directorate-General for Research, Science and Society, 2006.

6 van Arensbergen P, van der Weijden L, van den Besselaar P. Gender differences in scientific productivity: a persisting phenomenon? Scientometrics 2012; 93(3):857-68.

Contacts of the corresponding author:

Virginia Tsapaki, MSc, PhD,
Medical Physics Unit, Konstantopoulio General Hospital,
Agias Olgas 3-5,
14233 Nea Ionia, Greece,
tel +306944671499, +302132057132,
fax: +302132057158,
email: virginia@otenet.gr

Madan M Rehani, PhD, Professor of Medical Physics (Retd), Radiation Safety Specialist, IAEA (Retd),
Harvard Medical School and Massachusetts General Hospital, Boston,
Tel: +43-676-3407850, Email: madan.rehani@gmail.com

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

H. M. Linares Rosales [1], R. Alfonso Laguardia [1]

[1] Nuclear Engineering Department, Higher Institute of Technologies and Applied Sciences, Havana, Cuba.

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.

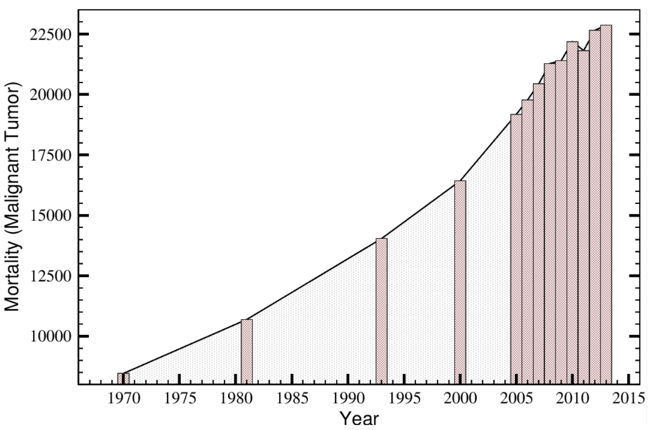


Fig.1.Cancer incidence in Cuba [1, 2]

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.

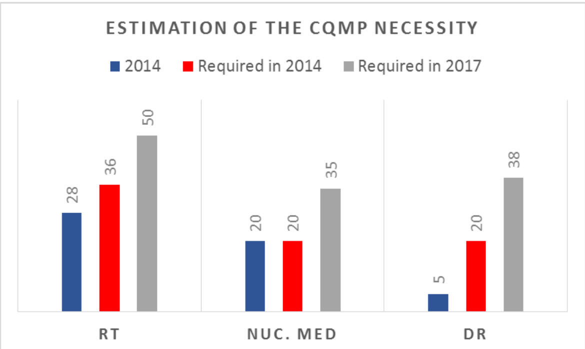


Fig. 2. Medical physicist requirements in 2014 and near future (based on indexes proposed in [3]).

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.

References

1. Dirección de Registros Médicos y Estadísticas de Salud, Ministerio de Salud Pública de Cuba (2014) Anuario Estadistico de Salud 2013. ISSN: 1561-4425, La Habana, 2014.
2. Dirección de Registros Médicos y Estadísticas de Salud, Ministerio de Salud Pública de Cuba (2013) Anuario Estadistico de Salud 2012. ISSN: 1561-4425, La Habana.
3. OIEA, El fisico médico: Criterios y recomendaciones para su formacion académica, entrenamiento clínico y certificación en America Latina, (2010). Viena, STI/PUB/1424.
4. CNSN Res. Nro. 41/2011, (2011). Guía de Seguridad para la práctica de Radioterapia, La Habana
5. CNSN Res. Nro. 40/2011, (2011). Guía de Seguridad para la práctica de Medicina Nuclear. Abril 2011
6. IAEA TCS-37, (2012). Clinical training of medical physicis TS specializing in radiation oncology, IAEA, Viena.
7. IAEA TCS-50, (2011). Clinical training of medical physicists specializing in nuclear medicine, IAEA, Viena.
8. IAEA TCS-47, (2009). Clinical training of medical physicists specializing in Diagnostic Radiology, IAEA, Viena.

Contacts of the corresponding author:

Author: Haydee Maria Linares Rosales
Institute: Higher Institute of Technologies and Applied Sciences.
Street: Salvador Allende esquina Luaces, Plaza de la Revolucion
City: Havana
Country: Cuba
Email: haydee@instec.cu, haydeemarialinares2709@gmail.com

EDUCATIONAL RESOURCES

The AAPM's Resources for Medical Physics Education Wherever You Are

Yakov Pipman[1] and Charles Bloch[2]

[1] Chair – International Educational Activities Committee, AAPM, USA
[2] Chair – AAPM Online Learning Services Subcommittee, and Univ. of Washington Dept. of Radiation Oncology, Seattle, WA, USA

Abstract— **Educational and instructional materials are a critical resource in the academic and professional preparation of Medical Physicists. The access to this material is one of many barriers that Medical Physicists in low and middle income countries encounter in their academic and professional pursuit. The American Association of Physicists in Medicine (AAPM) has a vast repository of information and didactic material, created through many years of dedicated voluntary efforts by its members. Most of this material is collected in the Virtual Library. A cornerstone of the AAPM's mission is to advance the education and professional practice of Medical Physics. Consequently, the AAPM has made these resources available to the profession. This article describes the various educational and scientific resources available, and the ways that AAPM members and others can have access to these resources in order to advance the practice of Medical Physics worldwide.**

Keywords— **Online, virtual library, Web-based, Learning, Education**

I. INTRODUCTION

The education and training requirements for clinical Medical Physicists have been the subject of several documents in North America [1] [2] and internationally [3] [4][5][6] in recent years. These documents are very detailed in terms of the content and offer valuable tools for the organization of programs. They contain abundant references to textbooks and other educational resources and are often used as guidelines to many academic and training programs worldwide. Some of these programs are at different stages of implementation but all are pursuing advances in the education and training of Medical Physicists. One common need is that of teaching materials and trained faculty.

Beyond new graduates and trainees, established Medical Physicists, require constant learning in order to maintain proficiency in the continuous advances in Medical practice and the introduction of modern equipment and techniques.

Educational and instructional materials in Medical Physics are a critical resource in the process of teaching and training competent professionals. While it is known that teaching and training cannot be accomplished by lectures and reading material alone, lectures and reading materials are essential components of this learning process.

Medical Physicists have been involved in the teaching and education of other Medical Physicists, and of other professionals, from the very early years of the profession. With the increased use of electronic media, the pace of creation of new material has accelerated significantly in the last two decades. Over the years, members have produced a vast and sophisticated array of didactic material, lectures and reports on the scientific and practical aspects of Medical Physics, and they continue doing so.

The AAPM has recognized the value of these resources and created a vast repository of information and didactic material on its website as part of its mission to advance the education and professional practice of Medical Physics.

Members of the AAPM get free access to use the vast majority of these educational resources in their electronic version. Physical copies are available at affordable cost. Publications and materials that are considered to be important for wider audiences are often made available at no cost.

It is well known that access and affordability vary widely across nations and regions. What is affordable in North America may be beyond the reach of the majority of students and professionals in low and middle income countries (LMIC).

Medical Physicists in LMIC's encounter significant challenges in their quest to achieve the necessary skills in the profession. One of these barriers is the ready availability of educational and instructional materials and the cost of printed books and manuals. The other is the limited access to experienced professionals until a critical mass of expertise and skills develops locally.

Recognizing that membership in the AAPM may not always be an option for all Medical Physicists in LMIC's, the AAPM makes special accommodations for students and professionals in developing countries to benefit from these resources.

We review the AAPM resources, and ways to access them, in the following section.

Fig. 1 The AAPM's webpage link to Resources

II. MATERIALS AND METHODS

The AAPM's webpage (www.aapm.org) links directly from its front page to several educational resource areas (Fig 1). While many of these materials are easily, and often freely, obtainable from the AAPM, the readers must abide by the "Copyright and Permissions" policy of the AAPM as spelled out at the end of this article.

The main areas are:

1. Two main journals are published by the AAPM:

   "Medical Physics" [7] is the scientific journal of the AAPM and is an official science journal of the Canadian Organization of Medical Physics (COMP), the Canadian College of Physicists in Medicine (CCPM), and of the IOMP. It publishes research concerned with the application of physics and mathematics to the solution of problems in medicine and human biology. It is available in print and online through individual and library subscriptions. All AAPM members have free access to the online version. A considerable number of articles are "Open Access" and available to the general public. [8]. Among these are items in categories such as "Author's Choice", "Editor's Picks", Editorials, Books and Publications, Medical Physics Letter, Review Articles, Vision 20/20, Point/Counterpoint discussions, Focus Series, Award Winning Papers, Ph.D. Abstracts and the 50th Anniversary Papers.

   The Journal of Applied Clinical Medical Physics (JACMP) [9] is an applied journal, which publishes papers that can help clinical medical physicists perform their responsibilities more effectively and efficiently for the increased benefit of the patient. JACMP was established in 2000 and is an open access electronic journal published bi-monthly by the AAPM, and therefore available freely to anyone interested. Articles are grouped in sections such as: Radiation Oncology Physics, Medical Imaging, Radiation Measurements, Radiation Protection and Regulations, Education, Management and Profession, Technical Notes and Non-ionizing Radiation topics. Periodically there are articles in a series named "Parallel/Opposed" that presents arguments and a discussion on the topic at hand.

2. AAPM Reports: The AAPM periodically publishes official reports [10]. These are typically extensive and detailed documents on scientific, professional or educational topics which have undergone extensive review by members of the various committees and councils of the AAPM. The frequency and subjects of these reports depend on the work of many AAPM member volunteers and therefore is not regular. In the last five years - 2010 to 2014 - a total of 33 reports were published. The electronic versions of these reports are freely available on the AAPM's website.

3. AAPM Monographs and Summer School proceedings are reviews of medical physics topics and are primarily the output of many of the AAPM Summer Schools, and more recently the spring clinical meetings and specialty meetings. They can be purchased from Medical Physics Publishing (MPP) [11], a non-profit outfit dedicated to the publication and distribution of educational and scientific books in medical physics and related fields, founded in 1985 by Dr. John Cameron.

4. Selected Presentations from the AAPM Annual Meetings, recent AAPM Summer Schools and other meetings, are recorded in CD or DVD format. As of the end of 2014, a total of 34 collections of presentations were available for purchase from Association Archives [12].

5. The Women's Professional Subcommittee (WPSC) publishes a Newsletter for the members of the AAPM. It includes selected news items and notices coinciding with the vision of the WPSC, including opportunities for leadership and mentorship within the organization, providing avenues for connecting women medical physicists around the world, addressing programming in areas of professional development that may not be addressed in other forums, and drawing attention to the important work that many women medical physicist do. Access to the Newsletter, which is published twice a year, requires a member's login.

6. The Newsletter of the AAPM is a source of information about activities and items of interest to the members. It contains timely information and serves as a forum for lively debate. It is published bi-monthly as an interactive PDF and is distributed to over 8,000 members and affiliates. A login is required to access its contents [13].

7. E-News is released to AAPM members every three weeks via email and carries timely summaries of issues related to educational and professional topics [14].

8. NCRP Publications became freely available online to AAPM members starting in April 2015. This includes all digitally-available NCRP Publications, going back to 1971.

9. Medical Physics Practice Guidelines (MPPGs) [15] are clear and concise statements of the minimum acceptable level of routine medical physics practice to support a clinical service. These MPPG's can be referenced by clinical physicists, accreditation bodies, regulators, and hospital administrators.

10. The AAPM Virtual Library [16] is the central repository of resources. Hundreds of members use it for their continuing education, research, and information needs. The Virtual Library includes streaming video and/or audio of speakers as well as slides of the presentations from AAPM meetings and conferences. This includes the Annual Meetings, Summer Schools and Spring Clinical Meetings as well as specialty meetings such as the 2015 Incident Learning Workshop, the 2014 Radiation Oncology Program Accreditation Meeting, the 2013 CT Dose Summit and more. Presentations from the annual Conference of Radiation Control Program Directors (CRCPD) [17] meetings are also included. Transcription of the audio is also included for some presentations. All content in the AAPM virtual library is free to members.

11. For an additional fee, AAPM members can also obtain Medical Physics Continuing Education Credits (MPCEC) from the Commission on Accreditation of Medical Physics Education Programs (CAMPEP) [18] by answering question sets on these presentations. CAMPEP credits are recognized as category 1 credits by the American Board of Radiology (ABR) [19] and satisfy the maintenance of certification (MOC) requirements of the ABR. The AAPM Online Learning Services Subcommittee routinely formulates and posts question/answer sets for selected Virtual Library presentations and other source material in the Online Learning Center.

12. The AAPM Online Learning Center is the web page home for the Virtual Library and the MPCEC mentioned above. There are also links to the Self Assessment Modules (SAMs), another type of educational credit specified by the ABR.

13. Access to the resources is one of the many benefits of membership in the AAPM. The categories of membership – Full, Emeritus, Corresponding, International Associate, Resident, Junior, Student – depend on the education, experience, place of residence and the degree of involvement desired. The requirements and benefits are described in detail on the AAPM's website [20].

    Members of all categories, including International affiliate member of the AAPM have access to the same resources as full members, with all of this information available at no additional cost. Moreover, much of the content of the Summer Schools, annual meeting, the Spring Clinical meeting as well as specialty meetings are posted online.

    Physicists from any country can apply for Full Member status but many not living in North America might find Corresponding Membership more appropriate.

    For physicists in Developing Countries [21], the Partners in Physics Program (PIP) offers the opportunity to have the application fee and dues waived. Information about the PIP program is available through the International Affairs Committee of the AAPM.

    The membership application process is described in the website [21] and in a flow chart [22] to guide the applicant to the best suited membership category. It entails a few simple steps from the applicant:

    - Answer a few questions about your Education, Location, etc.
    - Download the appropriate Membership Application (MS Word format).
    - Fill out the application, then email to membership@aapm.org along with any documentation to be considered (CV, List of Publications, Certifications)
    - The AAPM will send an invoice via email for the application fee, if it is required.

    Educational Resources, such as Proceedings of the AAPM Summer Schools, Continuing Education Programs from the Annual Meetings and AAPM Task Group Reports are also available to medical physicists in Developing Countries that are interested in the AAPM, regardless of other criteria. The main requirement is to register as a Developing Country Educational Associate (DCEA) and obtaining a DCEA USERNAME and PASSWORD [24].

III. RESULTS AND DISCUSSION

The AAPM provides educational materials in electronic format to medical physics worldwide including selected articles in Medical Physics, all articles in JACMP, all AAPM Reports, and all Medical Physics Practice Guidelines.

Additional material is available for a fee, including all articles in Medical Physics, AAPM Monographs and Summer School proceedings, CD or DVD recordings from the Annual Meetings and Summer Schools.

All of the material above is available for no extra charge to all members (including International Affiliates) as well as additional material available only through AAPM membership. That additional material includes NCRP publications and the AAPM Virtual Library.

Non-members have access to many resources provided by the AAPM as described above.

The AAPM is looking into the viability of providing fee-based access to the Virtual Library and Medical Physics Continuing Education Credits for non-members as well. Until such a decision is made, however, full access is available to physicists outside the U.S. at a greatly reduced rate (for Corresponding Members or International Affiliates) or at the standard rate for Associate Members.

IV. CONCLUSIONS

We presented the educational resources made available by the AAPM to the Medical Physics community worldwide.

We hope that this article will be of help to further the international educational mission of the AAPM and to the further development of medical physics in Developing Countries by complementing their educational, training and continuing education programs.

Most of these resources are freely accessible to all interested parties. Although some of the material is restricted to AAPM members, Medical Physicists in Developing countries, and others who qualify as such, have special access to much of it in electronic form..

ACKNOWLEDGMENTS

We thank the many hundreds of AAPM members that contribute to the preparation of Task Group reports, presentations and other didactic material to the Virtual Library over the years, as well as the AAPM's technical staff that manages this content and the supporting web application.

COPYRIGHT AND PERMISSIONS

REFERENCES

1. http://www.aapm.org/pubs/reports/RPT_197.pdf
2. http://www.aapm.org/pubs/reports/RPT_249.pdf
3. http://www-pub.iaea.org/MTCD/Publications/PDF/IAEA-TCS-56_web.pdf
4. http://www-pub.iaea.org/MTCD/publications/PDF/TCS-37_web.pdf
5. http://www-pub.iaea.org/MTCD/publications/PDF/TCS-47_web.pdf
6. http://www-pub.iaea.org/MTCD/publications/PDF/TCS-50_web.pdf
7. http://www.medphys.org/
8. http://scitation.aip.org/content/aapm/journal/medphys/info/open-access
9. http://www.jacmp.org/index.php/jacmp
10. http://www.aapm.org/pubs/reports
11. https://medicalphysics.org/SimpleCMS.php?content=booklist.php&category=monographs
12. http://www.associationarchives.com/SITES/aapm
13. http://www.aapm.org/pubs/newsletter/
14. http://www.aapm.org/pubs/enews/March26th2015.asp
15. http://www.aapm.org/pubs/MPPG/
16. http://www.aapm.org/education/VL/
17. http://www.crcpd.org/
18. http://www.campep.org/
19. http://www.theabr.org/
20. http://www.aapm.org/memb/newmembinstructions.asp
21. http://www.aapm.org/org/developing_countries.asp?tab=1#TabbedPanels1
22. http://www.aapm.org/memb/default.asp#apply
23. http://www.aapm.org/memb/prospect/apply.asp
24. http://www.aapm.org/pubs/IntlEdResourcesReg.asp
25. http://www.aapm.org/terms.asp
26. http://www.medphys.org/PermissionRequests.asp

Contacts of the corresponding author:

Author: Yakov Pipman
Institute: AAPM
Street: 40, Slocum Crescent, Forest Hills
City: New York, 11375
Country: USA
Email: ypipman@gmail.com

SAFRON
Improving Safety in Radiotherapy

Debbie Bray Gilley[1], Ola Holmberg [1]

[1]International Atomic Energy Agency, Division of Radiation, Transport and Waste Safety, Radiation Safety and Monitoring Section, Radiation Protection of Patients Unit

Abst**ract-Safety incidents occur in radiotherapy. If we do not acknowledge that there is need to collect information on safety incidents, this may lead to a lack of understanding or learning from these incidents. In an effort to promote safety improvements in radiotherapy, the IAEA has developed an incident reporting and learning system. The Safety in Radiation Oncology(SAFRON) reporting and learning system is a voluntary, non-punitive, anonymous reporting and learning system on the Internet, aimed to enable global sharing of information on safety related events and safety analysis in order to improve the safe planning and delivery of radiotherapy. SAFRON contains over 1230 reports of incidents from around the world. It allows the viewer to search for information that might be helpful in enabling the safe use of radiation in radiotherapy centres.**

Keywords—**Radiotherapy Safety, Incident Learning Systems, SAFRON, Safety Barriers, Patient safety,**

I. OVERVIEW

Safety incidents (or near misses and minor incidents) are key indicators of a medical facilities safety performance. The goal in reporting and evaluating safety incidents is to improve awareness by recognizing unsafe conditions and acting on these events before they escalate into severe accidents. Near miss and incident analysis can also be used to identify themes and trends that the radiotherapy center should focus on to improve patient safety and manage risk. Radiotherapy centers may have problems in identifying potential serious errors if they are not aware of near misses or minor incidents because they fail to capture the information. The term “incident” refers to any unintended event, including operating errors, equipment failures, initiating events, accident precursors, near misses or other mishaps, or unauthorized act, malicious or non-malicious, the consequences or potential consequences of which are not negligible from the point of view of protection or safety.[1]. Incidents are an outcome of organizational failures that should have been addressed [2]. However, learning from incidents should not only focus on preventing recurrence, but also on making the radiotherapy processes in a facility inherently safer. Identifying the unwanted deviations and learning from them leads to safer and more reliable processes, which will result in fewer incidents, thus safer radiotherapy and potentially improved outcomes [3]. This paper presents the Safety in Radiation Oncology (SAFRON) learning system developed by the International Atomic Energy Agency. Its purpose is to address the need to learn from incidents and implement this learning in practice. It is a system that can be used to report, review, analyze and learn about events within the individual radiotherapy center and also share and learn from information in the larger international radiotherapy community.

II. BACKGROUND

Patient safety is a comparatively new discipline that has rapidly risen to star status. This rise began in the late 1990s, with eye-opening report that documented the potential scale of harm caused by medical errors, “To Err is Human” [4] that addressed patient safety issues in the United States. The publication outlined significant improvements that could be made in patient safety. One such recommendation was to identify errors and learn from them. To accomplish this, there must be a comprehensive strategy to create an environment that encourages organizations to identify errors, evaluate causes and take appropriate actions to improve performance reducing the chance for future errors. Participating in external reporting systems extends the learning from just one radiotherapy center to the community of centres allowing others to also learn from the event.

The British Institute of Radiology, et al [5] published “Towards Safety Radiotherapy” in 2008, outlining specific improvements that could be made in patient safety including recommending “each radiotherapy department to have a system for reporting and analyzing errors”. The lesson learnt should be fed back to the staff in an effort to learn from errors. The recommendations from this publication was for a reporting system to be effective, it should be separate from any enforcement authority; be able to receive reports in which centres can be identified but treated with total confidentiality; be able to maintain patient confidentiality; and have the formal endorsement of stakeholders through professional bodies. This would lead to a specialty-specific voluntary system of reporting, analysis and learning from radiotherapy events.

In 2012, the American Society of Radiation Oncology (ASTRO) published a response to the 2010, US Congressional Hearing on Safety in Radiation Oncology [6]. "Safety is no Accident," encouraged employees to report both errors and near-misses. [7] The reporting of near-misses was recognized as a powerful tool for identifying problems in the work flow process before they reach the patient and contribute to an error.

In parallel to the activities taken by healthcare professional and radiotherapy professional organizations, the International Atomic Energy Agency (IAEA) Steering Panel of the International Action Plan for Radiological Protection of Patients in 2008 recommended the IAEA develop a reporting system for radiotherapy. This recommendation led to a Consultants Meeting on the Development of an Educational Reporting System for Radiotherapy (CS-160) in December 2008. [8]

The CS160 report recommended the following attributes to be considered in creating a reporting and learning system:

- The ability to report both incidents and near incident;
- Ability to lean from the incidents and near incidents;
- Be dynamic;
- Be applicable to a wide range of settings;
- Be able to integrate new technology or processes;
- Enable feedback;
- Support education and training;
- Ability to easily share information;
- Ability to integrate retrospective reporting with prospective risk analysis;
- Ability to integrate with existing systems complementing national and mandatory systems;
- Ability to assist in patient safety assessment;
- Incorporate safety of medical workers in radiotherapy;
- Ability to influence safety culture and improve outcomes; and
- Enable research.

Reporting systems are designed to meet two purposes. They are designed to meet regulatory requirements where the administration of the radiation varies from the planned or prescribed dose. The mandatory reporting usually focuses on the failure to follow the physician's orders. These reports do not imply harm to the patient. In many instances they result in administrative fines, increased regulatory oversight and in very serious events to "cease and desist orders". Such systems ensure a response, hold medical facilities accountable for maintaining safety, respond to the public's right to know, and require changes to the internal safety environment that should reduce the likelihood of such events occurring.

The second purpose is the use of voluntary reporting systems that are non-punitive and confidential, which can also be used to improve safety. Voluntary reporting systems generally focus on a much broader set of errors including near misses in an effort to detect system weaknesses before the occurrence of serious harm. Near misses can provide a wealth of information to radiotherapy facilities in support of their quality improvement efforts. The goal of these reporting systems is to analyze the information gathered and identify ways to prevent future events. Most important for both types of reporting systems is that the collecting of reports by either system while not sharing the information leads to little value when aiming to improve patient safety.

III. Development of SAFRON

In 2010 the development and testing of an international safety learning system in radiation oncology began at the IAEA. The system incorporated many of the recommendations for the CS160 report and Figure 1 below describes the flow of information. As the diagram demonstrates, the feedback to the external group is essential to encourage support for safety improvements. The name SAFRON was chosen as an acronym for SAFety in Radiation ONcology and followed the naming features of other projects within the IAEA.

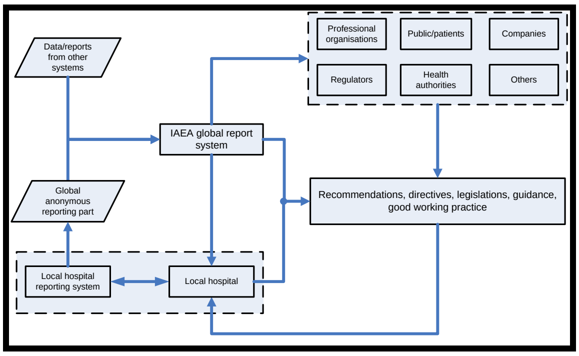


Figure 1 Flow chart outlining the information flow between the reporting institutes, the IAEA global safety reporting and learning system and other targeted groups, and indicating how this may influence decision makers, regulators, best practice development, etc.

The system was designed in English. The reports are anonymous. The reports are confidential for both the event data and registered user. The system is protected under the IAEA NUCLEUS gateway from intruders who may edit, add or delete information or contaminate the database.

The input of reports has been designed using limited free text fields. The narrative of the description of the event is free text and a response to “other” in the collection of data is free text. The remaining information is provided with the use of drop down menus, check boxes and charts where multiple selections can be made. This supports the easy use of the system and ability to perform data analysis.

The order of the reported data is based on radiotherapy process steps. The process steps used in SAFRON were derived from the World Health Organizations Radiotherapy Risk Profile [9] as well as the British Institute of Radiology, et al [5] publication “Towards Safety Radiotherapy”. This allows the entire process to be analyzed readily identifying corresponding steps which the failure is associated with and where the failure was identified. For those unfamiliar with the process steps there is help screen information.

The reports include information on severity of the event using the severity scale developed by the Alberta Heritage Foundation for Medical Research. [10] This severity scale has been used at radiotherapy centres in Canada.

The report also requests the contributor to evaluate causality of the event using a systematic table identifying job factor, systemic/management factors and personal factors described in the document “A Reference Guide for Learning from Incidents in Radiation Treatment”. [10] The contributor is also able to provide the corrective action proposed by the center to prevent the reoccurrence of the event. Special consideration was given to the design of the data to allow the participant to complete the process in a few minutes.

To build the system and test its “usability”, data from the Radiation Oncology Safety Information System (ROSIS) [11] and IAEA reports [12] were “mapped” into SAFRON. The information was manipulated, reviewed and searched using the available parameters in the system. A pilot study was conducted by 10 radiotherapy professionals who entered data and performed search queries on the system. The results of the pilot program indicated that the system was operational. The pilot participants requested the addition of safety barrier information. This was added to SAFRON in an effort to capture information on barriers that failed to identify the incident, barriers that identified the incident and barriers that might have identified the incident if the barrier would have been available. This is a unique feature of SAFRON.

Information on safety barriers was not available for the ROSIS or IAEA reports prepopulated for the pilot study but are being collected from contributors in the recent submittals.

What safety barrier	failed to identified the incident?	identified the incident?	might have identified it?
Verification of patient ID	☐	☐	☐
Verification that pretreatment condition have been taken into account	☐	☐	☐
Verification of imaging data for planning (CT scan, fusion, imaging modality, correct data set)	☐	☐	☐
Verification reference points	☐	☐	☐
Physician peer review	☐	☐	☐
Review of treatment plan	☐	☐	☐
Independent confirmation of dose	☐	☐	☐
Time out	☐	☐	☐
Use of record and verifying system	☐	☐	☐
Verification of treatment accessories	☐	☐	☐
Image based position verification	☐	☐	☐
In vivo dosimetry	☐	☐	☐
Intra-treatment monitoring	☐	☐	☐
Regular independent chart checks	☐	☐	☐
Regular clinic patient assessment	☐	☐	☐
Post treatment evaluations (evaluation of clinical and process)	☐	☐	☐
Independent review of commissioning	☐	☐	☐
Regular internal audit	☐	☐	☐
Regular external audit	☐	☐	☐
Regular equipment performance verification	☐	☐	☐
Other, please specify	☐	☐	☐

Figure 2 Information on Safety Barriers in the SAFRON reporting and learning system.

IV. SAFRON TODAY

SAFRON was launched on December 12, 2012, and currently contains 1231 reports. [13] These are combinations of actual incidents and near misses from ROSIS, IAEA reports and SAFRON participants. Participation in SAFRON includes facilities in all regions of the world with diverse radiotherapy capabilities from single-unit Cobalt teletherapy centres to centres with protons or advanced 12 linear accelerator centres. SAFRON participants estimate they will treat 64, 319 new patients each year. In addition to participating centres, there are two government organizations that contribute to SAFRON, the French Nuclear Safety Authority (Autorité de Sûreté Nucléaire), ASN and the Conference of Radiation Control Program Directors These reports are on incidents that met the regulatory threshold for notification to the government authorities.

Participants are encouraged to report near misses since they provide information of the adequacy of the safety infrastructure in place. Corrective actions and causality are also considered in each report, thus the opportunity to learn from the incident or near miss. There are several participants that use the SAFRON system as their own internal reporting system. To do so, they can track their own submissions by changing the parameters for the dataset contributor to review their own events by using a drop down menu that allows them to see only the events they have added to the system. The institute also has full access to all reports on the website allowing the participant to benchmark against international reports.

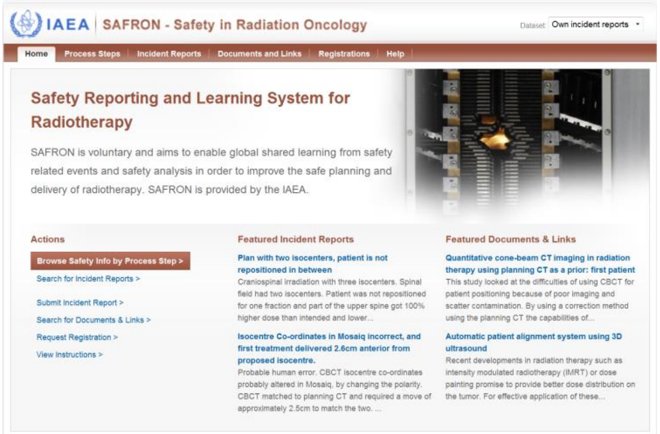


Figure 3 SAFRON for individual facility use

V. LEARNING FROM SAFRON

With 1231 reports available for analysis, early observations are available for many of the types of incidents and near misses. More importantly there are recommendations in the change of procedures from the event. An example can better demonstrate the effectiveness of the system.

In reviewing the data, the pre-treatment phase account for 615 reports. Within this process step, there are 255 reports related to the sub-process step of treatment planning. Further analysis into a finer grid of sub-processes indicates that treatment information transfer errors account for 109 reports. Evaluating these reports; 76 are identified as reports where incorrect data was entered into the treatment planning system. For the radiotherapy center, consideration should be given to adding an additional requirement for a review of the transfer of data before treatment, verifying that the correct information was submitted. Even in those institutions that have automatic transfer of data from imaging to treatment planning to record and verify, there are identified incidents where the wrong CT scan was used, the wrong patient file was used or the orientation of the patient for the imaging study was different than the treatment planning orientation. This can have significant consequence when the patient is receiving a few high dose treatments such as in stereotactic radiosurgery.

In the treatment phase, a similar review can be performed. There are 548 reports in the treatment phase. These are further defined as reports concerning treatment setup (393) treatment delivery (63), treatment verification (75), treatment monitoring (2) and other (12). Within the process step on treatment setup, reports concern the patient setup (393), treatment unit setup (154) and use of accessories (105). With a significant number of reports in the treatment phase and the potential for the error to reach the patient it may be of interest to facilities to focus corrective actions to prevent these types of incidents and near miss. A robust safety system would have barriers in place to prevent errors at the treatment setup process. Some of the recommendations provided by the participants in this area are standardization of treatment protocol, second independent review of treatment parameters and the use of time out before treatment. Something as simple as a new procedure standardizing the use reference marks could prevent a future accident.


Bony match done for patient that was supposed to have soft tissue match imaging.

Treatment modality:	External beam radiotherapy
Date of discovery:	2014-11-26
Who discovered the incident?	Radiation therapist/Staff at treatment unit treating patients
How was the incident discovered?	Found at later stage during patient treatment
What phase in the process is the incident associated with?	3.3.1. On-set imaging process
Where in the process was incident discovered?	3.3.3. Other
Was anyone affected by the incident?	Yes, one patient
Was any part of the prescribed treatment delivered incorrectly?	Yes
How many fractions were delivered incorrectly?	1
Total number of fractions prescribed:	30
Prescribed dose per fraction (Gy):	2.00
If relevant, please estimate the dose deviation from the prescribed dose per fraction:	No information provided
Clinical incident severity:	Minor incident
If the incident-cause is related to equipment (hardware or software), please specify the make, model and version number:	
Describe the incident in detail:	Standard Chest imaging is predominantly bony matching with keeping an eye on soft-tissue matching. This patient was soft-tissue matching only as per imaging note. Staff performed bony match in error for one #. Resulting in 0.9cm variation sup/inf. Picked up in offline image review.
Describe the causes of the incident:	8.1 Failure to address recognized hazard
Did the incident reach the patient?	Yes
What safety barrier failed to identify the incident?	Image based position verification
What safety barrier identified the incident?	
What safety barrier might have identified the incident?	Time out In vivo dosimetry
Describe contributing factors to the incident:	patient was not receiving imaging process as per protocol - however RT should be checking imaging note prior to matching
Suggest preventive action(s):	na

Figure 4, an example of a SAFRON Report

VI. SAFRON FUTURE

Just as radiotherapy is continuing to evolve, so is SAFRON. New search features are planned as well as an expansion of capabilities to include brachytherapy and radiopharmaceutical therapy. Offering SAFRON in other languages needs to be addressed. An effort to identify qualified radiotherapy personnel to assist with translations for the text fields is under consideration. Realizing that participants have limited time and capabilities to perform essential analysis, more published information is planned. There are other radiotherapy reporting systems where coordination and sharing of information may be possible.

There is a project underway to address the feasibility of adding a prospective risk analysis feature to SAFRON. This is based on the work of medical physicists associated with the Latin American Forum of Radiological and Nuclear Regulatory Agencies (FORO). [14] SEVRRA is a software tool used to facilitate the assessment of risk levels of radiotherapy services and to standardize regulatory assessment activities in radiation safety practices. Using reports in SAFRON, the system can help participant's identify potential risk of errors.

VII. CONCLUSION

As important as gathering the data for learning purposes is the dissemination to external groups which may not be in the position to enter reports but can review all the information in SAFRON. These include: some groups of healthcare professionals; educators and trainees; resource allocating organizations; institutes, clinics and hospitals; manufacturers, government authority, influencing organizations such as professional societies; patient advocacy groups; the public, media, researchers and the patients. In addition, the Agency provides information through newsletters and compiled reports summarizing, analyzing and drawing conclusions from the global safety database. As more information becomes available, best practice guidelines, directives, suggested regulations and other instruments will be made available to support improved safety in radiotherapy.

As new knowledge becomes available it will require the collective support of all groups to advancing the field of safety in radiotherapy.

REFERENCES

1. IAEA Safety Glossary Terminology Used In Nuclear Safety And Radiation Protection 2007 Edition http://www-pub.iaea.org/MTCD/publications/PDF/Pub1290_web.pdf
2. Reason J. Managing the risks of organizational accidents. Aldershot, UK: Ashgate; 1997.
3. Shafiq J, Barton M, Noble D. Lemer C, Donaldson LJ, An international review of patient safety measures in radiotherapy practice. Radiotherapy and Oncology 92 (2009) 15-21.
4. Kohn LT, Corrigan JM, Donaldson MS. National Research Council. To Err Is Human: Building a Safer Health System. Washington, DC: The National Academies Press, 2000.
5. British Institute of Radiology, Royal College of Radiologists (Great Britain), Institute of Physics and Engineering in Medicine, National Patient Safety Agency, Society and College of Radiographers. Towards Safer Radiotherapy. Royal College of Radiologists, 2008.
6. US House of Representatives, Committee on Energy and Commerce, Subcommittee on Health. Medical radiation: an overview of the issues. http://energycommerce.house.gov/index.php?option=com_content&view=article&id=1910:medical-radiation-an-overview-of-the-issues&catid=132:subcommittee-on-health&Itemid=72
7. American Society for Radiation Oncology. (2012b). Safety is No Accident. Available at: https://www.astro.org/Clinical-Practice/Patient-Safety/Safety-Book/Safety-Is-No-Accident.aspx.
8. Available from the IAEA request a copy at SAFRON-Contact@IAEA.org.
9. World Health Organization. Radiation Risk Profile WHO/IER/PSP/2008 access at: http://www.who.int/patientsafety/activities/technical/radiotherapy_risk_profile.pdf
10. Cooke DL, Dubets M, Heshmati R, Iftody S, McKimmon E, Powers J. Lee RC, Dunscombe PB. HTA Initiative #22 A Reference Guide for learning from Incidents in Radiation Treatment. Alberta Heritage Foundation for Medical Research, 2006. http://www.ihe.ca/documents/HTA-FR22.pdf
11. Radiation Oncology Safety Information System access at http://www.rosis.info/index.php
12. International Atomic Energy |Agency. https://rpop.iaea.org/RPOP/RPoP/Content/InformationFor/HealthProfessionals/2_Radiotherapy/AccidentPrevention.htm
13. International Atomic Energy Agency https://rpop.iaea.org/SAFRON/
14. El Foro Iberoamericano de Organismos Reguladores en seguridad nuclear, radiológica y física (el FORO). Aplicación del método de la matriz de riesgo a la radioterapia Volumen 1: texto principal Informe del Proyecto sobre. Recomendaciones de seguridad de las instalaciones radiactivas de radioterapia, basadas en la experiencia operacional (lecciones aprendidas) y los resultados de los estudios de APS, 2010. (In Spanish). Access: http://www.foroiberam.org/documents/193375/3c13c762-55a3-4ef6-867e-3e97d914f734
15. IAEA Safety Glossary Terminology Used In Nuclear Safety And Radiation Protection 2007 Edition http://www-pub.iaea.org/MTCD/publications/PDF/Pub1290_web.pdf
16. Reason J. Managing the risks of organizational accidents. Aldershot, UK: Ashgate; 1997.
17. Shafiq J, Barton M, Noble D. Lemer C, Donaldson LJ, An international review of patient safety measures in radiotherapy practice. Radiotherapy and Oncology 92 (2009) 15-21.
18. Kohn LT, Corrigan JM, Donaldson MS. National Research Council. To Err Is Human: Building a Safer Health System. Washington, DC: The National Academies Press, 2000.
19. British Institute of Radiology, Royal College of Radiologists (Great Britain), Institute of Physics and Engineering in Medicine, National Patient Safety Agency, Society and College of Radiographers. Towards Safer Radiotherapy. Royal College of Radiologists, 2008.
20. US House of Representatives, Committee on Energy and Commerce, Subcommittee on Health. Medical radiation: an overview of the issues. http://energycommerce.house.gov/index.php?option=com_content&view=article&id=1910:medical-radiation-an-overview-of-the-issues&catid=132:subcommittee-on-health&Itemid=72
21. American Society for Radiation Oncology. (2012b). Safety is No Accident. Available at: https://www.astro.org/Clinical-Practice/Patient-Safety/Safety-Book/Safety-Is-No-Accident.aspx.
22. Available from the IAEA request a copy at SAFRON-Contact@IAEA.org.
23. World Health Organization. Radiation Risk Profile WHO/IER/PSP/2008 access at: http://www.who.int/patientsafety/activities/technical/radiotherapy_risk_profile.pdf
24. Cooke DL, Dubets M, Heshmati R, Iftody S, McKimmon E, Powers J. Lee RC, Dunscombe PB. HTA Initiative #22 A Reference Guide for learning from Incidents in Radiation Treatment. Alberta Heritage Foundation for Medical Research, 2006. http://www.ihe.ca/documents/HTA-FR22.pdf
25. Radiation Oncology Safety Information System access at http://www.rosis.info/index.php
26. International Atomic Energy |Agency. https://rpop.iaea.org/RPOP/RPoP/Content/InformationFor/HealthProfessionals/2_Radiotherapy/AccidentPrevention.htm
27. International Atomic Energy Agency https://rpop.iaea.org/SAFRON/
28. El Foro Iberoamericano de Organismos Reguladores en seguridad nuclear, radiológica y física (el FORO). Aplicación del método de la matriz de riesgo a la radioterapia Volumen 1: texto principal Informe del Proyecto sobre. Recomendaciones de seguridad de las instalaciones radiactivas de radioterapia, basadas en la experiencia operacional (lecciones aprendidas) y los resultados de los estudios de APS, 2010. (In Spanish). Access: http://www.foroiberam.org/documents/193375/3c13c762-55a3-4ef6-867e-3e97d914f734

Contacts for the corresponding author:
Author: Debbie Gilley
Institute: International Atomic Energy Agency
Address: Vienna International Centre, PO Box 100, 1400
City: Vienna
Country: Austria
Email: D.Gilley@IAEA.org

e-BOOK "THE PIONEERING OF E-LEARNING IN MEDICAL PHYSICS" (The development of e-Books, Image Databases, e-Dictionary and e-Encyclopedia)

S. Tabakov[1,2], V. Tabakova[1]

[1] Dept. Medical Engineering and Physics, King's College London, King's College Hospital, London SE5 9RS, UK
[2] International Organization for Medical Physics (IOMP), IPEM, York YO24 1ES, UK

Abstract— **The e-book "The Pioneering of e-Learning in Medical Physics" describes a chronology of 7 international projects (1994-2014) which are among the first in the world to develop and introduce original e-learning in the teaching process (all projects are in the field of medical physics).**

Keywords— **Education and Training , e-Learning**

I. INTRODUCTION

The period 1990-2010 was very important for education and training in medical physics and for the international growth of the profession. The developments during these two decades naturally followed the innovations in medical technology during the previous two decades (1970s and 80s) when many new types of medical equipment were introduced in healthcare – e.g. Diagnostic Ultrasound, Computed Tomography, Positron Emission Tomography, Magnetic Resonance Imaging, etc. The workforce of medical physicists, dealing with the safe and effective medical use of this equipment, needed new forms of expanded education and specialised practical training.

Studying this medical technology was related to its practical use, but very limited time was available for training, as the medical equipment is used intensively for diagnostic and therapeutic purposes. Also, the dynamic development of the profession needed equally fast and flexible methods for development of such materials. At that time the customary printed media involved a significant period between the development of the materials and their paper print. The answer to this was in the use of IT technology for development of effective teaching materials.

II. BOOK DESCRIPTION

On this background a project team of specialists with considerable teaching experience (from UK, Sweden, Italy, Portugal, Ireland and Bulgaria) took on the task of developing the first e-learning materials in medical physics. The team has not followed other e-learning examples, as at the time no publications with practical methods and steps for development of e-learning materials existed. The book describes how the projects Consortia solved the task through a sequence of 7 fully original projects (Fig.1). The book aims to give a more detailed description of this development process, its challenges and successes, as well as the testing and implementation of e-learning in the profession – an experience which could be useful to other e-learning developers and colleagues (this is consistent with the main concept of the projects - "learning through examples"). In this way the book keeps the chronology of the creation of the ideas and their development through various stages, as well as the methodology applied for this.

The first projects described in the book were initiated when the terms *e-learning* and *e-books* did not exist. Today these are parts of the educational process and medical physicists could be proud that the profession was one of the first in the world to develop its own original electronic Image Databases, e-books and fully embrace e-learning. The team of 'pioneers' also believed in the advantages of e-publishing and was one of the first in the world to publish Educational Image Databases CD-ROMs with ISBN numbers – i.e. as printed books. The first such materials are:

- Atlas of Pathology: Urological Pathology CD-ROM, 30 Dec 1997, Springer-Verlag, ISBN 3540146571
- EMERALD Image Database, Training Courses in Medical Radiation Physics CD-ROM, 19 February 1998, King's College London, ISBN 1870722035
- Developmental Psychology Image Database CD-ROM, 30 April 1998, McGraw-Hill, ISBN 0072896914

The outcomes of the 7 international educational projects (1994-2014) can be summarised as:

- Four International Conferences on Medical Physics Education and Training (with attendees from 36 countries)
- Five textbooks (Workbooks) with training tasks in Medical Physics and two related Teacher's Guides
- Five e-books based on the above Workbooks (including 250 training tasks, explained in 1300 pages)
- Five CD-ROMs with Image Databases for Medical Physics training (with 3100 images)
- Three Educational web sites in Medical Physics (with volume about 1GB)
- A Multilingual Dictionary of Medical Physics (translated in 29 languages)
- An on-line Encyclopaedia of Medical Physics (with 3000 entries/articles and over 2500 images and diagrams)
- A number of MSc courses in Medical Physics in Europe, Asia and Latin America

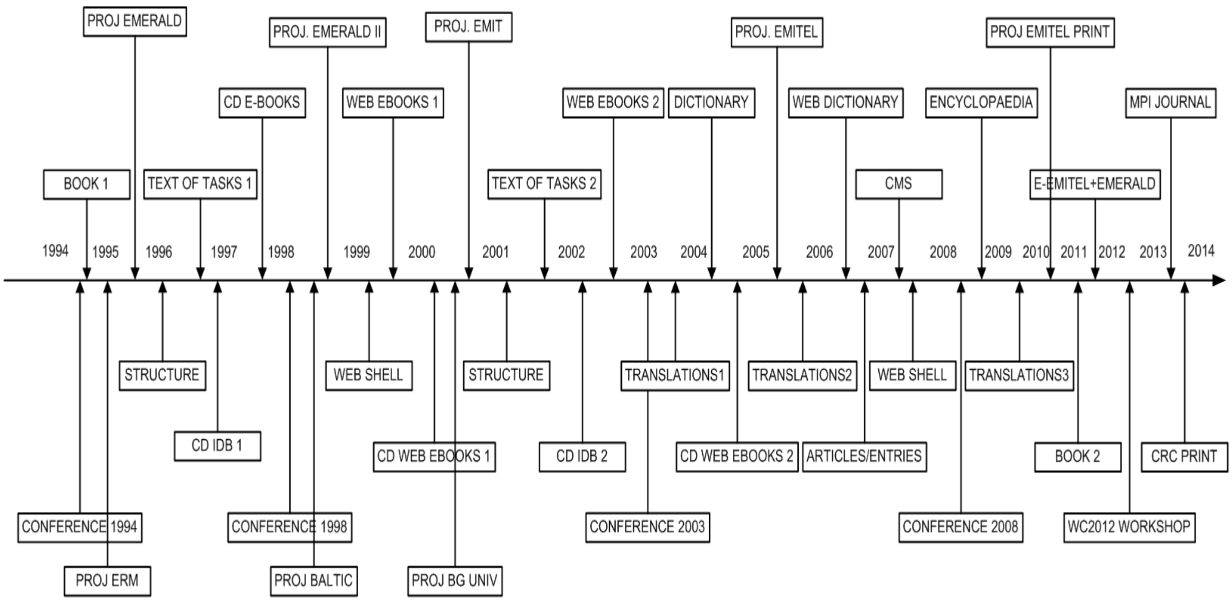


Fig. 1 The timeline (chronology) of the projects described in the book (1994-2014)

Although the book has a specific scientific background and approach, it also presents an example of successful international team work. To emphasise this angle of the collaboration the book describes the comradeship and communications between the team members, all of whom have worked on the projects mainly during their free time. The described projects generated more than a hundred publications and presentations, which could form a separate index, but the book aims to focus on the working methods, outcomes and impact of the projects.

III. IMPACT

Currently thousands of colleagues from all over the world are regularly using the pioneering educational web sites hosting the described e-learning materials (Fig.2). Other teams and projects (also briefly described in the book) developed and presented additional e-learning materials, web sites, simulations and methods. All these, often free and highly effective teaching materials, helped enormously the global development of the profession, especially in the developing countries. As per the IOMP data, during the first 30 years of its formation (1963) the number of medical physicists globally increased with 6,000 (c. 2,000 per decade), while at the next 20 years (1995-2015) it increased with almost 8,000 (c. 4,000 per decade). This significant growth was underpinned by various education and training activities, including the e-learning developed by the projects described in the book. The success and global impact of these projects was the reason for the inaugural award for education of the European Union – the Leonardo da Vinci Award, which the described projects received in 2004.

For all members of these projects, and indeed for the whole profession, this high recognition was extremely important, as it was also a boost for the visibility of the importance of medical physics in contemporary healthcare.

The book also shows an example of continued success in international collaboration. The first project EMERALD, described in the book, was initiated in 1994 by a small enthusiastic team of about 15 ‘pioneers’, but after 10 years the final project EMITEL attracted some 300 specialists from 36 countries, making it the largest international project in the profession. Altogether, the projects described in the book attracted about 400 participants, contributors and supporters. The results achieved could not have been possible without the hard work and ideas of all these colleagues. The book is dedicated to all project contributors and supporters.

The book includes the following main chapters:

- 1.The Medical Physics Education and Training Conference, Budapest 1994;
- 2.EMERALD Project - the Development of the First Medical Physics e-learning Materials;
- 3.EMERALD II Project – the First Medical Physics Educational Web Site;
- 4.EC TEMPUS projects in Bulgaria and the Baltic States;
- 5.EMIT Project – EMERALD Continuation and Medical Physics Dictionary;
- 6.Thesaurus and Multilingual Dictionary Development;
- 7.Other Medical Physics e-learning Projects;
- 8.EMITEL Project – the Encyclopaedia of Medical Physics;

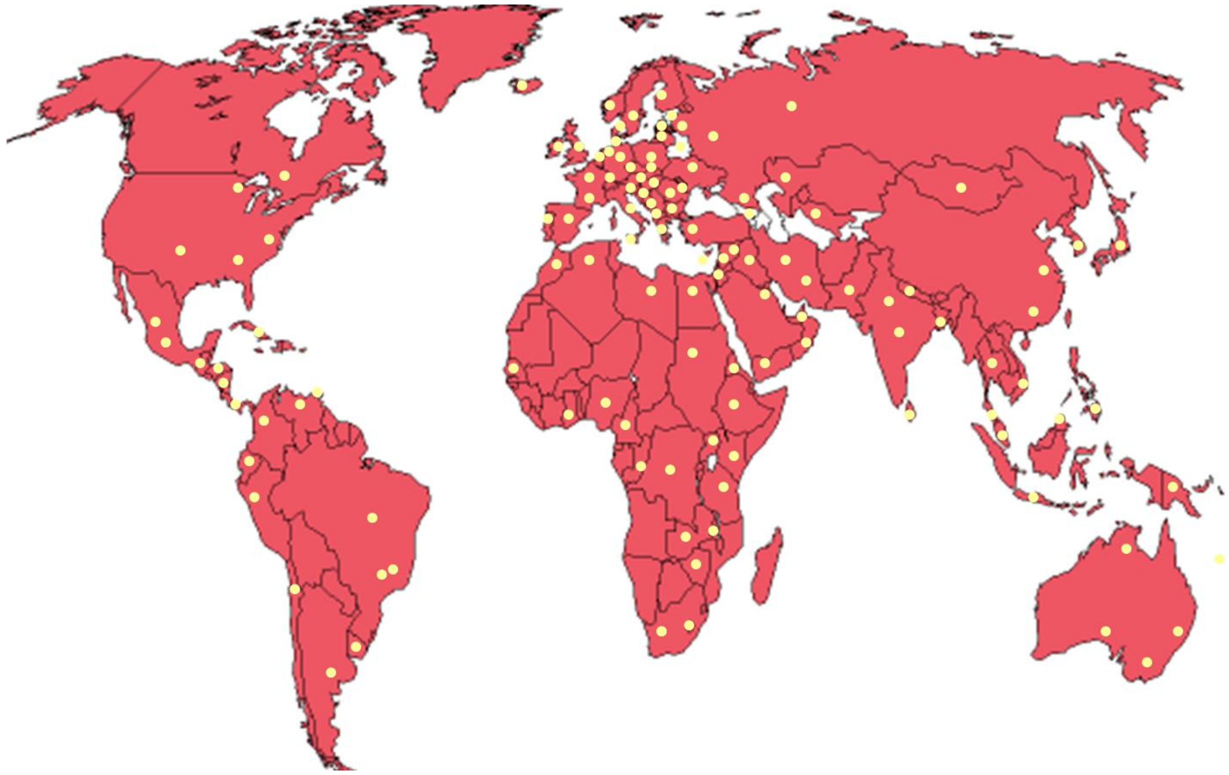


Fig. 2 World map showing the dissemination of the descrtibed e-learning materials in over 100 countries

- 9.Organisation and Development of the Encyclopaedia;
- 10. Post-EMITEL Activities.

The chapters describing projects EMIT and EMITEL, as well as the related chapters 6 and 8 include specific methodology for development and organization of a Dictionary and Encyclopaedia – activities which can be of use in various professions.

IV. CONCLUSION

The Conclusion of the book underlines the pioneering role of medical physics for the development and introduction of e-learning in the teaching process. It also lists potential areas of development of e-learning, including:

-The need of stable electronic format, which will keep unchanged the product of the author (i.e. format independent of software version changes);

-The need of using effective e-learning platform, which main function is the delivery of knowledge (independent of proprietary templates and current graphic design);

-The need of use of e-learning platforms allowing easy update – essential for dynamic professions such as medical physics;

-The threat of shortened longevity of some e-learning products and specially computer simulations and the need of using user-friendly software shells;

-The necessity of recognition of all e-learning development process as *bona fide* research;

-The necessity of a forum for quick exchange of information about new e-learning products (a function served by the Journal *Medical Physics International*).

The e-book lists all contributors to the described projects, the Medical Physics Dictionary and the Encyclopaedia of Medical Physics.

All materials and e-books described in the book are available at: www.emerald2.eu & www.emitel2.eu

The e-book can be downloaded free from the web site: http://www.emerald2.eu/mep_15.html

Contacts of the corresponding author:

Author: Slavik Tabakov, PhD, FIPEM, FHEA, FIOMP
Institute: King's College London, UK
Email: slavik.tabakov@emerald2.co.uk

SUMMARY OF THE IAEA "REGIONAL MEETING ON MEDICAL PHYSICS IN EUROPE: CURRENT STATUS AND FUTURE PERSPECTIVES"

Joanna Izewska [1]

[1] International Atomic Energy Agency, Vienna International Centre, PO Box 100, Vienna, Austria

On 7-8 May 2015, participants from over 30 Member States of the International Atomic Energy Agency (IAEA) in Europe gathered in Vienna to discuss the current status of and future perspectives for medical physics in the Europe Region. Representatives of international professional organizations, the World Health Organization, national regulatory bodies, Health Ministries and academia as well as medical physicists came together to discuss and build awareness of the important role of medical physicists in the practice of radiation medicine. Discussion topics included the overall status of medical physics in the Europe region, the medical physicist roles and responsibilities in the context of the existing international and European basic safety standards and recommendations[1], requirements for medical physics education and training, certification and registration of individuals and accreditation of training programmes, opportunities for structured clinical training and continuous professional development, as well as the adequacy of staffing to ensure adequate and safe clinical practices.

Prior to the meeting, a survey on medical physics status was conducted jointly by the IAEA and the European Federation of Organizations in Medical Physics among national medical physics societies in 36 European countries. Information was collected on national educational frameworks, recognition of the profession, staffing levels and major issues in medical physics. The survey results confirm that there is the need to create national mechanisms to implement international basic safety standards and recommendations in aspects concerning the medical physics profession and to implement the European directives in national legislation in several countries. The results also suggest that medical physics staffing levels in many countries are insufficient. At the same time, harmonization of medical physics education and training within Europe is not adequate and accredited clinical training programmes and corresponding continuous professional development (CPD) schemes are deficient in majority of countries. Another issue highlighted, was lack of recognition of medical physics as a health profession which impacts various aspects of medical physicist work and welfare. At the national level, the medical physics profession is missing in the list of recognized professions in several countries, which results in issues within the legal and fiscal environments; at the local level, lack of recognition within clinical teams results in, inter alia, suboptimal utilization of medical physicists' skills and qualifications including poor involvement of clinical physicists in hospital governance boards.

Participants at the meeting endorsed a set of recommendations addressed to the IAEA Member States in the Europe Region, which will be disseminated by the IAEA. In accordance with the provisions of "*Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*" (General Safety Requirements Part 3, IAEA 2014) regarding the role of medical physicists in ensuring safety in diagnostic and therapeutic procedures involving the application of ionizing radiation, the meeting recommended that the Member States of the Europe Region fully recognize the clinically qualified medical physicist (CQMP) as a health professional with specialist education and training in the concepts and techniques of applying physics in medicine and competent to practice independently in one or more of the subfields (specialties) of medical physics. A similar recommendation was published in the *"Joint position statement by the IAEA and WHO – Bonn call for action"*[2]. Another important recommendation by the meeting participants was to ensure that medical physics aspects of therapeutic and diagnostic procedures, including patient and equipment related tasks and activities are performed by adequately trained CQMPs or under their supervision. Establishing the appropriate qualification framework for CQMPs including education, specialized clinical training, certification, registration and continuing professional development in the specializations

[1] The following standards and recommendations are referred to: *Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards*, General Safety Requirements Part 3 (IAEA, 2014); European Council Directive 2013/59/Euratom; *Roles and Responsibilities, and Education and Training Requirements for Clinically Qualified Medical Physicists*, IAEA Human Health Series No. 25 (IAEA, 2013); *European Guidelines on Medical Physics Expert*, Radiation Protection No 174 (European Commission, 2014).

[2] https://rpop.iaea.org/RPOP/RPoP/Content/Documents/Whitepapers/Bonn-Call-for-Action.pdf

of medical physics, i.e. radiation therapy, nuclear medicine and diagnostic and interventional radiology was also recommended. The meeting stressed on that international guidelines on staffing levels in medical physics should be followed and fulfilled. At the same time, the meeting urged that mechanisms need to be developed for integration of medical physics services in all centres practising radiation medicine and for establishing, where appropriate, independent Medical Physics Departments in which accredited clinical training can take place. The meeting participants also requested that involvement of CQMPs in hospital governance boards and relevant national health committees be promoted. Another important recommendation addressed the need for establishing and enforcing the legislative and regulatory requirements related to radiation safety in medical imaging and therapy for aspects concerning medical physics, in accordance with the international and, where applicable, European basic safety standards.

It is expected that recommendations of the meeting will bring progress in strengthening medical physics capacity in the Europe Region through steps and actions that can be taken at various levels towards the implementation of international and European standards and recommendations, as well as for activities leading to the harmonization of medical physics education, training, accreditation, certification and registration, and finally towards the full recognition of the medical physicist as a health professional in the Europe Region. The recognition and proper education of medical physicists is an important factor for the future perspectives of medical physics. Such recognition, together with the assistance provided to Member States by the IAEA, will contribute to continued improvements in patient healthcare, high quality and safe radiation imaging and treatment in the Europe Region.

EDITORIAL NOTE: An abstract of this meeting, made by Dr Stelios Christofides, EFOMP Past-President and Chair EFOMP Professional Matters Committee, will also be published in the next issue of the IOMP Newsletter Medical Physics World.

Contacts of the corresponding author:

Author: Joanna Izewska
International Atomic Energy Agency, PO Box 1000, Austria
Email: J.Izewska@iaea.org

Photo of the participants in the IAEA “Regional meeting on Medical Physics in Europe, 7-8 May 2015, Vienna

MASTER'S OF ADVANCED STUDIES IN MEDICAL PHYSICS

2016 – 2017

The Abdus Salam International Centre for Theoretical Physics (ICTP) and the University of Trieste, Italy announce the third Master's Programme in Medical Physics (MMP), a two-year training programme in the field of Medical Physics, co-sponsored by The World Academy of Science (TWAS) with the patronage of the Trieste University Hospital.

The programme will be held from 1 January 2016 until 31 December 2017 and will lead to an Advanced Studies Master's Degree in Medical Physics. The first year will be spent in Trieste, Italy, while the second year will be dedicated to clinical professional training in a medical physics department of a hospital in the programme's training network. Courses are held in English.

The Master's Programme is designed to provide young promising graduates in physics or equivalent (mainly from developing countries that are members of the United Nations, UNESCO or IAEA) with post-graduate theoretical and clinical training suitable to be recognised as Clinical Medical Physicists in their countries.

The minimum qualification for applicants is a degree equivalent to a M.Sc. in Physics or related fields. Candidates who have received their degree outside Italy must obtain a *"Dichiarazione di Valore"* from the Embassy in their country, testifying that their curriculum studiorum is equivalent to the Italian *"Laurea specialistica"* (12 years of primary and secondary school and a University study allowing to enter in a PhD programme). The selection of candidates will be based on their university performance, research activity and professional experience in the field. Adequate proficiency in the English language is required. The maximum number of students admitted is 18.

A limited number of full or partial scholarships will be awarded to successful candidates from developing countries, thanks to the support of the IAEA, TWAS, IOMP, EFOMP and ICTP.

More information on the selection procedure and scholarships can be found on the programme's website at http://www.ictp.it/programmes/mmp.aspx.

FIRST YEAR PROGRAMME:

Anatomy and physiology as applied to medical physics - Radiobiology - Radiation physics - Radiation dosimetry - Physics of nuclear medicine - Medical physics imaging fundamentals - Physics of diagnostic and interventional radiology (X rays, US, MRI, Hybrid systems) - Physics of radiation oncology - Radiation protection - Information Technology in medical physics - Medical statistics

IN TOTAL 330 HOURS OF LESSONS AND 230 HOURS OF GUIDED EXERCISES

SECOND YEAR PROGRAMME:

Clinical training in radiotherapy, diagnostic and interventional radiology, nuclear medicine and radiation protection in a hospital of the clinical network (hospitals in Northern Italy and other nearby countries)

IN TOTAL 1200 HOURS

To apply online: https://onlineapps.ictp.it/ENTER/APPLICANT/1773.mhtml

Application deadline: 15 June 2015

For more information please visit the programme website: http://www.ictp.it/programmes/mmp.aspx

IOMP AWARDS

COLIN G. ORTON AWARDED THE MARIE SKLODOWSKA-CURIE AWARD OF IOMP, 2015

.

The Marie Sklodowska-Curie Award is one of the highest awards given by the International Organization for Medical Physics. It was established to honour scientists who have distinguished themselves by their contributions to education and training, advancement of medical physics knowledge based upon independent original research and/or advancement of the medical physics profession.

Colin Orton is the sixth recipient of this prestigious award which is only given every three years. Colin Orton worked at St. Bartholomew's Hospital Medical College, London University on his M.Sc. and Ph.D. degrees under the guidance of Professor Joseph Rotblat. In 1961 he was given the title Instructor and taught physics to premedical students and radiation oncologists studying for their Boards. This involvement in teaching was going to characterise Colin's whole career. It was during this period that he worked with many great medical physicists early in their careers, including Jack Fowler, Don Herbert, Chris Marshall, and Vernon Smith, to name a few.

In 1966 at a British Institute of Radiology meeting in London he met Dr. Milton Friedman who offered him a Chief Physicist/Assistant Professor position in his Radiation Oncology Department at NYU Medical Center, where he stayed until 1975. On his 1st day at work, the radiobiologist in the department came to his office and asked him if he'd be willing to teach radiobiology to the residents because he preferred to be in the lab and didn't like to "waste time" teaching. This led to Colin Orton's lifelong research interest in biological aspects of radiotherapy, especially time/dose relationships. He edited the *Quarterly Bulletin* of the American Association of Physicists in Medicine (AAPM) and initiated a series of "Mind Benders". One of them involved solving a relatively simple Nominal Standard Dose (NSD) problem, which he also sent to about 30 experts worldwide who had written papers using the NSD equation. Over 50% of the responders submitted the wrong answer, including the originator of the NSD concept himself, Dr. Frank Ellis (although he did send a telegram stating that he was very embarrassed and correcting his answer). This led Dr. Orton to simplify the NSD by introducing the Time Dose Factor (TDF) which made practical radiobiology accessible to many in particular after Dr. Eric Hall included the TDF tables into his now famous radiobiology text book. In return for producing these tables for the book, Dr Hall introduced Dr. Orton to Frank Ellis in the lobby of the Palmer House in Chicago during the AAPM Annual meeting a few weeks later. Drs. Orton and Ellis then sat in the lobby for several hours and wrote the 1st draft of the first of several papers on the TDF concept.

Based on this radiobiology work and the understanding of the underlying principles, Colin Orton developed and promoted the use of high dose rate brachytherapy with fractionation schemes to make it safe and effective.

After working as Chief Physicist and Associate Professor of Radiation Medicine at Rhode Island Hospital, Brown University, Providence, RI Colin was recruited as Chief Physicist/Professor at the Radiation Oncology Center/Wayne State University, Detroit, where he stayed until his retirement in 2003. Here he was part of the team that developed the world's first superconducting cyclotron for use in neutron therapy.

Also during his time in Detroit Colin Orton was elected President of the AAPM and, later, Chairman of the American College of Medical Physicists (ACMP) and, later still, President of the American Brachytherapy

Society (ABS). At Wayne State he directed the first ever CAMPEP-accredited medical physics graduate program for over 20 years, with close to 200 M.S. and Ph.D. graduates. It was during the mid-1980s that Larry Lanzl, then President of the IOMP, involved him in IOMP activities, first as the Editor of the new *Medical Physics World*, and later as Secretary-General. While SG of the IOMP he established the Libraries for Developing Countries program. This culminated in his being elected IOMP President and later President of the IUPESM.

In the late 1990s Dr. Orton was appointed Editor of *Medical Physics*, a position he held for eight years, after which he continued his involvement with the journal as the Moderator of the Point/Counterpoint series, which he had initiated in 1998. Although Dr. Orton officially "retired" in 2003, he continued to remain academically active running the Point/Counterpoints, teaching courses and most recently leading the newly established International Medical Physics Certification Board as president.

During his career Dr. Orton has delivered over 500 presentation world-wide, published over 250 papers (many of them cited more than 100 times), 50 book chapters, and 19 books, and has received numerous honors including the AAPM Coolidge Award, the ACMP Marvin M. D. Williams Award, the Ulrich Henschke Award of the American Brachytherapy Society, fellowship of IOMP and the IUPESM Award of Merit.

Congratulations on behalf of IOMP Executive Committee:

Dr Tomas Kron, PhD
Chair IOMP Awards and Honours Com
Peter MacCallum Cancer Centre, Melbourne, Australia

WILLIAM R. HENDEE: AWARDED THE IOMP'S HAROLD E. JOHNS MEDAL, 2015

At the 2015 World Congress, the IOMP awarded the Harold E. Johns Medal to a medical physicist with many unique qualities; one who is an example for fellow colleagues to emulate, and who has been a mentor to an enormous number of medical physicists. This physicist is known as a reformer, a person full of energy and enthusiasm, a mover and shaker, and an achiever beyond imagination not only in academic medical physics but in clinical, administrative and policy-setting roles. Professor William R. Hendee, known to many as "Bill" is an esteemed colleague and a wonderful, engaging person.

Bill grew up in the country in the southern U.S. state of Mississippi. His interest in physics was piqued by an inspiring high school physics teacher. This interest led to a bachelors degree in physics from Millsaps College, also in Mississippi, after which he received an Atomic Energy Commission fellowship to study at Vanderbilt University. A second fellowship took him to the University of Texas Southwestern Medical School in Dallas, where he studied with Professor Jack Krohmer. Bill received a PhD in 1962 in medical physics and then returned to Mississippi to teach at Millsaps College and also participate in the civil rights movement. Soon afterwards, he became chairman of the department of physics and astronomy at Millsaps College.

Bill pursued his interest in medical physics, and when an opportunity arose, he joined the faculty of the Department of Radiology at the University of Colorado Health Sciences Center in Denver. His accomplishments at Colorado were numerous: he built one of the country's most highly respected medical physics departments, created a highly-respected graduate medical physics program and a postdoctoral fellowship program, built one of the six Centers for Radiological Physics that were funded by the National Cancer Institute, and created the Rocky Mountain Radiation Therapy Planning Network, which brought computerized treatment planning capabilities to radiation therapy departments in rural areas in and around Colorado. For the last ten years of his tenure at Colorado, Bill was professor and chairman of the Department of Radiology; he is the only medical physicist to our knowledge to have been chairman of an academic radiology department.

In 1985, Bill moved to Chicago to become Vice President for Science, Technology and Public Health at the American Medical Association, and subsequently served as the Executive Secretary of the AMA Council of Scientific Affairs. Then in 1991 Dr. Hendee left the AMA to join the Medical College of Wisconsin (MCW) as Senior Associate Dean for Research and Dean of the Graduate School of Biomedical Sciences. During his time at MCW, he also served as Vice Chair of Radiology, President of the MCW Research Foundation, and Interim Dean of the MCW School of Medicine. He retired from these administrative positions in 2005-06, but until the end of 2014 he retained academic appointments at MCW as Distinguished Professor of Radiology, Radiation Oncology, Biophysics and Bioethics. He also held the positions of Professor of Biomedical Engineering at Marquette University, Adjunct Professor at the University of Wisconsin-Milwaukee, and Adjunct Professor of Radiology at the University of New Mexico, University of Colorado, and Mayo Clinic, Rochester, MN. Dr. Hendee has authored or edited approximately 30 books, and has authored or co-authored more than 450 peer-reviewed scientific publications.

Dr. Hendee has served as president of several organizations, including the American Association of Physicists in Medicine, Society of Nuclear Medicine, American Institute of Medical and Biological Engineering, and American Board of Radiology. He recently completed a term as Chair of the Board of Directors of the American Board of Radiology Foundation, and was President and Chair of the Board of Directors of the Commission on Accreditation of Medical Physics Educational Programs. For ten years, Bill served as the Editor-in-Chief of the journal *Medical Physics*, where he oversaw a number of changes that increased considerably the quality, visibility and reputation of the journal.

Dr. Hendee was also an active contributor to the IOMP. He served for two terms as Chair of the Publications Committee of the IOMP and for a term as Chair of the Science Committee. He has been a member of the IOMP Executive Committee, and served on the

IOMP Board of Delegates as a representative of the American Association of Physicists in Medicine.

Dr. Hendee and his wife Jeannie divide their time between their homes in Rochester, MN and Wautoma, WI. They have seven children and seven grandchildren.

Congratulations on behalf of IOMP Executive Committee:

Geoffrey S. Ibbott, Ph.D.
Chair IOMP Scientific Com
Professor and Chairman
Department of Radiation Physics
UT M. D. Anderson Cancer Center

PETER H S SMITH AWARDED THE IUPESM AWARD OF MERIT, 2015

The IUPESM Award of Merit is awarded triennially by the International Union of Physics and Engineering Sciences in Medicine (IUPESM) at the World Congress on Medical Physics and Biomedical Engineering to honour professionals who have exerted a significant impact on the science and scientific practice of Medical Physics and Biomedical Engineering and have significantly influenced the development of the professions of Medical Physics and/or Biomedical Engineering.

During 2015 Dr Peter H S Smith was elected by the IUPESM Award and Honours Committee as the recipient of this very prestigious Award.

Peter H S Smith graduated in physics and chemistry from the University of Keele in 1965 and took his DPhil in Solid State Physics from the University of Oxford in 1970. In 1988 Peter Smith was elected Fellow of the UK Institute of Physics and Engineering in Medicine (IPEM). In the same year he received a Certificate in Health Economics from the University of Aberdeen. Additionally to these Peter Smith was Certificated as a Radiation Protection Adviser.

Very early in his career Peter Smith worked as voluntary Assistant Lecturer at the University College of Science and Education in Ghana. Later he worked as Medical Physicist at the Royal Marsden Hospital, London. From 1977 to 1994 he was the founding Director of North Wales Medical Physics and Clinical Engineering Service, initiating and developing a comprehensive medical physics, except for radiotherapy physics, and engineering service for the whole of North Wales. Following this, from 1994 to 2003, he was Chief Executive of the newly established Northern Ireland Regional Medical Physics Agency. Alongside this he was Visiting Professor at the University of Ulster.

Initial scientific research by Peter Smith was in the field of nuclear medicine, new radiopharmaceuticals for imaging and therapy and pharmo-kinetics, and he then moved to radiation protection, patient dosimetry and environmental radiation. However, due to the nature and circumstances of his main posts, his major focus was on facilitating research, establishing research programmes and collaboration with local universities.

Throughout his career Peter Smith has been actively involved in professional organisations at the UK, European and the international level and has held numerous positions of several professional organisations as well as serving on many governmental and health advisory committees. Among these he has been Treasurer and then President-Elect of the UK Institute of Physics and Engineering in Medicine (IPEM); Honorary Scientific Secretary of the British Institute of Radiology (BIR); Treasurer of the European Federation of Organisations for Medical Physics (EFOMP) 1997-2003; Secretary General of the International Organisation for Medical Physics (IOMP) 2003 to 2009; Treasurer of the International Union of Physics and Engineering in Medicine (IUPESM) 2006-2009 and 20012-2015.

Peter Smith has actively involved in the organisation of many Conferences and World Congresses, including Chair of the International Conference on Medical Physics, 2001, Belfast, UK. He has also taken part in numerous International projects, including the project EMIT, awarded with the EU Leonardo da Vinci Award, and the project EMITEL, developing the first Medical Physics e-Encyclopaedia.

After 2006 Peter Smith took an active part (with Fridtjof Nuesslin) in the discussions of IOMP with the International Labour Organisation, related to the inclusion of the professions of medical physicists in the International Standard Classification of Occupations (ISCO-08). This was a major achievement for the profession, especially for many developing countries, where the professions were not officially recognised. Following this Peter Smith took part at the initiation of the discussions with the World Health Organisation (WHO), leading to the signing of a Memorandum of Understanding and agreement of a joint plan of action. This was followed up by succeeding Officers of the IOMP and resulted in 2015 with the recognition of the

IOMP as a NGO (Non-Governmental Organisation) by the WHO.

The active participation of Peter H S Smith in the field of the global medical physics professional development has been widely recognised and acknowledged.

Congratulations on behalf of IOMP Executive Committee:

Slavik Tabakov, PhD, Hon.Prof.
Vice-President IOMP
Dept. Medical Eng. & Physics, King's College Hospital, London, UK

ADRIANA VELAZQUEZ BERUMEN, HONORARY MEMBER, INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS (IOMP), 2015

Adriana is a biomedical engineer of Mexican origin currently senior advisor of Medical Devices in the Essential Medicines and Health Products Department, Health Systems and Innovation Cluster of the World Health Organization (WHO) in Geneva, Switzerland, where she has been since 2008. The unit has created a website that includes all WHO publications on medical devices, a list server for disseminating information on medical devices and has created a network of focal points responsible of Medical Devices from Ministries of Health .

She is founder of CENETEC (National Center for Health Technology Excellence/ Centro Nacional de Excelencia Tecnologica en Salud) in Mexican Ministry of Health and of Global Initiative on Health Technologies, Medical Devices Technical series and Compendium of innovative technologies for Low resource settings in WHO, and of the Global Forum on Medical devices, which has convened around 700 participants from 100 countries in 2010 and 2013

She is an passionate about delivery of health services with appropriate and affordable health technologies particularly for those in low resource settings, specially the sickest and the poorest. She believes in collaboration and thus has created networks with Academia, industry representatives, NGOs and experts around the world. Among her latest achievements at the WHO, a notable one is her getting a number of non-governmental organizations admited into official relations with WHO in January 2015: (Global Medical Technology Alliance; Humatem; International Organization for Medical Physics; RAD-AID International; Health Technology Assessment international; Global Diagnostic Imaging, Healthcare IT and Radiation Therapy Trade Association), to add to the existing ones in radiology ISR, radiographers, ISRRT, biomedical engineering IFMBE and hospital engineering IFHE, among others.

She has had various honorary positions as president of the Mexican Biomedical Engineering Society,(SOMIB), President of the latin American council for Biomedical Engineering (CORAL), chair of the clinical engineering division of IFMBE, and member of the board of INAHTA, network of health technology assessment agencies.

We are now in the XXI century and still patients have no access to indispensable technologies, what will you do?

Adriana firmly believes that the medical physicists are indispensable health work force, to provide safer and quality treatment to cancer patients to increase their survival and quality of life.

Access to affordable and good quality technologies to diagnose and treat patients is difficult but when you have a dream, share it, do not give up, fight for it and ask like-minded to join you, that is the only way to succeed.

Health technologies can provide early diagnosis and effective treatment when used safely, let the medical physicist support your work on radiation, to prevent premature mortality.

IOMP is delighted and honored and to have Adriana as a Honorary member.

Congratulations on behalf of IOMP Executive Committee.

Madan M Rehani, PhD,
Secretary-General, IOMP
Vice President Elect, IOMP

JAMES A BRINK: HONORARY MEMBER OF INTERNATIONAL ORGANIZATION FOR MEDICAL PHYSICS, 2015

When it comes to leadership in moving radiation protection in radiology to a level that its impact can be evident, the name of Dr. James Brink comes shining.

His contributions through Image Wisely, as founding co-chair, the Scientific Vice President for Radiation Protection in Medicine of the National Council on Radiation Protection and Measurements (NCRP) and chair of the NCRP scientific committee that defined diagnostic reference levels for medical imaging in the United States (NCRP Report No. 172, 2012), he plays many roles at a global level.

Dr Brink is Radiologist-in-Chief at Massachusetts General Hospital (MGH) and the Juan M. Taveras Professor of Radiology at Harvard Medical School. He earned a BS degree in Electrical Engineering at Purdue University and an MD at Indiana University before completing his residency and fellowship at Massachusetts General Hospital. He joined the faculty at the Mallinckrodt Institute of Radiology at Washington University School of Medicine where he rose to the rank of Associate Professor prior to joining the faculty at Yale University in 1997. Promoted to Professor in 2001, Dr. Brink was appointed Interim Chair in 2003 and Chair of the Yale Department of Diagnostic Radiology in 2006. On February 1, 2013, Dr. Brink left Yale to serve as Radiologist-in-Chief at MGH. While he has broad experience in medical imaging, including utilization and management of imaging resources, he has particular interest and expertise in issues related to the monitoring and control of medical radiation exposure. Dr. Brink is a fellow of the Society for Computed Body Tomography/Magnetic Resonance and a fellow of the American College of Radiology (ACR). For ACR, he serves as on the Executive Committee as Vice-Chair, Board of Chancellors. For the American Roentgen Ray Society (ARRS), Dr. Brink is Past-President (2011-2012); he was awarded the ARRS Gold medal in 2015.

"The global reach of the IOMP speaks to its importance in the care of patients world-wide, and I am most humbled to be awarded honorary membership in such an august organization," said Brink.

It is most appropriate that Dr Brink is among the first batch of two Honorary members of IOMP and will be awarded at the World Congress on Medical Physics and Biomedical Engineering being held at Toronto on 6-12 June 2015.

I have personally been amazed how Dr Brink is able to participate in so many activities and can accomplish so much, as he does.

Congratulations on behalf of IOMP Executive Committee

Madan M Rehani, PhD,
Secretary-General, IOMP
Vice President Elect, IOMP

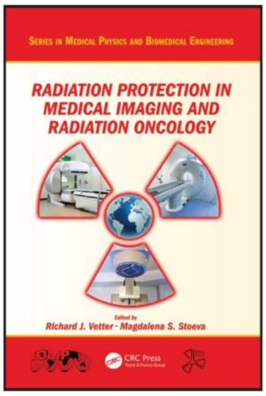
.

BOOK REVIEW

"*RADIATION PROTECTION IN MEDICAL IMAGING AND RADIATION ONCOLOGY*"

Slavik Tabakov, PhD, CSci, FIPEM, FHEA, FIOMP, Hon.Prof. [1,2]

[1] Dept. Medical Engineering and Physics, King's College London, King's College Hospital, London SE5 9RS, UK
[2] International Organization for Medical Physics (IOMP), IPEM, York YO24 1ES, UK



The new book from the CRC Series on Medical Physics and Biomedical Engineering is *Radiation Protection in Medical Imaging and Radiation Oncology* (Editors R J Vetter and M Stoeva). The book presents a unique view on the subject. It is written by experts in the field – collaboration between IOMP and IRPA. This unique book lists the Radiation Protection issues, structures and activities in almost all countries in the world.

The Content and Structure of the book are excellent. These are really necessary for a book with such coverage and volume. The book will be very useful reference for various specialists for many years ahead.

The book has over 430 pages, separated in 20 Chapters:

Chapters 1 and 2 are Introductory (IOMP and IRPA) - setting the international scene on the subject.

Chapter 3 presents the Radiation Protection (RP) philosophy - the background, the history and the philosophy of RP in healthcare. This is a condensed chapter written in very clear language.

Chapter 4 gives and overview of Medical Health Physics, listing the main areas of medicine where radiation is used and the main RP issues related with this.

Chapter 5 presents details of RP in Diagnostic Radiology, listing specific RP measures in this area; facilities design and shielding; equipment commissioning, maintenance and decommissioning; policies and procedures; designation of areas; dose assessment; protection of patients and staff, etc.

Chapter 6 presents details of RP in Nuclear Medicine, again listing specific RP measures in this area; discussing similar issues plus considerations in radionuclide therapy

Chapter 7 presents details of RP in Radiation Oncology, covering the fields of External beam therapy and Brachytherapy

The following unique chapters set the scene of RP around the world:

Chapter 8 presents the regulatory structures and issues in Africa;
Chapter 9 – the same for Asia and Oceania;
Chapter 10 – the same for the European Union;
Chapter 11 – the same for the Middle East;
Chapter 12 – the same for North America;
Chapter 13 – the same for Latin America;

The following chapters present the RP roles, policies and activities of various International Organisations:

Chapter 14 - the International Atomic Energy Agency (IAEA)
Chapter 15 – the World Health Organisation (WHO);
Chapter 16 – the International Organization for Medical Physics (IOMP);
Chapter 17 - the International Union for Physical and Engineering Sciences in Medicine (IUPESM)

Chapter 18 discusses some RP education and training activities in the international arena;

Chapter 19 discusses medical exposures - adverse consequences and unintended exposures

Chapter 20 discusses the informed consent in Radiation Medicine practice and research

The book includes appendices and extended index.

Throughout this book the reader will find lots of data, tables and diagrams. This is an excellent reference which will be useful in all medical physics departments. It will be good if the book would be regularly updated and re-published (e.g. at 10 years), thus keeping an eye on the global progress in this field.

PhD ABSTRACT

DEVELOPMENT, OPTIMISATION AND VALIDATION OF AN *IN VIVO* SINGLE-VOXEL MRS QUANTIFICATION SCHEME USING BRAIN TISSUE WATER SIGNAL AS A REFERENCE

Abdul Nashirudeen Mumuni[1]

Supervisors: Barrie Condon[2], Jonathan Cavanagh[3]

[1]Department of Human Biology, School of Medicine and Health Sciences, University for Development Studies, Tamale, Ghana
[2]Neuroradiology, Institute of Neurological Sciences, Southern General Hospital, Glasgow, UK
[3]Institute of Health and Wellbeing, College of Medical, Veterinary and Life Sciences, University of Glasgow, UK

I. Introduction:

Magnetic resonance spectroscopy (MRS) is a means of measuring the chemical composition, often referred to as metabolites, of the human body non-invasively and *in vivo*. It is a research tool mostly used in the investigation of neurological disorders [1]. Since its concentration is reported to be constant most of the time, signal from brain tissue water has been used previously as a reference in the quantification of the metabolites [2].

However, studies aimed at measurement of the total water signal are often confronted with time constraints and patient compliance issues, which consequently impact on the accuracy of the results. The use of average values from the literature, on the other hand, does not resolve these accuracy issues. Meanwhile, there are indications that brain tissue water content could vary widely in certain disease conditions such as in brain tumors and inflammation. In such situations, absolute metabolite quantification using the literature estimates of tissue water content will be inaccurate while the measurement of cerebral water content using the available techniques will be impractical for the patients due to scanning time considerations.

This study thus aimed to develop a suitable in vivo quantification technique of the total brain tissue water signal within relatively tolerable time limits for patients. Aspects of the signal acquisition techniques were validated in psoriasis patients and in functional MRS studies of healthy volunteers.

II. Method and materials:

All experiments were carried out on a 3 T General Electric (GE) MR scanner, using an eight-channel receive-only head coil. Spectra were processed using the Spectroscopy Analysis by GE (SAGE) software package (version 7).

A standard metabolite spectral acquisition on the GE MR scanner acquires some unsuppressed-water spectra at the beginning of a PRESS pulse sequence (varying echo times, *TE* and repetition times, *TR* were used for different experiments in this study). Using the SAGE software package (version 7), the unsuppressed-water and suppressed-water spectra were separated to estimate cerebral water and metabolite concentrations, respectively after adjusting those signals for coil loading, relaxation and partial volume effects.

III. Results and discussion:

Serial phantom and human studies conducted over the research period showed that the precision of the scanner was consistently better than 12% and 26% for *in vitro* and *in vivo* measurements, respectively of water and metabolite spectra.

Voxel position-dependent RF sensitivity profile equations were developed by recording unsuppressed water signals (from a phantom) at varying positions covering the whole volume of the head coil. Using those standard equations, the coordinates of any *in vivo* voxel could be substituted into an appropriate profile equation to estimate an unsuppressed-water signal area that could be used as a reference signal to quantify brain tissue water content. This cerebral water quantification technique is superior to the previous techniques because it does not require extra unsuppressed-water acquisitions, or corrections for variations in the sensitivity of the head coil as both the *in vivo* and reference signals are acquired from the same voxel position.

The developed referencing technique was subsequently used to accurately quantify cerebral water content in healthy volunteers and in psoriasis patients (for the first time).

In the healthy volunteers, the average water content, WC of frontal brain grey matter, GM was found to be higher than that of white matter, WM (GM/WM WC ± SE = 46.37 ± 2.58/42.86 ± 2.46 mol/kg; p = 0.02); parietal voxels also showed a similar comparison (GM/WM WC ± SE = 37.23 ± 1.70/34.14 ± 2.02 mol/kg; p = 0.03); both findings being consistent with previous reports [2]. Water content measured from five voxel positions in the brain did not show significant variation by one-way ANOVA (p = 0.60); there was also no variation with age ($p > 0.05$) and gender ($p > 0.05$). Water content in the psoriasis patients did not also vary significantly (one-way ANOVA, p = 0.63)

Among five brain metabolites quantified using the cerebral water referencing method, only the mean concentration of creatine, Cr was found to be significantly lower in the frontal GM of the psoriasis patients, PsA compared to healthy controls, HC at baseline (PsA/HC ± SE = 6.34 ± 0.38/7.78 ± 0.38 mM/kg; p = 0.01) and post-TNF-α blockade medication (PsA/HC ± SE = 6.69 ± 0.25/7.78 ± 0.38 mM/kg; p = 0.03). No metabolite changed significantly with medication ($p > 0.05$). The significant change in Cr concentration in psoriasis thus suggests that Cr may not be a reliable denominator in studies of psoriasis that express the metabolite concentrations as ratios.

T1 and T2 relaxation times of cerebral water and the metabolites were measured in the prefrontal GM (*T1/T2* ± SE = 1574 ± 61/147 ± 6 ms) and bilateral hippocampi (*T1/T2* ± SE; left = 1475 ± 68/178 ± 83 ms, right = 1389 ± 58/273 ± 98 ms). These estimates were consistent with reported values; relaxation times for cerebral water were however measured for the first time in those regions. The measured relaxation times were used to correct the water and metabolite signals for relaxation effects in the absolute quantification studies discussed above.

The spectral processing technique was further validated in functional MRS studies focusing on the water peak. While healthy volunteers received a visual stimulus, the resulting BOLD effects on the metabolite and water spectral peaks were recorded, and were found to be comparable to previous reports [3]. For the first time, this study further investigated the impact of temporal resolution (determined by NEX) on the amount of the BOLD signal from cerebral water and metabolites. In a single visual activation paradigm, the BOLD effect resulted in increased water peak area which differed significantly between NEX values of 2 and 8 ($p < 0.01$); this observation also was true for NAA and Glu. The findings thus suggest that temporal resolution of the MRS data could result in significant differences in the results of functional MRS studies.

IV. Conclusion:

This study has developed and implemented a referencing method for quantification of total cerebral water content, suitable as a reference for estimation of brain metabolite concentrations, in vivo. Validation studies show that the technique is appropriate for studies involving both patients and healthy subjects.

References

1. Drost, D.J., W.R. Riddle, and G.D. Clarke, Proton magnetic resonance spectroscopy in the brain: report of AAPM MR task group #9. Medical Physics, 2002. 29(9): p. 2177-2197.
2. Brief, E.E., et al., Absolute metabolite concentrations calibrated using the total water signal in brain H-1 MRS. NMR in Biomedicine, 2009. 22(3): p. 349-354.
3. Zhu, X.H. and W. Chen, Observed BOLD effects on cerebral metabolite resonances in human visual cortex during visual stimulation: a functional (1)H MRS study at 4 T. Magn Reson Med, 2001. 46(5): p. 841-7.

Corresponding author

Author: Abdul Nashirudeen Mumuni

Institute: Department of Human Biology, School of Medicine and Health Sciences, University for Development Studies

City: Tamale

Country: Ghana

Email: mnashiru@uds.edu.gh

Conflict of interest: None

INFORMATION FOR AUTHORS

PUBLICATION OF DOCTORAL THESIS AND DISSERTATION ABSTRACTS

A special feature of Medical Physics International (on line at www.mpijournal.org) is the publication of thesis and dissertation abstracts for recent graduates, specifically those receiving doctoral degrees in medical physics or closely related fields in 2010 or later. This is an opportunity for recent graduates to inform the global medical physics community about their research and special interests.

Abstracts should be submitted by the author along with a letter/message requesting and giving permission for publication, stating the field of study, the degree that was received, and the date of graduation. The abstracts must be in English and no longer than 2 pages (using the MPI manuscript template) and can include color images and illustrations. The abstract document should contain the thesis title, author's name, and the institution granting the degree.

Complete information on manuscript preparation is available in the INSTRUCTIONS FOR AUTHORS section of the online journal: www.mpijournal.org.

For publication in the next edition abstracts must be submitted not later than /august 1, 2014.

INSTRUCTIONS FOR AUTHORS

The goal of the new IOMP Journal Medical Physics International (http://mpijournal.org) is to publish manuscripts that will enhance medical physics education and professional development on a global basis. There is a special emphasis on general review articles, reports on specific educational methods, programs, and resources. In general, this will be limited to resources that are available at no cost to medical physicists and related professionals in all countries of the world. Information on commercial educational products and services can be published as paid advertisements. Research reports are not published unless the subject is educational methodology or activities relating to professional development. High-quality review articles that are comprehensive and describe significant developments in medical physics and related technology are encouraged. These will become part of a series providing a record of the history and heritage of the medical physics profession.

A special feature of the IOMP MPI Journal will be the publication of thesis and dissertation abstracts for will be the publication of thesis and dissertation abstracts for recent doctoral graduates, specifically those receiving their doctoral degrees in medical physics (or closely related fields) in 2010 or later.

MANUSCRIPT STYLE

Manuscripts shall be in English and submitted in WORD. Either American or British spelling can be used but it must be the same throughout the manuscript. Authors for whom English is not their first language are encouraged to have their manuscripts edited and checked for appropriate grammar and spelling. Manuscripts can be up to 10 journal pages (approximately 8000 words reduced by the space occupied by tables and illustrations) and should include an unstructured abstract of no more than 100 words.

The style should follow the template that can be downloaded from the website at:

http://mpijournal.org/authors_submitapaper.aspx

ILLUSTRATIONS SPECIAL REQUIREMENTS

Illustrations can be inserted into the manuscript for the review process but must be submitted as individual files when a manuscript is accepted for publication.

The use of high-quality color visuals is encouraged. Any published visuals will be available to readers to use in their educational activities without additional approvals.

REFERENCE WEBSITES

Websites that relate to the manuscript topic and are sources for additional supporting information should be included and linked from within the article or as references.

EDITORIAL POLICIES, PERMISSIONS AND APPROVALS

AUTHORSHIP

Only persons who have made substantial contributions to the manuscript or the work described in the manuscript shall be listed as authors. All persons who have contributed to the preparation of the manuscript or the work through technical assistance, writing assistance, financial support shall be listed in an acknowledgements section.

CONFLICT OF INTEREST

When they submit a manuscript, whether an article or a letter, authors are responsible for recognizing and disclosing financial and other conflicts of interest that might bias their work. They should acknowledge in the manuscript all financial support for the work and other financial or personal connections to the work.

All submitted manuscripts must be supported by a document (form provided by MPI) that:

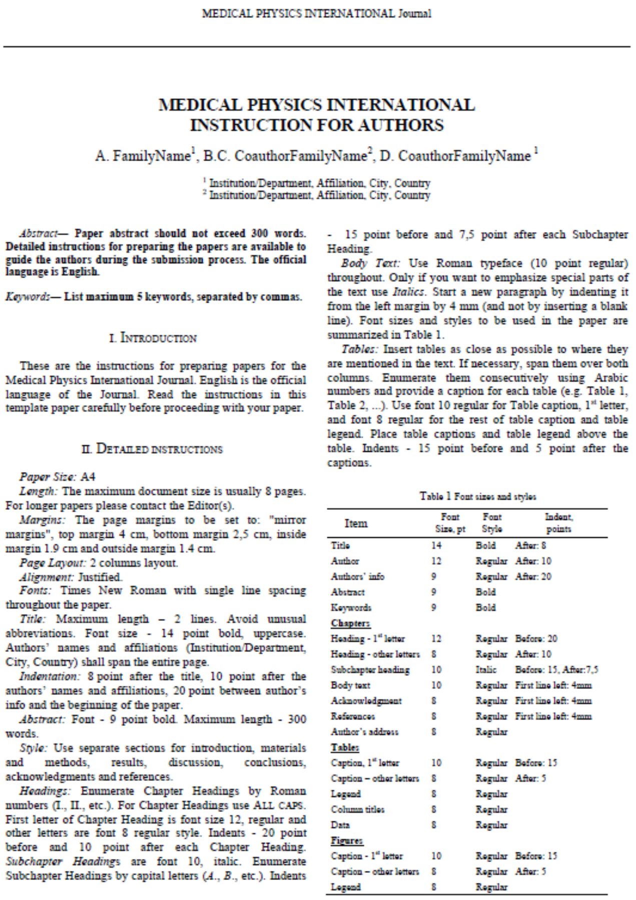
• Is signed by all co-authors verifying that they have participated in the project and approve the manuscript as submitted.

• Stating where the manuscript, or a substantially similar manuscript has been presented, published, or is being submitted for publication. Note: presentation of a paper at a conference or meeting does not prevent it from being published in MPI and where it was presented can be indicated in the published manuscript.

• Permission to publish any copyrighted material, or material created by other than the co-authors, has been obtained.

• Permission is granted to MPI to copyright, or use with permission copyrighted materials, the manuscripts to be published.

• Permission is granted for the free use of any published materials for non-commercial educational purposes.



MEDICAL PHYSICS INTERNATIONAL Journal

MEDICAL PHYSICS INTERNATIONAL INSTRUCTION FOR AUTHORS

A. FamilyName[1], B.C. CoauthorFamilyName[2], D. CoauthorFamilyName [1]

[1] Institution/Department, Affiliation, City, Country
[2] Institution/Department, Affiliation, City, Country

Abstract— **Paper abstract should not exceed 300 words. Detailed instructions for preparing the papers are available to guide the authors during the submission process. The official language is English.**

Keywords— **List maximum 5 keywords, separated by commas.**

I. INTRODUCTION

These are the instructions for preparing papers for the Medical Physics International Journal. English is the official language of the Journal. Read the instructions in this template paper carefully before proceeding with your paper.

II. DETAILED INSTRUCTIONS

Paper Size: A4

Length: The maximum document size is usually 8 pages. For longer papers please contact the Editor(s).

Margins: The page margins to be set to: "mirror margins", top margin 4 cm, bottom margin 2,5 cm, inside margin 1.9 cm and outside margin 1.4 cm.

Page Layout: 2 columns layout.

Alignment: Justified.

Fonts: Times New Roman with single line spacing throughout the paper.

Title: Maximum length – 2 lines. Avoid unusual abbreviations. Font size - 14 point bold, uppercase. Authors' names and affiliations (Institution/Department, City, Country) shall span the entire page.

Indentation: 8 point after the title, 10 point after the authors' names and affiliations, 20 point between author's info and the beginning of the paper.

Abstract: Font - 9 point bold. Maximum length - 300 words.

Style: Use separate sections for introduction, materials and methods, results, discussion, conclusions, acknowledgments and references.

Headings: Enumerate Chapter Headings by Roman numbers (I., II., etc.). For Chapter Headings use ALL CAPS. First letter of Chapter Heading is font size 12, regular and other letters are font 8 regular style. Indents - 20 point before and 10 point after each Chapter Heading. *Subchapter Headings* are font 10, italic. Enumerate Subchapter Headings by capital letters (*A.*, *B.*, etc.). Indents - 15 point before and 7,5 point after each Subchapter Heading.

Body Text: Use Roman typeface (10 point regular) throughout. Only if you want to emphasize special parts of the text use *Italics*. Start a new paragraph by indenting it from the left margin by 4 mm (and not by inserting a blank line). Font sizes and styles to be used in the paper are summarized in Table 1.

Tables: Insert tables as close as possible to where they are mentioned in the text. If necessary, span them over both columns. Enumerate them consecutively using Arabic numbers and provide a caption for each table (e.g. Table 1, Table 2, ...). Use font 10 regular for Table caption, 1st letter, and font 8 regular for the rest of table caption and table legend. Place table captions and table legend above the table. Indents - 15 point before and 5 point after the captions.

Table 1 Font sizes and styles

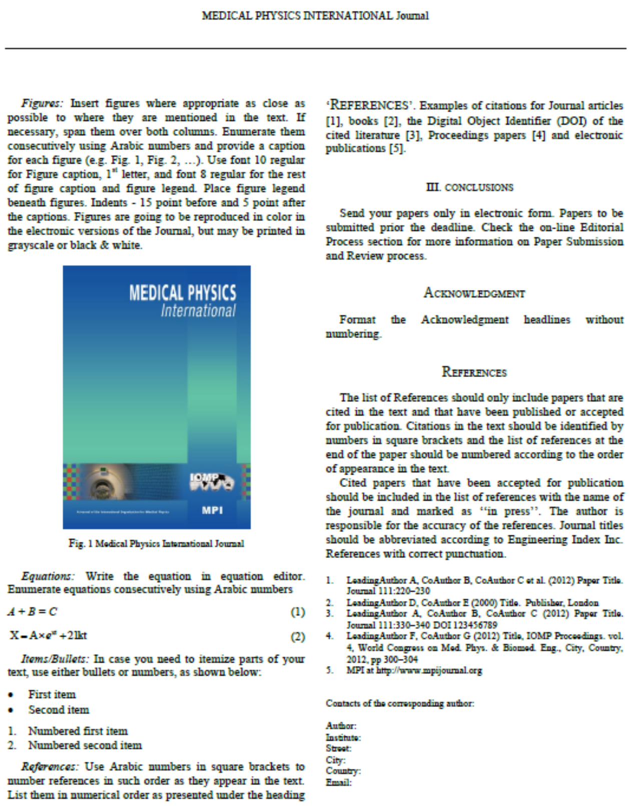
Item	Font Size, pt	Font Style	Indent, points
Title	14	Bold	After: 8
Author	12	Regular	After: 10
Authors' info	9	Regular	After: 20
Abstract	9	Bold	
Keywords	9	Bold	
Chapters			
Heading - 1st letter	12	Regular	Before: 20
Heading - other letters	8	Regular	After: 10
Subchapter heading	10	Italic	Before: 15, After:7,5
Body text	10	Regular	First line left: 4mm
Acknowledgment	8	Regular	First line left: 4mm
References	8	Regular	First line left: 4mm
Author's address	8	Regular	
Tables			
Caption, 1st letter	10	Regular	Before: 15
Caption – other letters	8	Regular	After: 5
Legend	8	Regular	
Column titles	8	Regular	
Data	8	Regular	
Figures			
Caption - 1st letter	10	Regular	Before: 15
Caption – other letters	8	Regular	After: 5
Legend	8	Regular	

SUBMISSION OF MANUSCRIPTS

Manuscripts to be considered for publication should be submitted as a WORD document to: Slavik Tabakov, Co-editor: slavik.tabakov@emerald2.co.uk

MANUSCRIPT PROPOSALS

Authors considering the development of a manuscript for a Review Article can first submit a brief proposal to the editors. This should include the title, list of authors, an abstract, and other supporting information that is appropriate. After review of the proposal the editors will consider issuing an invitation for a manuscript. When the manuscript is received it will go through the usual peer-review process.



MEDICAL PHYSICS INTERNATIONAL Journal

Figures: Insert figures where appropriate as close as possible to where they are mentioned in the text. If necessary, span them over both columns. Enumerate them consecutively using Arabic numbers and provide a caption for each figure (e.g. Fig. 1, Fig. 2, ...). Use font 10 regular for Figure caption, 1st letter, and font 8 regular for the rest of figure caption and figure legend. Place figure legend beneath figures. Indents - 15 point before and 5 point after the captions. Figures are going to be reproduced in color in the electronic versions of the Journal, but may be printed in grayscale or black & white.

Fig. 1 Medical Physics International Journal

Equations: Write the equation in equation editor. Enumerate equations consecutively using Arabic numbers

$$A + B = C \quad (1)$$

$$X = A \times e^{\pi} + 2lkt \quad (2)$$

Items/Bullets: In case you need to itemize parts of your text, use either bullets or numbers, as shown below:

- First item
- Second item

1. Numbered first item
2. Numbered second item

References: Use Arabic numbers in square brackets to number references in such order as they appear in the text. List them in numerical order as presented under the heading 'REFERENCES'. Examples of citations for Journal articles [1], books [2], the Digital Object Identifier (DOI) of the cited literature [3], Proceedings papers [4] and electronic publications [5].

III. CONCLUSIONS

Send your papers only in electronic form. Papers to be submitted prior the deadline. Check the on-line Editorial Process section for more information on Paper Submission and Review process.

ACKNOWLEDGMENT

Format the Acknowledgment headlines without numbering.

REFERENCES

The list of References should only include papers that are cited in the text and that have been published or accepted for publication. Citations in the text should be identified by numbers in square brackets and the list of references at the end of the paper should be numbered according to the order of appearance in the text.

Cited papers that have been accepted for publication should be included in the list of references with the name of the journal and marked as ''in press''. The author is responsible for the accuracy of the references. Journal titles should be abbreviated according to Engineering Index Inc. References with correct punctuation.

1. LeadingAuthor A, CoAuthor B, CoAuthor C et al. (2012) Paper Title. Journal 111:220–230
2. LeadingAuthor D, CoAuthor E (2000) Title. Publisher, London
3. LeadingAuthor A, CoAuthor B, CoAuthor C (2012) Paper Title. Journal 111:330–340 DOI 123456789
4. LeadingAuthor F, CoAuthor G (2012) Title, IOMP Proceedings. vol. 4, World Congress on Med. Phys. & Biomed. Eng., City, Country, 2012, pp 300–304
5. MPI at http://www.mpijournal.org

Contacts of the corresponding author:

Author:
Institute:
Street:
City:
Country:
Email: