MEDICAL PHYSICS ORGANISATIONS

MEDICAL PHYSICS IN CANADA

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I. Historical Perspective

Medical physics has a long and illustrious history in Canada. Röntgen discovered X rays in November 1895 and the first medical use of X rays in Canada occurred soon thereafter in early February 1896 at McGill University in Montreal and at the University of Toronto. Becquerel discovered natural radioactivity in 1896 and Rutherford carried out his seminal work on radioactivity at McGill University during the early years of the 20-th century. These events laid the foundation for medical use of X rays and radioactivity in Canadian clinical and academic institutions, generated employment for physicists in Canadian medical centres, and paved the road for eventual formation of Canadian medical physics organizations.

Many physics departments across Canada had already during the 1930s and 1940s made significant contributions to efforts in making the use of ionizing radiation in medicine safe and efficient. There were many pockets of significant early contributions to medical physics spread across Canada; however, none of them was as important, far-reaching, and visionary as the programs developed by Harold E. Johns, first in Saskatoon and then in Toronto. Dr. Johns completed his Ph.D. studies in Physics at the University of Toronto and his first job was with the University of Saskatchewan and the Saskatchewan Cancer Commission in Saskatoon.

While in Saskatoon in the late 1940s and early 1950s, Dr. Johns invented the cobalt-60 teletherapy machine for cancer therapy, built the first such machine for clinical use, and developed a first rate medical physics graduate program. This program trained many graduate students who upon graduation made significant contributions to medical physics in their own right and formed the early links in Johns's medical physics dynasty, now already extending into five generations.

In the mid 1950s Johns moved to Toronto accompanied by some of his former graduate students. Together with medical staff they built the Princess Margaret Hospital (PMH) and the University of Toronto into pre-eminent and world-renowned centres for radiotherapy and medical physics. The research carried out by PMH staff and students was at the forefront of medical physics and Dr. Johns' book "The Physics of Radiology" which he co-authored with his former student and colleague Dr. John R. Cunningham, is still considered, after four editions, the most authoritative and complete text on radiological physics. Dr. Johns had a profound influence on the practice of medical physics in Canada and its current high standards can to a large extent be attributed to his vision and dedication to the medical physics profession.

The year 1980 was a watershed year in Canadian medical physics. Notably, Harold Johns' retirement that year forced a redistribution of leadership in the Canadian medical physics community. Several other important events also took place during that year which helped to distribute the concentration of Canadian medical physics away from Toronto and the PMH to other centres across Canada: (1) the Canadian College of Physicists in Medicine was formed, (2) several new radiotherapy centres were established and many older centres were expanded or rejuvenated, (3) several new graduate education programs in medical physics were inaugurated, and (4) the X-ray section of the National Research Council (NRC) in Ottawa was reorganized and its dosimetry work expanded.

After 1980 medical physics service, teaching, and research spread rapidly to major provincial centres across Canada. Canadian imaging physics also underwent a major expansion, most notably with the opening of the Robarts Research Institute in London, Ontario and the Reichman Research Institute in Toronto, both staffed with many eminent medical physicists who proved that radiotherapy physics was not the only exciting and important branch of contemporary medical physics.

Toward the end of the 1980s many senior medical physicists believed that radiotherapy physics was a completed discipline with exhausted research opportunities and that imaging physics became the most innovative area of research in medical physics. However, the early 1990s proved that this sentiment was premature considering the explosion in radiotherapy physics research engendered during that period by rapid advances in treatment planning, technology of dose delivery, and imaging for radiotherapy. The advent of the CT-simulator, intensity modulated radiotherapy, and image guided radiotherapy has significantly increased the complexity of dose delivery in radiotherapy and highlighted the importance of medical physics in imaging and treatment of cancer.

In recent years, the new technological developments in dose delivery caused the convergence of imaging and radiotherapy physics and introduced the PET functional imaging to radiotherapy. Just like during the introduction of medical use of ionizing radiation in diagnosis and treatment of disease more than a century ago, Canada of today offers its population state-of-the-art technological developments in imaging as well as in radiotherapy, and medical physicists form an important component in development and delivery of these services.

II. Treatment Technology and Techniques

The Canadian approach to cancer therapy is focused on provincial cancer foundations. This approach, despite some practical drawbacks, has enabled Canadian institutions to build relatively large cancer therapy centres with an assortment of modern equipment and a critical mass of medical physicists. Access to state-of-the-art imaging and therapy equipment is of benefit not only to patients but also to medical physicists who, in addition to gaining the most up-to-date practical experience, can carry out applied research on modern and sophisticated imaging and dose delivery equipment. For example, the installation of a third generation 25 MV clinical linac in Toronto in the early 1970s stimulated research into the basic properties of high-energy X-ray and electron beams used clinically. Another example is Winnipeg that, during the 1980s gained a worldwide reputation as an important centre for portal imaging research.

Since the invention of cobalt-60 teletherapy during the 1950s, Canada has maintained its position on the forefront of radiotherapy and medical physics. As a result of a strong collaboration between physicians and medical physicists in large Canadian cancer hospitals several new imaging and treatment techniques were developed in Canada and rapidly translated into clinical use. Examples of Canadian innovations are half-body and total body photon irradiation as well as cone beam imaging developed in Toronto and moving beam techniques, such as rotational total skin electron irradiation and dynamic stereotactic radiosurgery, developed in Montreal.

III. Medical Physics Organizations

The first Canadian national medical physics organization was formed in 1955 as the Division of Medical Physics (DMP) under the auspices of the then 10-years-old Canadian Association of Physicists (CAP). The DMP developed its own constitution and objectives, obtained funding through individual CAP members who opted to join and pay dues to the division, and met annually as a component of the CAP congress at the time and location chosen by the CAP.

For a number of years this arrangement was satisfactory; however, with the ever-increasing growth of the DMP membership, it became apparent that an independent organization of Canadian medical physicists would offer more flexibility and better funding opportunities. This sentiment eventually prevailed in 1989 and lead to the formation of the Canadian Organization of Medical Physicists (COMP) that is independent from the CAP, has its own constitution, by-laws, membership requirements, and head office, organizes its own annual meetings, and funds its operation through membership dues and proceeds from annual meetings and exhibits.

The COMP seamlessly continued the medical physics tradition of the original DMP-CAP and during the past two decades grew into a very strong national medical physics organization that is well respected nationally as well as internationally and maintains strong links to the International Organization for Medical Physics (IOMP), the American Association of Physicists in Medicine (AAPM) as well as the CAP. Current COMP membership stands at 511, producing a rate of 15 medical physicists per million people in Canada. Considering that the mean rate of medical physicists per million people in the World is about 3, the rate of 15 ranks Canada among highly developed countries in the medical physics domain.

An elected 10-member board chaired by the President runs the COMP with support from an Executive Director and administrative staff. In addition to various standing and ad-hoc committees, the COMP has a prestigious awards program with the COMP Gold Medal its highest honour. The COMP also bestows Fellowship upon selected senior medical physicists and endorses the Sylvia Fedoruk Prize in medical physics that is sponsored by the Saskatchewan Cancer Agency and recognizes the best medical physics research paper that originated in Canada in a given calendar year. Jointly with the CAP, the COMP sponsors the Peter Kirkby Memorial Medal for outstanding service to Canadian physics.

As part of its annual meeting the COMP conducts a highly successful young investigators' symposium. The symposium competition, a highlight of annual meetings, is named in honour of John R. Cunningham, a highly respected and decorated Canadian medical physicist.

IV. Certification of Medical Physicists

In order to deal with professional issues specific to medical physicists the Canadian College of Physicists in Medicine (CCPM) was formed in 1980 with a mandate to organize procedures for professional certification, continuing education, and maintenance of certification for Canadian medical physicists. The original "grandfathers" of the CCPM were six senior medical physicists from across Canada: S.O. Fedoruk, A.F. Holloway, H.E. Johns, J.C.F. MacDonald, R.M. Mathieu, and M.E.J. Young.

The CCPM certifies medical physicists on two levels. The CCPM Membership level is attained through a written and oral examination aimed at establishing candidate's competence for work in medical physics; the advanced level CCPM Fellowship is attained through a rigorous oral examination of candidates holding the rank of senior medical physicist. An eight-member board chaired by the President runs the CCPM; the chief examiner and the examination board run the examination process, and the COMP and examination fees provide funding for the CCPM.

The minimum requirements for admission to CCPM Membership examination are an advanced degree in Physics (preferably in the medical physics specialty) and 2 years of clinical experience. A CCPM Member can apply for CCPM Fellowship examination upon completing 7 years of clinical experience. Currently, the CCPM comprises 235 Members and 161 Fellows, highlighting the high degree of professional certification among Canadian medical physicists with 396 Member or Fellow certifications among the 511 COMP members.

V. Accreditation of Medical Physics Educational Programs

To promote and ensure quality of academic programs in medical physics the American Association of Physicists in Medicine (AAPM) started to offer formal accreditation of medical physics academic programs in 1988. The first U.S. institutions with accredited programs in medical physics were the University of Wisconsin in Madison and Wayne State University in Detroit, both accredited in 1988; the first Canadian institution with such an accreditation was McGill University in 1993.

During the 1990s the responsibility for accreditation of medical physics educational programs was transferred to a new independent commission, referred to as the Commission on Accreditation of Medical Physics Educational Programs (CAMPEP) that is currently sponsored by five organizations. In addition to the AAPM and the COMP, the organizations sponsoring the CAMPEP are: the American College of Radiation Oncology (ACRO), the American College of Radiology (ACR), and the Radiological Society of North America (RSNA). Currently the CAMPEP accredits the following educational programs in medical physics: M.Sc., Ph.D., radiation oncology physics residency, imaging physics residency, certification of didactic coursework in preparation for residency, and continuing education.

With regard to accreditation Canadian medical physics educational programs are doing well considering the population ratio of 9 : 1 between the U.S. and Canada. Of the 43 graduate programs currently accredited by the CAMPEP, nine (21 %) are in Canada; of the 64 radiotherapy residency programs, 8 (12.5 %) are in Canada, and of the 8 imaging residency programs, one (12.5 %) is in Canada.

VI. Medical Physics Research and Innovation

Medical physics research and innovation have a strong tradition in Canada and plenty of role models, most notably in Harold Johns and a number of his contemporaries who were active in medical physics during the 1950s through 1970s. One of the benefits of the Canadian model of nationalized health care delivery is that it resulted in a concentration of cancer therapy in large hospitals in major Canadian cities. This, in turn, produced the formation of relatively large medical physics departments with a critical mass of medical physicists that are involved not only in service work but also with teaching and applied research.

The respectable research productivity by Canadian medical physicists is evident from the "Medical Physics" journal, the official science journal of the AAPM with co-sponsorship by the COMP and the CCPM. To every five articles in "Medical Physics" originating from U.S. institutions there is, on the average, one article that originates in Canada. This ratio exceeds significantly the population ratio between the two countries, and simply reflects better opportunities for medical physics research in a few larger medical centres of Canada in comparison with a large number of relatively small physics operations with no protected research time that are prevalent in the U.S.

VII. Canadian versus American Medical Physics

A unique characteristic of Canadian medical physics is its strong collaboration with the AAPM. The AAPM has close to 8000 members and 440 of these are Canadians, members of the COMP, and work in Canadian institutions. From its formation in 1958 the AAPM accepted Canadians with full membership rights and privileges and one can find Canadian members on the AAPM Board of Directors, various councils, committees, task groups and as recipients of various AAPM honours and awards. The relationship between Canada and the U.S. as far as medical physics is concerned is truly exemplary and of obvious benefit to both sides. It is notable that, on the average, every 10 years the AAPM holds its annual meeting in Canada jointly with the COMP. These meetings are always memorable and strengthen the ties between the two organizations and the two countries.

While the AAPM benefits from the contribution of Canadian members, the AAPM also provides Canadians with a world-class medical physics forum; over ten times the size of the COMP. It turns out that Canadian medical physics measures up in this forum quite well. For example, to date Canadian medical physicists won 34 % of the Farrington Daniels awards (13 of 38) and 24 % of the Sylvia Sorkin-Greenfield awards (7 of 29). The AAPM bestows the two awards annually for the best articles published in "Medical Physics" journal, respectively, on the subject of radiation dosimetry and on any other medical physics subject with the exception of radiation dosimetry.

Canadian medical physicists also won 10 % of the highest-honour awards that the AAPM bestows on an AAPM member, the Coolidge award (4 of 40). Another source of pride for Canadian medical physics is the performance of Canadian medical physics graduate students in the John R. Cameron Young Investigators' Symposium held during the annual AAPM meetings. Of the 10 students, who are admitted to the oral competition based on their abstract as well as supporting documentation and then present their talk in the competition, typically three students are from Canadian institutions and at least one of them typically finishes among the three winners of the competition.

VIII. Conclusions

Canada has the distinction of being in the group of the four inaugural countries that in 1963 sponsored the formation of the International Organization for Medical Physics (IOMP). The other three countries are the U.K., Sweden, and the U.S. This year, as we celebrate 50 years of the IOMP, Canada's medical physics remains strong, providing excellent clinical service in imaging and radiotherapy, carrying out respectable research and innovation, and providing great educational opportunities for young physicists who aspire to a rewarding career in medical physics.

The main characteristics of Canadian medical physics are summarized as follows:

1. High level of professionalism;
2. Strong national medical physics organizations;
3. Professional certification process run by medical physicists for medical physicists;
4. Excellent graduate and residency teaching programs spread across Canada;
5. Excellent research and innovation productivity; and
6. Concentration of clinical and academic medical physics programs in relatively large centres across Canada, providing a critical mass of medical physicists.

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