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THE ROLE OF A PHYSICIST IN RADIATION ONCOLOGY

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AMERICAN ASSOCIATION OF PHYSICISTS IN MEDICINE

STATEMENT ON
THE ROLE OF A PHYSICIST IN RADIATION ONCOLOGY

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This statement follows that entitled “The Roles, Responsibilities, and Status of the Clinical Medical Physicist,” issued by the AAPM in 1985, to concentrate on the role and relationships of the clinical medical physicist practicing in radiation oncology.

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THE ROLE OF A PHYSICIST IN RADIATION ONCOLOGY

The first responsibility of the radiation oncology physicist is to the patient--to assure the best possible treatment given the state of technology and the skills of the other members of the radiation oncology department.

A radiation oncology physicist brings a unique perspective to the clinical team in a radiation oncology program: that of a scientist trained in physics, including radiological physics, and also in clinical, basic medical, and radiobiological sciences. The physicist performs an important role working along with the radiation oncologist, the radiotherapy technologist and others, to assure the accurate delivery of all aspects of a treatment prescription.

Responsibilities of Radiation Oncology Physics

In radiation oncology, physicists have the primary responsibility for the following, except where the responsibility is noted as shared:

Planning for resource allocation with radiation oncologists, administrators, and technologists, including:

- Equipment usage, selection and replacement,
- Staff requirements, assignments, and recruitment,
- Budget preparation,
- Program operation, and
- Continuing review of the program's policies and procedures.

Physical aspects of all radiation sources (radioactive materials and radiation producing machines) used in a radiation oncology program, including:

- Performance specification, acceptance testing and commissioning of new equipment,
- Calibration of the sources and maintenance of all information necessary for their appropriate use,
- Development and maintenance of a quality assurance program for all treatment modalities, localization procedures, and computational equipment and programs to assure that patients receive

prescribed doses and dose distributions, within acceptable degrees of accuracy,

- Maintenance of all instrumentation required for calibration of sources, measurement of radiation, and calculation of doses, and
- First-order maintenance of treatment units (in conjunction with any inhouse electronic technician).

The radiation safety program (possibly shared with an institution's radiation safety officer, including:

- Development and administration of the radiation safety program, including compliance with all regulating and certifying agencies (e.g., the Nuclear Regulatory Commission, the Joint Commission on Accreditation of Health Care Organizations, the Occupational Safety and Health Administration, and appropriate state and local agencies),
- Administration of a personnel radiation monitoring program,
- Supervision of source preparation and handling during brachytherapy, and the continual maintenance of the brachytherapy source inventory,
- Participation on the institutional Radiation Safety Committee, and other committees (e.g., General Safety) as needed, and
- Calculation of shielding required for new or renovated treatment rooms, radioactive-source storage and handling facilities, and brachytherapy patient rooms.

The physical aspects of patients' treatments, including:

- Consultations with radiation oncologists on the physical and radiobiological aspects of patients' treatments, and the development of treatment plans.
- Acquisition and storage of data for treatment plans,
- Calculation of dose distributions and machine settings for patient treatments,
- Design and fabrication of treatment aids and treatment-beam modifiers.
- Assurance of the accuracy of treatment unit parameters and settings used for a patient's treatment, including correct transfer of parameters between the simulator, treatment plan and the treatment unit, and periodic review of each patient's chart.

- *In-vivo* measurement to verify the dose delivered to a patient.
- Assisting the radiation oncologists in statistical analysis for evaluation of treatment efficacy, and participation in clinical trials,
- Development of techniques (hardware, software, or procedural) to improve the delivery of radiation treatments,
- Participation at patient-discussion conferences, and
- Continuing education of the radiation oncology staff.

Interaction with the medical physics community, including:

- Participation at radiation oncology physics or related medical meetings to receive and disseminate state-of-the-art information, and
- Participation in peer review.

Because of the training received in analytical processes and scientific principles, the physicist plays a principal role in development of systems and policies, the review of consistency between plans and their execution, and problem-solving. After the development and testing of a procedure, a physicist may delegate to other appropriately trained personnel the routine performance, while maintaining responsibility and supervising as required. The work of dosimetrists involved in the computation of dose distributions and machine settings is a common example of such delegation. Because of the scientific complexity and regulatory specifications, the performance of calibrations cannot be delegated.

Physics Staffing

While the list in the previous section outlines most of the major, identifiable activities performed by a radiation oncology physicist, it is by no means exhaustive. The nature and relative importance of the different activities depend on the particular working relationships between the physicists and radiation oncologists in a given program. However, the list does present a typical set of responsibilities. Some of the activities, such as maintaining a calibrated ionization chamber, provide basic support for a program regardless of the number of patients treated each year or the number of treatment machines operated. Other activities, such as routine quality assurance, depend on the number of treatment units to be checked, while still others (e.g., patient consultations) depend on the number of patients treated.

Research and teaching (other than inservice and continuing education sessions necessary for safety, compliance, or patient care) explicitly fall outside of the considerations of this report. Radiation *Oncology in Integrated Cancer Management,*[1] the report of the Inter- society Council for Radiation Oncology (on which the American Association of Physicists in Medicine participates)* gives staffing levels considered as the minimum “necessary for patient care.” Physics staffing should never fall below the levels suggested in the current edition of that report.

Because of the difficulty in obtaining qualified physicists (see the section below on *Qualifications of a Radiation Oncology Physicist),* some administrators of radiation oncology programs hire under-trained medical physicists** or surrogates for radiation oncology physicists, such as physicists trained in other fields, dosimetrists, or technologists. In some cases, radiation oncologists have endeavored to perform the physics services themselves. To assure proper and safe treatments, all radiation oncology facilities must have at least one qualified physicist responsible for the physics program, with a sufficient time commitment to allow familiarity with the daily operations of treatments and authority to make changes in procedures as necessary. A qualified physicist can supervise, delegate, and coordinate the activities of any ancillary physics staff.

The Physics Section of a radiation oncology facility may include some, or all, of the following trained specialists:

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*Other member societies authoring this report (commonly called “the Blue Book”) include the: American College of Medical Physics, American College of Radiology, American Radium Society, American Society for Therapeutic Radiology and Oncology, North American Hyperthermia Group, Radiation Research Society, Radiological Society of North America, and Society of Chairmen of Academic Radiation Oncology Programs.

**The AAPM has developed a description of the general and specialized education and relevant experience considered by the AAPM to form the core training for a clinical radiation oncology physicist.[3]

Physics assistants-- Physics assistants, who usually begin their training with either a bachelor's degree in science, or prior training in radiotherapy technology, may perform many routine physics functions under the supervision of a physicist, such as:

- Treatment-unit quality-assurance measurements,
- Radiation-level readings around brachytherapy patients,
- Brachytherapy source inventory, ordering, and shipping,
- Personnel radiation monitors handling.

Dosimetrists-- Dosimetrists are personnel specially trained in performing specified, and usually patient-oriented physics tasks. Examples of tasks commonly performed by dosimetrists include:

- Assembling patient data required for dose calculations,
- Calculating dose distributions,
- Manufacturing compensators, immobilization molds and related devices, and custom-made blocks,
- Computing treatment times or control monitor units,
- Performing *in-vivo* dosimetry for patient treatments,
- Performing periodic checks on treatment records.

Many of these functions apply to both external beam and brachytherapy treatments. Dosimetrists perform these tasks under the supervision of a physicist, who holds the actual responsibility for their proper execution. Dosimetrists, or other individuals specially trained to perform certain tasks under the purview of a physicist, form an integral part of the radiation oncology team.

The difference between a dosimetrist and a physics assistant may be quite arbitrary in some institutions, but usually a dosimetrist only performs duties directly related to treatment planning and dose calculation.

Mold-room technologists and block cutters-- The demand for increased precision in treatment delivery has led to an increased use of individualized immobilization devices, such as body molds, bite-blocks, and casts. The fabrication of low-melting-temperature alloy shielding blocks for patients' treatments improves reproducibility, and has become commonplace. Persons fabricating such blocks or immobilization devices on a continuing basis develop increased skill and efficiency. Since financial support for a full-time block cutter or mold-room technologist may require a substantial patient load (depending on charge structures), a dosimetrist or physics assistant may fulfill this function in departments with smaller workloads.

Electronic technicians-- Electronic technicians make repairs on the program's equipment. Adequate staffing reduces down-time waiting for outside service personnel. Many physicists have not had formal training in electronic equipment repair, but, through experience, can often complement an electronic technician during repairs.

In addition to these specialized support persons, the physics section requires access to machine-shop facilities for the construction or modification of special devices needed quickly or not commercially available.

Routine clinical physics functions should be transferred to such specially-trained, support persons. The basic functions performed by a physicist should center around problem-solving. This delegation of routine activities to technical staff saves funds compared to having a physicist perform these functions, and frees the physicist for other necessary activities not appropriate to the training of other individuals.

Qualifications of a Radiation Oncology Physicist

Evaluating the competency of a physicist for a position in a radiation oncology program based on interviews and a curriculum vitae can prove difficult. The statement by the AAPM defining a Qualified Expert[2] can serve as a guide. The excerpt cited below lists only those subspecialty certifications appropriate to radiation oncology.

Although individuals may exist who, by virtue of their training and experience, may also be qualified, certification in an appropriate area by one of the organizations listed below is the only way easily to determine adequacy of preparation to function independently as a clinical medical physicist. The AAPM encourages its members to obtain certification in the fields of desired specialization and recommends that expertise be sought among properly certified individuals. It is of critical importance that the agency or employer seeking expertise insure that the type and/or subspecialty of certification match the expertise being sought.

CERTIFYING ORGANIZATIONS

THE AMERICAN BOARD OF RADIOLOGY (ABR) certifies physicists in the specialties of:

Therapeutic Radiological Physics
Radiological Physics
Roentgen Ray Physics

Certification by the ABR includes examination in clinical aspects of medical physics, medical radiological equipment and instrumentation, and radiation safety.

THE AMERICAN BOARD OF MEDICAL PHYSICS (ABMP) certifies physicists in:

Radiation Oncology Physics
Hyperthermia Physics
Medical Radiation Protection [for radiation safety]

Certification by the ABMP includes examination in clinical aspects of medical physics, appropriate equipment, instrumentation, and radiation safety.

THE CANADIAN COLLEGE OF MEDICAL PHYSICS (CCMP) certifies physicists in radiological physics. Fellowship or membership implies equivalent testing to ABR certification in radiological physics (all subspecialties).

THE AMERICAN BOARD OF HEALTH PHYSICS (ABHP) certifies physicists in:

Comprehensive Health Physics [for radiation safety]

Following the policy outlined in the AAPM statement, only those persons certified by the ABR in Therapeutic Radiological Physics or Radiological Physics, The Canadian College of Medical Physics, or by the ABMP in Radiation Oncology Physics, can be assumed competent to function independently in a clinical situation. Certification by the ABHP or by the ABMP in Medical Radiation Protection indicates competence only in radiation safety aspects of radiation oncology, and not in the practice of radiation oncology physics. Participation in a post-graduate training program and practical experience alone do not imply competency.

Relationship between Radiation Oncology Physicists and other Persons in a Radiation Oncology Program

1. Relationship with radiation oncologists

   A collegial relationship should prevail between radiation oncologists and radiation oncology physicists. Both the physicist and the physician must feel free to express their professional opinions, and should always consider the opinion of the other.

   While the nature of the personal relationship between a radiation oncologist and a physicist shapes the exact form that patient consultations and treatment planning take, a set of typical divisions of responsibilities and interaction patterns can be identified. The radiation oncologist holds the responsibility for verifying the diagnosis and specifying the doses to be delivered to the treatment targets, as well as limitations on doses to critical structures. The physicist, however, should be aware of whether the prescription for a given patient is consistent with previous, similar patients, and also consider possible critical, dose-limiting structures. Any inconsistency noted by a physicist should be discussed with the radiation oncologist.

   Following discussions with the physician about a patient's treatment, the physicist is responsible for the generation of possible treatment plans. The plans should evolve from, but not necessarily be limited to, those discussed with the radiation oncologist. The actual calculation of the dose distributions can be performed by other trained technical personnel, under the supervision of a physicist. (The supervision does not mean constant surveillance, but the plans must be reviewed by a physicist, and the review documented.) Because of limitations of radiation therapy treatment planning computer systems, approximations may cause calculated dose distributions to differ from the actual dose distributions. The physicist is responsible for interpreting these calculations and advising the radiation oncologist where such differences may be clinically significant. Selection of a plan comes through a second discussion between the radiation oncologist and the physicist.

Before the initiation of a patient's treatment, the parameters defined during planning and simulation must be transferred to the treatment unit. To assure that the information transfers correctly between the various stages and that all persons involved interpret plans and patient marks properly, the team of the physicist and radiation oncologist should follow the plan and patient through each step. Understanding the effects of changes in variables on the patient's dose and dose distribution composes the core of a radiation oncology physicist's training, making the physicist a crucial person in assuring the accuracy of the treatment planning and execution process at each step. Since the physicist already carries the responsibility for the technical quality assurance for the treatment units, including responsibility for the quality assurance of the physical treatment consolidates accountability. Additionally, integrating the physicist into the treatment flow heightens the physicist's awareness of the problems to be addressed in the clinical setting.

While the radiation oncologist maintains the final responsibility for the patient's treatment, the physicist is responsible for the physical accuracy of the doses delivered. Thus, a physicist should not allow treatment to commence until satisfied that all aspects of the treatment are sufficiently under control and that uncertainties in doses fall within acceptable tolerances. If any aspect of a treatment plan seems inappropriate to the point of being detrimental to the well-being of the patient or to the safety of the staff, and the radiation oncologist does not agree with such an assessment, the physicist has an ethical obligation to seek outside reconciliation of the difference of opinion.

2. Relationship with radiotherapy technologists (radiotherapists)

A collegial relationship should exist between physicists and radiation therapy technologists. Each must recognize the expertise and experience of the other, and seriously consider ideas suggested by the other. Physicists play a key role in translating the desired treatment plan into a set of instructions for technologists to execute.

Employment Arrangements

Some of the more common employment relationships for a physicist in radiation oncology include*:

1. The physicist as an employee of the hospital

   The status of the physicist as an employee of a hospital has ranged from that of a technician with some special technical skills (particularly for calibration of treatment units and dose calculations), through that on a par with any of the medical staff. Often, a physicist serves as a departmental administrator. Depending on the organization in the hospital, the physicist may or may not be included in policy decision-making. Excluding the physicist from the decision-making structure (either policy-making or treatment planning) or utilizing only the technical aspects of a physicist's training seriously limits the effectiveness of a physicist, and detrimentally affects the efficiency of operation of the hospital.

2. The physicist in a physicians' corporation

   Generally, physicians staffing a radiation oncology department in a hospital work as part of a physicians' corporation which contracts with the hospital to provide the services. Employees of a physicians' corporation may receive benefits not available through employment by a hospital. Physicians and physicists in such a corporation may be employees or partners. The main difference between an employee and a partner centers around involvement in the corporate decisions. Becoming a partner sometimes involves a substantial financial investment in the corporation; however, sometimes shares are awarded on the basis of years of service in the corporation. Being a partner in a physicians' corporation provides a physicist with considerable control over the working environment, but this arrangement may not be legal in some states.

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*The list explicitly excludes employment relationships for physicists practicing at a university, where the academic rank systems may prevail, or a multiplicity of optional arrangements exist.

3. The physicist as a contractor to provide physics services through a physicists' corporation

    Some physicists provide services to hospitals through corporations similar to those of physicians. Such a situation provides more financial independence for a physicist at the price of increased financial risk. Particularly when a large corporation provides services to several smaller hospitals, such physics consultation services can provide access to expensive, limited use equipment (e.g., automated, computer controlled scanning equipment or dose planning computers) which any of the hospitals alone could not afford. Also, a large physics consultation service can assure coverage of a client hospital without disruptions for vacations, meetings, or illness. Furthermore, the group practice of medical physics may bring together physicists with varied expertise, which can lead to better and more efficient resolutions to problems. Hospitals sometimes find it administratively easier to contract out for physics services than maintain personnel on their budgets. Again, as with physicians' corporations, physicists can work in a physicists' corporation as a partner or as an employee, with the same considerations as discussed above.

4. The physicist as the owner of a radiation oncology facility

    The establishment of a radiation treatment facility requires a considerable outlay in capital for the purchase of the equipment. However, with a reasonable patient census, most radiation therapy equipment pays for itself in a few years. Alternative situations could include contracting with a hospital to provide all the radiation oncology services, while the hospital purchases the equipment. Such a situation provides the physicist with the most control over the working environment.

Each type of practice arrangement has advantages and disadvantages. A physicist entering into a given situation should consider the merits of the particular arrangement, and the possibilities of alternative arrangements.

In any of the employment settings, physicists frequently find that they carry some administrative or managerial responsibilities. While such duties take time from physics-based activities proper, they often provide a measure of control over the working environment. Participation in the business aspects often proves rewarding for both the physicist and the clinic, in part (but only in part) because of the physicist's understanding of the technical side of the operation. Managerial activities include, but would not be limited to, strategic planning, services assessment, and facility analysis. Assistance with financial matters with which physicists have little training or expertise can be contracted through an accounting service.

Regardless of the employment situation, the physicist should be an active participant in discussions, planning, and decisions, as stated above as part of the physicist's responsibility. Topics particularly pertinent for physics involvement include:

1. Patient treatment techniques and planning,
2. Physics fee structure,
3. Physics staffing,
4. Physics budget,
5. The physicists' duties and relationships to departmental and institutional personnel and administrators,
6. Facility planning,
7. Negotiations and performance criteria for equipment, and
8. Equipment acceptance testing and performance verification.

REFERENCES

1. Inter-society Council for Radiation Oncology, "Radiation Oncology in Integrated Cancer Management" March 1991.
2. American Association of Physicists in Medicine, Professional Council, "Qualifications for Independently Performing the Duties of a Clinical Medical Physicist" *AAPM Newsletter 16 (5),* 6 (Sept. -Oct. 1991).
3. American Association of Physicists in Medicine, Presidential ad hoc Committee on the Clinical Training of Radiological Physicists, "Essentials and Guidelines for Hospital-based Medical Physics Residency Training Programs" November (1989).