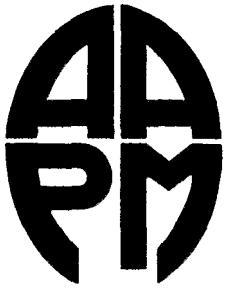
AAPM REPORT NO. 42

THE ROLE OF THE CLINICAL MEDICAL PHYSICIST IN DIAGNOSTIC RADIOLOGY



Published for the
American Association of Physicists in Medicine
by the American institute of Physics

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THE ROLE OF THE CLINICAL MEDICAL PHYSICIST IN DIAGNOSTIC RADIOLOGY

DESCRIPTION OF THE ROLE OF THE CLINICAL MEDICAL PHYSICIST IN DIAGNOSTIC IMAGING

REPORT OF TASK GROUP 2
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This statement follows that entitled "The Role, Responsibilities, and Status of the Clinical Medical Physicist," issued by the AAPM in 1986 [1], and concentrates on the role and relationships of the clinical medical physicist practicing in diagnostic imaging.

January 1994

Published for the
American Association of Physicists in Medicine
by the American Institute of Physics

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Further copies of this report may be obtained from:
American Association of Physicists in Medicine
One Physics Ellipse
College Park, MD 20740-3846

International Standard Book Number: 1-56396-311-6
International Standard Serial Number: 0271-7344

Published by the American Institute of Physics
500 Sunnyside Blvd., Woodbury, NY 11797

Printed in the United States of America

Table of Contents

Preface

This document concerns the role of the clinical medical physicist in diagnostic imaging, including descriptions of the medical physicist's responsibilities, relationships with other professionals, and practice conditions. This document is an official statement of the American Association of Physicists in Medicine (AAPM) for distribution to other professional societies, regulatory bodies, and any other interested parties. (The role of the medical physicist in radiation therapy is discussed in the publication entitled "The Role of a Physicist in Radiation Oncology"[1].)

It is important to stress that this document is not meant to be a presentation of the state of the practice but rather a proposal for the state of the art. In other words, this document sets goals for the professional and ethical practice of clinical medical physics as it relates to diagnostic imaging, goals we hope to achieve before the year 2000. While differences in the practice between major medical centers, community hospitals, and small clinical facilities presently exist, and will probably exist in the future, this does not imply that the ***quality*** of the services provided should be compromised. We also believe that there are some staffing problems due to the shortages of qualified clinical medical physicists. These and other questions must be dealt with and resolved in the decade of the 90's if the medical physics profession is to continue to grow and to provide the needed support to our clinical imaging colleagues.

Description of the Role of the Clinical Medical Physicist in Diagnostic Imaging

Introduction

The first responsibility of the medical physicist is to the patient-to ensure that the programs are in place to facilitate the production of quality diagnostic images consistent with the available technology and which optimize safety (including radiation, mechanical, and electrical) for the patient. The responsibility of providing a clinically diagnostic image is shared between the clinical medical physicist, the imaging physician, and the technologist assisting with the procedure. A clinical medical physicist qualified in diagnostic imaging brings a unique perspective to the clinical team in a diagnostic imaging department: a scientist trained in physics, including imaging and radiological physics, and also in basic medical, clinical, and radiobiological sciences. This document provides a definition of the specific roles of the medical physicist in realizing that objective.

It is important that the clinical medical physicist in a diagnostic imaging department be qualified. At the present time, state licensure is rare. In lieu of licensure, the AAPM has developed a definition of a qualified medical physicist (see page 10).

Responsibilities of the Clinical Medical Physicists

In diagnostic imaging, it is appropriate that the medical physicists participate in the planning for resource allocation for both diagnostic imaging and medical physics. Important contributions should be expected for:

1. Delineation of the Physical Aspects of Diagnostic Imaging Systems

- Specification of new equipment performance;
- Supervision of acceptance testing and performance verification;
- Supervision of calibration, preventive maintenance, repair of equipment and documentation of all relevant information;
- Development and maintenance of a quality management program for all imaging equipment to facilitate the production of images of optimum quality while minimizing radiation doses to patients;
- Responsibility for all instrumentation required for quality control, image quality, and patient exposure measurements;
- Determination of doses from radiological procedures;
- Assurance of the use of good radiological technique by the technologists, e.g., collimation, radiation protection, etc.

2. Establishing and Maintaining a Radiation Safety Program

- Development and administration of the radiation safety program;

- Administration of personnel radiation monitoring and as low as reasonably achievable (ALARA) programs;
- Supervision of the preparation, handling, and disposal of radionuclides;
- Participation in the institutional radiation safety committee and other committees as appropriate (e.g., environmental safety committee);
- Participation in the development of criteria for approval of new users of radiation;
- Determination of shielding required for new or renovated equipment rooms for ionizing radiation and for radiofrequency and magnetic fields;
- Design of special shielding devices;
- Facilitation of compliance with all regulating and certifying agencies (e.g., Nuclear Regulatory Commission, Joint Commission on the Accreditation of Healthcare Organizations, Occupational Safety and Health Administration, and appropriate state and local agencies);
- Response to emergency situations such as misadministrations and spills of radioactive materials;
- Review of policies and procedures related to radiation safety, action levels, and functions of the radiation safety officer.

3. Optimization of the Clinical Imaging Procedures

- Consultation with imaging physicians and others using medical imaging equipment regarding the radiological and radiobiological aspects of patient examinations;

- Monitoring of patient radiation exposures, comparison of these exposures to published surveys for similar examinations, and calculation of specific organ doses for diagnostic examinations;
- Optimization of imaging procedures, e.g., MRI protocols, radiographic techniques, technologist activities, efficient utilization of imaging equipment;
- Determination of specific patient and organ doses, e.g., fetal dose for a specific patient;
- Assistance to physicians in the evaluation of quantitative studies, such as the measurement of cardiac ejection fraction;
- Development of special software for the analysis of specific data or for the evaluation of quantitative functional studies;
- Design and fabrication of examination aids;
- Assistance to the imaging physician and other physicians using imaging equipment in the evaluation of examination efficacy and participation in image quality and perception studies;
- Initial education of the diagnostic imaging staff to ensure the efficient implementation of new technology;
- Consultation with patients regarding concerns about radiation exposure.

4. Participation in Planning for Resource Allocation

- Participation in the development and implementation of a cost containment program for medical physics activities and imaging equipment;
- Equipment usage and replacement;
- New facility design and development;

- Staff requirements, assignments, and recruitment of medical physics staff;
- Budget preparation;
- Program and department operations;
- Continuing review of the imaging department and medical physics program's policies and procedures.

5. Participation in Educational Programs
   - Didactic and laboratory teaching for radiology and nuclear medicine residents. This includes being responsible for physics training and preparing residents for the physics portion of the ABR or ABNM examinations;
   - Preparing questions for the ABR or ABNM examinations (on request);
   - Didactic and laboratory teaching for medical physics students;
   - Didactic and laboratory teaching for radiography students and other students in diagnostic imaging programs;
   - Continuing education for imaging physicians, nurses, technologists, and other medical physicists;
   - Continuing safety education for all employees in the institution who are exposed to ionizing radiation or working in the vicinity of magnetic resonance imaging systems;
   - Continuing education for institutional employees regarding other safety-related issues such as radioactive waste, etc.

6. Involvement in the Community in Public Education Activities
   - Lectures or demonstrations at local schools and colleges;

- Participation in science fairs, and physics and science clubs;
- Involvement with scouting and similar youth organizations.

7. Involvement with the Medical Imaging Community and Other Related Organizations
   - Participation at diagnostic imaging and medical physics meetings, and other scientific meetings and conferences, to learn and disseminate state-of-the-art information;
   - Participation in peer review including reviews of papers submitted for publication, grant applications, etc.;
   - Serving in an advisory capacity and working with federal and state regulatory agencies, and certification organizations such as the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO), the American College of Radiology Mammography Accreditation Program (ACR-MAP), and American Board of Radiology (ABR);
   - Participation in local, regional, and national governmental bodies addressing health and radiation safety issues.

A primary responsibility of the medical physicist in an imaging program is development and supervision of a quantitative quality control program. All of the elements of a good quality control program are contained in the above. It remains only to organize these parts into an effective program that functions within the institution's quality management program.

Because of the training in analytical processes and scientific principles, the medical physicist plays a principal role in the review of image quality and radiation exposure levels, the development of systems and policies, the review of consistency between plans and their execution, and problem solving. After the development of a testing or quality control procedure or the development of a new imaging procedure, the medical physicist may delegate to other appropriately trained personnel the routine performance of the procedure, while maintaining responsibility and supervision as required. Technologists making quality control measurements are a logical and cost effective example of such delegation. An exception is the determination of radiation doses which is complex and requires the expertise of a qualified medical physicist.

Medical Physics Staffing

Although the list in the previous section presents most of the major, identifiable activities usually performed by a clinical medical physicist in diagnostic imaging, the list is by no means exhaustive. The nature and relative importance of the different activities depend on the relationships between the medical physicists and imaging physicians in a given program. However, the list does present a typical set of responsibilities. Some of the activities, such as ensuring that test equipment and radiation measurement equipment are properly calibrated, provide basic support of a program regardless of the number of examinations or the amount of imaging equipment utilized. Activities such as routine quality control depend on the amount and complexity of imaging equipment at the facility, whereas others, such as determination of specific patient organ doses, depend on the number and type of examinations performed. The trilateral

report published by the AAPM, the American College of Radiology Commission on Physics and Radiation Protection, and the American College of Medical Physics entitled “Recommendations on Physics Staffing for Diagnostic Radiology” provides information regarding clinical medical physics staffing levels in diagnostic imaging[2]. Additional details are provided in AAPM Report No. 33 entitled “Staffing Levels and Responsibilities of Physicists in Diagnostic Radiology”[3]. These levels should be considered as minimal levels for clinical activities, which may vary considerably depending on the type of diagnostic imaging practice. Research and teaching activities require additional time commitments. Medical centers generally considered to be “centers of excellence” all have in-house medical physics programs. However, staffing varies and many institutions do not derive lull benefits from diagnostic physics staff because of inadequate staffing levels.

To ensure optimal diagnostic image quality and appropriate radiation exposures, all diagnostic facilities are encouraged to have at least one experienced and “qualified” (see page 10 and the AAPM Report entitled “The Roles, Responsibilities, and Status of the Clinical Medical Physicist” [4]) medical physicist responsible for the medical physics program. The medical physicist requires sufficient time commitment to allow familiarity with the daily operations of the department and authority to make changes in procedures and equipment as necessary. A certified medical physicist should supervise, delegate, and coordinate the activities of any medical physics staff.

The medical physics section in diagnostic imaging facilities may include radiological engineers or quality control technologists, or both:

Radiological Engineers-These individuals repair and perform preventive maintenance on diagnostic imaging equipment. Adequate staffing of in-house service personnel reduces downtime and equipment maintenance costs, while maintaining equipment quality and safety. This may provide an economic alternative to outside service contracts.

Quality Control Technologists-These technologists work with both clinical and medical physics staffs to realize the objectives of the quantitative quality control program. These tasks include:

- Imaging equipment quality control measurements, including processor quality control and nuclear medicine equipment uniformity and resolution;
- Periodic surveys of the condition of radiation-protection garments;
- Radiation safety surveys and wipe tests in nuclear medicine.

In addition to these specialized support personnel, the clinical medical physicist needs to have access to the services of an electronics shop and repair facility, machine shop, and adequate computer resources or an adequate budget for outside services, for the construction or modification of equipment and development or modification of software not available commercially.

Qualifications of a Clinical Medical Physicist

Evaluating the competency of a clinical medical physicist for a position in a diagnostic imaging program can prove difficult. The following statement by the AAPM can serve as a guide [5]:

Qualifications for Independently Performing the Duties of a Clinical Medical Physicist

The AAPM recognizes the need of both regulating bodies and those who obtain services of medical physicists to be able to determine who is qualified to perform certain activities. The training and experience of the membership of the AAPM vary widely. Therefore, membership in the AAPM should not be considered to qualify anyone to perform a particular service. There are, however, several organizations which certify persons to be qualified in certain areas in which expertise is typically sought among medical physicists.

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 to easily 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 ensure that the type or subspecialty, or both, of certification match the expertise being sought.

Certifying Organizations

The American Board of Radiology (ABR) certifies medical physicists in the specialties of Therapeutic Radiological Physics, Diagnostic Radiologic Physics, or Medical Nuclear Physics. ABR certification is also given in all of the above areas under the headings of Radiological Physics or Roentgen Ray Physics. Certification by the ABR includes examination in clinical aspects of medical physics, medical radiological equipment and instrumentation, and radiation safety. Use of nonionizing radiations are covered in the diagnostic and general examinations.

The American Board of Medical Physics (ABMP) certifies medical physicists in Radiation Oncology Physics, Diagnostic Radiological Physics, Nuclear Medicine Physics, Hyperthermia Physics, and Medical Radiation Protection, Certification by the ABMP includes examination in clinical aspects of medical physics, appropriate equipment and instrumentation, and safety.

The American Board of Science in Nuclear Medicine (ABSNM) certifies individuals in the separate areas of Nuclear Medicine Physics and Instrumentation, Nuclear Medicine Computer Science, Radiopharmaceutical and Radiochemistry Science, Radiation Protection, and Nuclear Magnetic Resonance.

The Canadian College of Physicists in Medicine (CCPM) 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 Radiological Physics, Diagnostic Radiological Physics, or Medical Nuclear Physics; by the ABMP in Diagnostic Radiological Physics or Nuclear Medicine Physics; by the ABSNM in Nuclear Medicine Physics and Instrumentation; or by the CCPM in Radiological Physics can be assumed to have attained the basic competency in their profession defined by their peers. (Certification by ABHP in Comprehensive Health Physics indicates basic competency only in areas related to radiation safety.) Participation in a postgraduate training program and practical experience alone do not imply competency. *Furthermore, it must be stressed that Board certification in areas other than diagnostic imaging does not imply knowledge in diagnostic medical physics.* Technical measurements are only part of the medical physicist's job. Equally demanding parts of the diagnostic medical physicist's responsibilities are in the interpretation of the radiation exposure levels and the transfer of technical information to imaging physicians and support staff. Management of these complex assignments requires experience and the buildup of trust developed over time by constant interaction.

Relationship Between Medical Physicists and Others in Medical Imaging Programs

1. Relationship with the Imaging Physician

A collegial relationship should prevail between medical physicists and physicians involved in medical imaging. Both the medical physicist and the imaging physicians must feel free to express their opinions in a professional manner and should always consider carefully the opinion of the other.

The nature of the personal relationship between the physician and the clinical medical physicist shapes the exact form of consultations between the two and the product of the effort. The physician is responsible for the diagnosis and is entitled to expect the medical physicist to ensure responsibility for the quality of the image. The medical physicist, however, should be aware of the clinical limitations of examinations, the doses optimal for image formation, the limitations of the imaging equipment, and other technical factors that may affect the quality of the examination or dose to the patient. Documented systematic problems should be corrected and the corrective action documentation brought to the attention of the institution's quality management committee.

The medical physicist should be cognizant of any federal or state government guidelines or regulations that have an effect on diagnostic imaging and the requirements of organizations responsible for certification of imaging, hospital, or clinical practices. The medical physicist is responsible for keeping the physician informed of patient doses and how they compare to doses used nationally, advances in the field of medical imaging, limitations of the imaging process, and the technical characteristics of specific imaging

equipment. The medical physicist must be aware of advances in relevant safety technologies, e.g., in MR safety and electrical safety, technologic limitations in imaging equipment, national standards of image quality, comparative aspects of different imaging modalities, relevant requirements of private certifying groups, relevant safety requirements for chemical safety, and relevant medical advances that will affect equipment purchase.

The clinical medical physicist should be aware of new technologies, in the field of medicine and from other fields that may impact on medicine or provide improvements in medical imaging. The physicist should be familiar with medical uses of new technologies in their areas of expertise and how these impact on the quality of patient care. This means that medical physics today incorporates all aspects of medicine, including cardiology, laser imaging, laser therapy, and other new technologies that are being developed. This expands the concept of the medical physicist far beyond its conventional (traditional) meaning. As the world changes, medical physicists must also change and use their expertise with the technologies to which they are capable of contributing.

While the imaging physician is responsible for the examination and final diagnosis, the medical physicist is responsible for the quality of the diagnostic images, the safety (radiation, mechanical, and electrical) of equipment, and the supervision of the techniques used by the technologist. If there is a problem that may affect the quality of the diagnostic images or the safety of the patient or personnel involved in the procedure, the medical physicist should advise the physician immediately. The medical physicist should consult with the imaging physician on technical factors which affect imaging or assist in interpretation of the images in light of unusual or

difficult imaging parameters. If there is a potential radiation, mechanical, or electrical safety hazard for the patient or staff, the medical physicist should not allow the examination to be performed until satisfied that proper actions have been taken to eliminate the hazard. The medical physicist should be available to advise imaging staff on how to respond to questions from the patient regarding radiation exposures. If the patient is unduly anxious about the potential for risk from radiation exposure, the medical physicist should assist the physician in counseling the patient. The medical physicist's first responsibility is to the patient and, consequently, there is an ethical obligation to seek outside reconciliation of serious differences of opinion with regard to image quality and patient safety.

2. Relationship with Technologists

A collegial relationship should also exist between medical physicists and the medical imaging technologist. Each must recognize the expertise and experience of the other, feel free to express opinions in a professional manner, and seriously consider ideas suggested by the other. The medical physicist should be able to advise the technologist on the roles of individual parameters defining the techniques in producing an optimal image. This combined expertise can facilitate the production of the highest quality images possible for diagnostic purposes.

Employment Arrangements

Some of the more common relationships describing the employment of a medical physicist in clinical medical imaging include:

1. The Medical Physicist in a Physicians' Corporation

Generally, physicians staffing a diagnostic imaging department in a hospital work as part of a physicians' corporation which contracts with the hospital to provide services. Employees of a physicians' corporation may receive benefits not available through employment by a hospital. Physicians and medical physicists in such a corporation may be employees or partners. Becoming a partner sometimes involves substantial financial investment in the corporation; however, partnership allows more involvement in making decisions and added financial benefits. At the present time, there are no mechanisms for direct reimbursement for medical physicists' services in imaging. The precedent has been set, however, for physics services being considered "technical". Should imaging physics services be accepted by Congress at some later date as reimbursable as a technical charge, the physicians' group including a medical physicist should be aware of the need to negotiate the reimbursement of medical physics services with the hospital.

2. The Medical Physicist in the University Setting

Employment relationships for the medical physicist practicing in a university setting may be similar to those described in items 1 and 3 entitled "The Medical Physicist in a Physicians' Corporation" and "The Medical Physicist as an Employee of the Hospital", respectively. In addition, academic rank systems may prevail or a multiplicity of optional arrangements may exist. For example, the medical physicist may be a university

employee with supplemental salary and benefits being paid from a physicians' corporation.

The medical physicist must be a member of the professional staff and preferably a member of the medical staff if employed by a university hospital. Often he or she acts as a technical administrator for the department and reports to the department chair as do the imaging physicians. The medical physicists' function in the department requires that he or she be intimately involved in all decisions affecting image quality, radiation protection, etc., as described under "Responsibilities of Clinical Medical Physicists".

3. The Medical Physicist as an Employee of the Hospital

The hospital may contract with a single medical physicist for services either as an outside contractor or an employee. It is important for the hospital to establish an administrative entity for the hospital-wide medical physics effort. The chair of that effort, who must be a medical physicist, should be administratively responsible for both financial and personnel management to the imaging department chair. The chair of the medical physics effort should be a member of the medical staff.

An important issue involves the opportunity to consult. The time and considerations under which consulting is allowed should be negotiated. The hospital should be fully informed if the medical physicist will use hospital equipment for consulting purposes because of the increased exposure to liability by the hospital.

The medical physicist must be a member of the professional staff and a member of the medical staff if employed by a hospital. Often he or she acts as a technical administrator for the department and reports to the department chair as do the imaging physicians. The medical physicist's function in the department requires that he or she be intimately involved in all decisions affecting image quality, radiation protection, etc., as described under "Responsibilities of Clinical Medical Physicists."

If the hospital is not affiliated with a university, the teaching responsibilities of the medical physicist are usually limited to radiographic technology students, a limited number of residents, or staff in-service training.

4. The Medical Physicist as a Contractor to Provide Services Through a Medical Physics Corporation

Some medical physicists provide services to hospitals through corporations similar to those of physicians. Such a situation provides more financial independence for a medical physicist at the price of increased risk. When a large corporation provides services to several smaller hospitals, such medical physics consultation services can provide access to expensive, limited-use equipment. A large medical physics consultation service can ensure coverage of a client hospital without disruptions for vacations, meetings, or illness. Such a large medical physics consultation service provides the opportunity to the individual medical physicists to consult with and learn

from their colleagues on a day-to-day basis, thereby enhancing the services provided by the group. Hospitals sometimes find it administratively easier to contract for medical physics services than to maintain personnel on their budgets. As with physicians' corporations, medical physicists can work in a medical physicists' corporation as a partner or as an employee.

Each practice arrangement has advantages and disadvantages which a medical physicist entering into a given arrangement should consider. These issues include, but are not limited to, salary, benefits, retirement contributions, vesting period, ability to consult, malpractice insurance coverage, and administrative (reporting) structure.

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