



An Updated Description of the Professional Practice of Diagnostic and Imaging Medical Physics

**The Report of AAPM Diagnostic Work and
Workforce Study Subcommittee**

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An Updated Description of the Professional Practice of Diagnostic and Imaging Medical Physics

Diagnostic Work and Workforce Study Subcommittee

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Abstract

This report is a description of the current professional practice of diagnostic and imaging medical physics from the American Association of Physicists in Medicine's (AAPM) Diagnostic Work and Workforce Study Subcommittee (DWWSS), and is not intended to be a revision to the AAPM Scope of Practice. Following publication of this report, AAPM intends to conduct a survey to more fully describe the current state of practice. **Prior to a successful survey, however, this report aims to accomplish a critical primary objective, which is to create a common language and perspective among diagnostic and nuclear medical physicists by presenting a new taxonomy to describe their duties and services.**

A future survey of diagnostic and nuclear medical physicists will be created using concepts and terminology presented in this report. In the interim, the authors believe this report will assist diagnostic medical physicists and those who procure diagnostic medical physics services by providing updated consensus time estimates and effort considerations for some diagnostic medical physics services.

Traditional ways to classify common diagnostic medical physics practice models (such as consultants, in-house or staff medical physicists, etc.) and practice settings (academic hospital, community hospital, free-standing center, etc.) no longer serve as an accurate means to characterize the work performed by diagnostic medical physicists in the modern healthcare environment. Furthermore, describing a service or offering as “comprehensive” may be intended to highlight the expertise of the individual providing the service, but may also imply that the service is unnecessary or excessively expensive. On the other hand, describing a service as “basic” may imply (favorably) that the cost is low, but also that the individual providing the service is less skilled or that the client is unwilling or unable to spend money or staff effort on anything that is not strictly required of them. Describing medical physics services as “basic” or “comprehensive,” or using similar terms, does not serve the purpose of this report.

A new model for classification of diagnostic medical physics services is proposed: The Levels of Service (LoS) model.

- **Level 1** services are regulatory requirements, requirements of national accreditation programs, or standards of nationally recognized professional societies, and are required to be performed by or under the supervision of a medical physicist. Level 1 services are well-defined, and there is a relatively high degree of agreement among medical physicists on procedures, time, and effort required to perform them. The most visible examples of Level 1 services are Equipment Performance Evaluations (EPEs), commonly referred to as medical physics surveys or equipment testing.
- **Level 2** services are well-described and are frequently the responsibility of a medical physicist. Medical physicists add value when performing these services by applying their education, training, and expertise. This includes both non-mandatory services [e.g., designing a fluoroscopy safety program as described in the National Council on Radiation Protection and Measurements (NCRP) Report 168] and mandatory services [e.g., serving as the Radiation Safety Officer (RSO) for a diagnostic imaging facility]. Level 2 services are carried out according to methods, procedures, or standards contained in published national or international guidance. Level 2 services are not performed exclusively by medical physicists.
- **Level 3** services are neither well-defined nor mandated by authorities outside the healthcare institution. Level 3 services are the least well-defined in terms of the amount of time or effort required. They may be broadly categorized as research or developmental services; they

include basic science or clinical research, as well as development, testing, and use of new tools, techniques, or methods.

This report also addresses **Level 0** activities, which are essential activities that may be considered the cost of making diagnostic medical physics services available. Examples of Level 0 activities would include obtaining continuing education, calibrating instruments, obtaining and maintaining professional certifications, etc. Some of these activities, such as maintaining professional credentials, are mandatory; the medical physicist or their employer may see others as optional or negotiable.

The subcommittee agrees unanimously that providing high-quality medical physics support includes, but often extends beyond, providing only Level 1 services. This report also discusses the evolution of medical physics services to lower levels, and it describes several common diagnostic medical physicist responsibilities in the current state of practice.

Historically, diagnostic medical physics support requirements mostly have been quantified by considering imaging equipment inventories and time requirements for routine testing. However, practice has evolved to include services and activities that do not lend themselves to effort estimates based solely on equipment inventories. The present and future needs for diagnostic medical physics services and staffing are best evaluated using a study that accounts for the breadth and depth of services needed to promote and sustain quality patient care; these services are provided today in diverse practice models and settings that will likely evolve further over time. Some medical physics services and activities can and should be quantified via a focused survey of the AAPM membership, while others are difficult and unnecessary to quantify precisely. Those that are less quantifiable are also often those that are novel, emerging, or have not yet become a universal standard practice in all institutions. As such, they are growth opportunities for diagnostic medical physics. The pace of change in medical imaging suggests that further changes will affect diagnostic medical physics practice sooner than such a study could feasibly be repeated. A model that is flexible will maintain some predictive capability if it can be used with new data as they become available, allowing this resource to remain relevant for several years even in the face of major new developments.

I. Introduction

This report is an updated description of the professional practice of diagnostic and nuclear medical physics from the American Association of Physicists in Medicine (AAPM)'s Diagnostic Work and Workforce Study Subcommittee (DWWSS) and is not intended to be a revision to the AAPM Scope of Practice.¹ Background information on previous AAPM efforts and reports can be found in the appendices.

The purpose of this report is two-fold: (1) to assist diagnostic and nuclear medical physicists and those who procure their services with an updated and robust model of the time and effort requirements for diagnostic medical physics coverage; and (2) to create a common language and perspective among diagnostic medical physicists by presenting a new taxonomy to describe diagnostic medical physics duties and services. The second purpose will assist medical physicists in answering professional practice survey questions in a consistent manner. A professional practice survey of diagnostic and nuclear medical physicists will follow this report, and the expectation is that survey participants will read and understand this report beforehand, as the survey will use concepts and terminology presented herein. The survey response data will be used to create staffing recommendations for the practice of diagnostic medical physics.

The categorization scheme discussed later could be applied to any of the subfields of medical physics.² The subcommittee recognizes that some work within the scope of practice of medical physics may be performed by individuals who do not meet the AAPM's definition of a qualified medical physicist (QMP),² or even by individuals who do not consider themselves medical physicists. For instance, the American College of Radiology (ACR) Ultrasound Accreditation Program requires that accredited ultrasound equipment have an annual survey. This survey requires Equipment Performance Evaluations (EPEs) that clearly fall within the scope of diagnostic medical physics.^{1,3} At this time, the ACR and other accrediting bodies strongly recommend, but do not require, that the ultrasound EPEs be performed or supervised by a QMP.³

The subcommittee has chosen to use the term "medical physicist" throughout this report to indicate "the diagnostic or nuclear medical physicist performing the work." This avoids inconsistent use of the well-defined term Qualified Medical Physicist. We do not imply that all work described herein is always performed by a QMP.

The medical physicist must meet the requirements of the regulatory and accrediting bodies with jurisdiction over the work being performed or the facility at which it is performed. Furthermore, it is the AAPM's position that the medical physicist should be, or should be operating under the appropriate supervision of, a QMP when performing any work that falls within the scope of practice of a medical physicist. Similarly, the subcommittee has chosen the term "client" to refer, in general, to any entity that engages the professional services of medical physicists. This includes those who employ medical physicists at their own institution, clinical departments within an institution (e.g., Interventional Cardiology or Surgical Services), as well as those who purchase the services of consulting medical physicists.

2. Rationale for a New Schema

2.1. The Expanding Role of the Diagnostic Medical Physicist

Medical imaging equipment has increased substantially in complexity; this has increased the necessity to have medical physicists evaluate and monitor equipment performance, image quality, and radiation dose information. The medical physicist has unique expertise in developing and evaluating suggested diagnostic reference levels and quality assurance programs for imaging equipment. Medical physicists play an important role in refining the clinical techniques and processing features to optimize

image quality and radiation exposure to the patients and staff. Additionally, medical physicists create and improve upon techniques and tools for solving new clinical problems and contribute to the education of other healthcare professionals.

As the diagnostic medical physicist's role evolves, it is not possible to identify all of the factors used by healthcare decision makers to determine the number of medical physicists required to provide adequate services in their facilities. However, this report will provide a framework for identifying the types and complexity of clinical services, specialized procedures, or advanced clinical research and services that will require the involvement of medical physicists.

2.2. Variability in Practice Environment

Identification of a simple and sufficient way to classify common practice models (e.g., consultants, in-house or staff medical physicists, etc.) and practice settings (e.g., academic hospital, community hospital, free-standing center, etc.) has proven difficult. From personal and shared experience, the authors agree that many of their colleagues practice within a mix or hybrid of commonly described practice models and settings and that these mixed models are becoming more common. For instance, medical physicists at a large academic medical center may also have responsibilities for assuring regulatory compliance at affiliated outpatient centers. It is important to understand and account for practice differences in order to create a realistic study of the costs and time requirements for providing medical physics services and support to medical imaging operations.

Some healthcare systems with multiple facilities and a large number of imaging systems employ their own diagnostic medical physicists, with these individuals practicing much like what historically has been considered "consulting;" i.e., most of the clinical service provided revolves around testing of imaging equipment and the reporting of results. Conversely, consulting medical physicists may be contracted by healthcare providers to support long-term projects or to provide ongoing consultations and other duties that previously would have been considered the role of an "in-house" diagnostic medical physicist. Consequently, the subcommittee determined that an accurate, comprehensive description of the professional practice of diagnostic medical physics requires a framework that does not depend on traditional understanding of consulting and in-house practice environments.

2.3. Levels of Service Model

Because of the complexity of the field and the wide variability in practice models described above, recent attempts to survey medical physicists' work based around traditional practice patterns have given confusing or unrealistic results (see Appendices 2 and 3 for further discussion).

The Levels of Service (LoS) model described below was selected for two purposes. First, it will provide clarity for respondents when incorporated into a future survey of the diagnostic medical physics workforce. Second, the LoS model can be used by both medical physics service providers and clients to objectively describe the medical physics services that are offered, needed, or desired. This avoids descriptions that have potentially negative or misleading connotations. For example, describing a service or offering as "comprehensive" may be intended to highlight the expertise of the individual providing the service, but may also imply that the service is unnecessary or excessively expensive. On the other hand, describing a service as "basic" may imply (favorably) that the cost is low, but also that the individual providing the service is less skilled or that the client is unwilling or unable to spend money or staff effort on anything which is not strictly required of them. Describing medical physics services as "basic" or "comprehensive," or similar terms, does not serve the purpose of this report.

The subcommittee unanimously agrees that all of the activities described in this report provide value when performed by a medical physicist. This, of course, assumes that the medical physicist provides all services in accordance with all federal and state regulations, professional and ethical standards and obligations, and that the recipient obtains all services it should for compliance and safety

purposes. The LoS model provides a flexible way to match medical physics services to clients' needs, and for all parties to freely discuss their priorities and budgets for medical physics services.

2.4. Level 1 Services

Level 1 services are regulatory requirements, requirements of national accreditation programs, or standards of nationally recognized professional societies, and they are required to be performed by or under the supervision of a medical physicist.* Level 1 services are clearly defined (either as methods, procedures, or outcomes) as part of the regulation or accreditation standard. Thus, there can be a relatively high degree of agreement among medical physicists about the correct way to perform these services and the amount of time and effort required. However, this agreement or consensus may take several years to reach after a new requirement is implemented.

The most visible example of Level 1 services is annual medical physics EPEs for imaging equipment. For some modalities, such as radiography, fluoroscopy, and PET, state regulatory requirements vary widely or may not exist at all; in these cases, the authors have used ACR–AAPM Technical Standards as a reference for Level 1 EPEs. For mammography, federal regulations define consistent requirements to be met across the United States. For some modalities, such as magnetic resonance imaging (MRI) and computed tomography (CT), accreditation programs define the requirements. In many cases, these surveys satisfy multiple overlapping requirements, such as accreditation requirements of the ACR, the Intersocietal Accreditation Commission (IAC), The Joint Commission, and RadSite™. In all cases, the accredited facilities are responsible to have the surveys performed and to maintain documentation of the results. The medical physicist provides direct value to the facility in several ways: the regulatory or accreditation requirement is met, allowing the facility to continue operation, and the process typically leads to improvements in quality and safety.

Level 1 services are generally the most well-defined services carried out by medical physicists, and the procedures are generally well established. One would expect substantial similarity when observing different medical physicists performing Level 1 annual surveys in different settings and geographic locations.

Practically, Level 1 services tend to be viewed as routine costs of doing business for facilities delivering medical imaging services. There is seldom any difficulty demonstrating the need to the client to retain appropriate staff or consultants to do this work because compliance is mandatory, and there are often clear standards for the qualifications of the medical physicist who does the work.

The subcommittee agrees unanimously that providing high-quality medical physics support includes, but often extends beyond, providing only Level 1 services.

2.5. Level 2 Services

Level 2 services are those that are well-described and are frequently the responsibility of a medical physicist. This includes both non-mandatory services and mandatory services. Given their education, training, and expertise, the medical physicist adds value when performing these services, especially with problem-solving in the clinic. In the LoS model, Level 2 services are carried out according to methods, procedures, or standards contained in published national or international guidance. Exam-

* The subcommittee recognizes that for some Level 1 activities there may be narrow exceptions to the standard that a service is “required” to be provided by a medical physicist. For instance, we consider the Annual MRI System Performance Evaluation to be a Level 1 activity, even though the ACR MRI Accreditation Program allows an MR scientist, who may not be a medical physicist, to perform the evaluation. Also, some state licensing programs and accreditation programs may allow individuals who do not meet the AAPM Professional Policy 1 Qualified Medical Physicist definition to provide services under “grandfather” provisions and alternative pathways to qualify to perform these services. Such individuals are usually referred to as medical physicists in the applicable regulations or program requirements.

ples of Level 2 medical physics services are found in sources such as AAPM reports, AAPM Medical Physics Practice Guidelines, National Council on Radiation Protection and Measurements (NCRP) publications, federal and state regulatory guides, National Electrical Manufacturers Association (NEMA) Standards, and other similar widely recognized reports, standards, and guidance documents. In contrast to Level 1 services, Level 2 services are not necessarily performed exclusively by medical physicists.

Level 2 services should be familiar to medical physicists, but the services and their value may be more difficult to quantify, especially for those who are not medical physicists. Since Level 2 services are described in readily available reference documents, it is reasonable for the medical physicist who provides these services—or the clients that opt for them—to estimate the amount of time and effort required for them.

Medical physicists provide direct value in performing Level 2 services, and these services inherently enhance safety and patient care quality. An example of a non-mandatory Level 2 service is implementation of an interventional fluoroscopy safety program based on NCRP Report No. 168.⁴ Such a program would exceed the minimum quality, safety, and training standards required by many state regulations, and the publication provides detailed guidance for such a program. A mandatory Level 2 service would be serving as a Radiation Safety Officer (RSO). A medical physicist is qualified and brings valuable expertise to this role, and each radioactive materials licensee is required to have one; however, other individuals can also meet the requirements and serve in this capacity. There is literature available to guide medical physicists in carrying out the various duties of an RSO.⁵

One additional type of Level 2 service would be extensions or expansions of Level 1 services. For example, a hospital required to have annual EPEs could choose to conduct such tests more frequently (e.g., semi-annual SPECT or fluoroscopy output). The additional testing would be considered Level 2 services. A medical physicist supplementing the tests required by regulatory or accreditation requirements with additional tests or evaluations would also be providing Level 2 services in conjunction with the Level 1 physics survey (e.g., advanced MRI QC tests for functions such as spectroscopy).

Appendix 2 of this report provides some examples of Level 2 services that are often performed by medical physicists. This information should be considered by clients wishing to have medical physicists perform Level 2 services so that the appropriate staffing and support can be planned. The services are characterized separately rather than associated with particular facility characteristics or medical physicist practice patterns.

For Level 2 services, the authors recommend that clients consult with a medical physicist to determine reasonable time and effort requirements.

2.6. Level 3 Services

Level 3 services are those services that are neither well-defined nor mandated by authorities outside the healthcare institution. Given their education, training, and expertise, medical physicists deliver value in performing these services. Level 3 services are the least well-defined in terms of the amount of time or effort required. These services might be broadly categorized as research or developmental services; they include basic science or clinical research, as well as the development, testing, and use of new tools, techniques, or methods.

The amount of medical physics effort required for Level 3 services is impossible to quantify broadly because the needs and priorities are specific to each facility and project. They are included in the model to make it clear that such services consume time, effort, and resources beyond the facility's needs for Level 1 and Level 2 medical physics services. Accordingly, it is appropriate to provide Level 3 services that suit the needs and goals of the individual client. The subcommittee expects that Level 3 services would account for the most differences in diagnostic medical physics staffing and effort

between medical centers with an active research program in medical imaging and one that does not, given similar facility sizes and equipment inventories.

Detailed effort requirements for Level 3 services are outside the scope of this report. It is recommended that each facility consider its needs and priorities to determine the appropriate amount of medical physics support for Level 3 services. Future surveys of the existing diagnostic medical physics workforce should account separately for time and effort devoted to Level 3 services.

2.7. Evolution of Services to Different Levels

Medical physics services often evolve to different service levels as time passes and specific procedures become more mature and widely accepted. As a general example, consider a new procedure that originates at Level 3 as part of a research or quality improvement project. This may result in a publication that gains the attention of other medical physicists and institutions. Eventually, a group of medical physicists who have undertaken similar efforts as Level 3 projects may form an AAPM task group and produce a report, which makes the details of the project available to the broader medical physics community on a Level 2 basis. As more facilities adopt these practices, at some point, they may become accepted widely enough that an accrediting body or regulatory agency decides that they should be made part of the standards or requirements. At this point, the activity becomes a Level 1 service.

This progression has happened for many diagnostic medical physics services and can be expected to play out similarly for emerging trends:

- Medical physics support for mammography began as a Level 3 service as the practice of mammography was gaining acceptance. There was a large variation in quality and a wide range of practices used by physicists to support it. The ACR Mammography Accreditation Program established voluntary guidelines, providing guidance for medical physics support as a Level 2 service. With the passage of the Mammography Quality Standards Act, subsequent U. S. Food and Drug Administration (FDA) regulations mandated accreditation and medical physics support for mammography, thus making it a Level 1 service.
- ACR accreditation of imaging modalities was truly voluntary, making the associated medical physics support a Level 2 service from the late 1990s into the mid-2000s. Around 2007, requirements for accreditation from large private payers—and eventually the Centers for Medicare and Medicaid Services (CMS)—advanced the demand for imaging accreditation. For many facilities today, accreditation is effectively mandatory, and for those accredited by the ACR, the medical physics support described in the CT, MRI, and Nuclear Medicine Accreditation Program Requirements is Level 1.
- CT protocol review committee participation by the medical physicist was established at Level 2 with the publication of AAPM MPPG 1.a⁶ and became a Level 1 service for all Joint Commission-accredited facilities effective July 1, 2015, with new accreditation requirements for diagnostic imaging.
- Support of MRI safety programs was a Level 2 service for many years, being principally carried out by physicians and MRI technologists in many settings. The ACR Expert Panel on MR Safety published the details of these programs in a series of publications, most recently in 2013.⁷ Medical physicists are becoming increasingly involved in MRI safety, and the 2015 ACR MRI Accreditation Program Requirements and documentation has made the annual review of the safety program an explicit (Level 1) responsibility of the medical physicist.⁸

2.8. Level 0 Activities

The subcommittee discussed an additional category of effort that requires separate consideration—the activities that maintain the medical physicist’s ability to practice and to provide services. In contrast to Levels 1 through 3, these activities provide value to the client indirectly. They ensure that

the medical physicist meets requirements to provide services, but in most cases they do not perceptibly affect the quality or cost of the services from the standpoint of the physicist's client. They are considered to be part of the cost of making diagnostic medical physics services available.

Examples of Level 0 activities would include obtaining and documenting continuing education; training in new modalities or on new equipment; calibrating instruments; procuring and repairing test equipment; obtaining and renewing state licenses, registrations, and similar credentials; obtaining and maintaining professional certifications; attending conferences; participating in professional organizations; etc. Some of these activities, such as maintaining professional licenses, are mandatory in some jurisdictions; the medical physicist or their employer may see others as optional or negotiable.

This discussion is not intended as a commentary on the inherent value of these activities. Clearly, continuing education is intended to reinforce or enhance skills and result in the delivery of higher-quality services. Minimum levels of continuing education are required to maintain proof of competence (e.g., to meet requirements for accreditation programs, maintenance of certification or state license). Institutions or individuals are free to set higher standards for the amount, type, and frequency of continuing education, as well as other optional Level 0 activities, such as professional organization participation. These activities consume the medical physicist's time and effort, which must be considered in workforce planning.

The subcommittee believes that correct accounting of monetary and time costs for Level 0 activities is one factor that can be overlooked in cost comparisons between staff (employed) and consulting medical physics support. It is likely to be impractical for a consultant to pass along such costs to their clients in an itemized fashion, so these costs must be built into the costs of services provided. In contrast, a facility that employs medical physicists will typically bear these costs, but they may not be specified as such in the accounting of the costs (salary and benefits) of the medical physicists. An accurate comparison between the costs of employed medical physicists versus a consulting contract should consider the cost and time requirements related to, and the benefits from, the Level 0 activities needed to sustain the medical physicist(s).

3. Common Diagnostic Medical Physicist Responsibilities

In order to give examples of how one might apply the LoS model, some common diagnostic medical physics duties are discussed below.

3.1. Professional Consultation and Communications

Medical physicists must effectively communicate their findings and recommendations to appropriate client leadership and clinical personnel so that they can be acted upon to make quality and safety improvements to patient care. It is vital for the medical physicist to be available to personnel at the client facility to answer any related or follow-up questions. This communication may take place via telephone calls, face-to-face meetings, or written reports. Most medical physicists, like other modern professionals, must also keep up with large volumes of email, text messaging, and other electronic forms of communication, where the expected response time is often near real-time.

Professional communications are a vital part of medical physics services for all LoS. It is important to allocate appropriate time to effectively perform this essential function.^{9,10}

3.2. Regulatory and Accreditation Compliance

Imaging facilities are required to have the services of a medical physicist in order to meet local, state, and federal regulations, as well as accreditation standards. These services are considered Level 1 services.

3.2.1. State Regulations

Most state regulations require that facilities using ionizing radiation for diagnostic or interventional purposes have the performance of their equipment evaluated routinely by a qualified individual. Depending on the state, this individual may or may not be a QMP. The frequency and extent of the required tests vary state to state and may be different for each type of equipment (e.g., dental vs. CT). The Conference of Radiation Control Program Directors (CRCPD) developed the Suggested State Regulations (SSR) for Control of Radiation¹¹ to provide guidance to state regulatory authorities and encourage consistency.

The SSRs specify that licensees or registrants of diagnostic x-ray equipment establish and maintain quality assurance programs consisting of minimum quality control assessments. Although some quality control assessments may be assigned to appropriately qualified personnel other than a medical physicist, quality control assessments for fluoroscopic and CT equipment and structural shielding design and evaluation for new and modified facilities with x-ray equipment are generally required to be conducted by, or under the direction of, a medical physicist. Performing the equipment evaluations and overseeing quality assurance programs under applicable state regulations would be Level 1 services for facilities in states that require them.

3.2.2. Mammography Regulations

The Mammography Quality Standards Act¹² (as amended by the Mammography Quality Standards Reauthorization Act of 1998 and 2004) and the Food and Drug Administration's MQSA Final Regulations¹³ establish minimum requirements for medical physicists and mammography equipment. Individual states may have different regulations, but they may not be less stringent than the federal requirements for mammography.

All mammography facilities must have a medical physicist conduct a mammography equipment evaluation of new equipment, conduct an annual survey of their equipment, and provide oversight for the facility's quality assurance program. Medical physicists performing mammography equipment surveys must meet specific FDA initial qualifications, continuing experience, and continuing education requirements.

3.2.3. Accreditation Requirements for Medical Physicists

Imaging accreditation programs are voluntary, but they have become de facto requirements for many facilities since they must be accredited to be reimbursed for services. For example, the *Medicare Improvements for Patients and Providers Act*¹⁴ (MIPPA) requires that outpatient facilities providing advanced diagnostic imaging services (i.e., CT, MRI, and NM, including PET) be accredited by an approved organization in order to be reimbursed by CMS.

At this time, there are four organizations approved by the CMS to provide this accreditation: ACR, IAC, The Joint Commission (TJC), and RadSite™. The survey requirements vary for each modality and organization. Likewise, each accrediting organization has different qualifications for the medical physicist providing these services. Maintaining education and experience to meet accreditation requirements are Level 0 activities, while the medical physicist's equipment performance evaluations required by the accreditation program are Level 1 services.

3.3. Equipment Performance Evaluation

Equipment performance evaluations (EPEs) are often a large part of the Level 1 services discussed above. However, for new types of equipment or when developing new methods for using existing equipment, the performance evaluations needed may be considered Level 2 or even Level 3 work. The subcommittee has included a list (see Appendix 1, Table 1) of typical or reasonable testing times to perform Level 1 EPEs. As previously mentioned, the authors have used ACR–AAPM Technical Stan-

dards as a reference for Level 1 EPEs, as well as ACR QC manuals where available. It is expected that additional testing beyond the minimum regulatory or accreditation requirements will take additional time, perhaps significantly longer than the Level 1 EPE.

The time values given in Appendix 1 for EPEs are not recommendations. Rather, they are considered reasonable time allotments for Level 1 medical physics EPEs for the various imaging modalities. The values were derived by consensus of the subcommittee*; they are similar to those reported by Cypel and Sunshine.¹⁵ Appendix 1 contains additional discussion.

3.4. Training and Education Programs

Medical physicists often develop or participate in training and educational programs specific to their expertise and practice environment. Virtually all hospitals and many non-hospital facilities that use ionizing radiation are required to provide initial and periodic radiation safety training for staff members who use radiation or who work in the vicinity of radiation sources. To maintain staff competency amidst the rapid change in imaging technology, medical physicists are often asked to provide specific in-service educational programs on technical topics (e.g., MR safety, digital imaging, dose reduction, or optimization techniques, etc.). In some environments, clinical medical physicists are expected to present lectures or provide entire courses to medical students, radiology residents,^{16,17,18} or schools of radiologic, nuclear medicine, MRI, or ultrasound technology. Teaching would typically be categorized as a Level 2 service, but in some instances there may be a requirement for training to be provided by a physicist, in which case teaching would be a Level 1 service.

While a medical physicist is competent in the physics relating to these topics, preparing and delivering effective training and educational programs is a separate skill. Preparing a one-hour lecture typically requires four to eight hours for a medical physicist experienced in teaching. Experienced teachers who have lectures prepared may be able to deliver a one-hour lecture with only a brief preparation time. Less-experienced teachers may require up to three to four times more time to prepare and rehearse lectures with accurate content at the appropriate level of complexity for the audience.

3.5. Patient Safety and Quality Improvement

The medical physicist often contributes technical expertise and clinical understanding to efforts to minimize patient risk and achieve quality improvement. These efforts may be ongoing processes (e.g., protocol optimization or MR safety program) or incident specific (e.g., root cause analysis of specific patient safety issues associated with the medical imaging). Medical physicist participation may be mandated by regulatory or accreditation requirements (e.g., CT protocol committees), making the activity a Level 1 service.

Other projects and initiatives may require Level 2 or even Level 3 services, depending on the particular goal and approach. The time required for these projects varies considerably with the institutional complexity and expectations for the medical physicist; the associated time should be considered when assessing medical physicist staffing needs or productivity.

Medical physicists are often needed to perform patient dose assessments and participate in root cause analyses of radiation-related patient incidents on an as-needed basis. Depending on the frequency and complexity of these events and the tools available to the medical physicist to assist in the

* The subcommittee's membership represents many practice environments, from medical physics private practice groups (consulting), to in-house community practice, to large academic institutions. They provide services for all diagnostic modalities that perform imaging, invasive, and therapeutic procedures. Some serve as RSOs as employees of organizations, while others provide these services in the capacity of a consultant. Practice environments range from providing services at a local, state, regional, and national level, and some medical physicists are involved in the education of residents (both medical physics and physician), graduate students, allied health professionals, and physicians.

analysis, such projects may be highly time consuming. Due to the safety nature of these projects, they often assume unplanned and urgent priority and can disrupt or delay the completion of other work.

3.6. Radiation Safety Officer Duties

The authority, responsibilities, and duties of the RSO are significant. The duties to be performed by the RSO depend upon the scope and complexity of the radiation protection program and the training and experience of the RSO.¹⁹ The RSO is responsible for management of a site's radiation protection program and must have authority to act on radiation safety problems. Action may include identification of problems, stopping unsafe operations, and implementing corrective actions. Responsibilities of RSOs are defined in regulation and in both state and federal regulatory guidance. It may be very time consuming for an RSO to perform all duties, so some duties may be delegated to other individuals. In some facilities, a physician serves as RSO and delegates many of the duties to a medical physicist. The time required to perform RSO duties (or those delegated by an RSO) will vary significantly based on the scope and size of the program. The subcommittee considers RSO a Level 2 service, but recognizes that the tasks the medical physicist performs as RSO will likely cover all levels of service. While medical physicists commonly meet the educational, training, and experience requirements to serve as RSO, they are not the only professionals qualified to serve as RSO. Appendix I of AAPM Report No. 160 contains a detailed table of RSO duties, a description of those duties, and a list of who must perform them (RSO or delegate).^{5,19}

3.7. Site Planning, Imaging Technology, and Informatics

There are many aspects to site planning where the medical physicist brings valuable expertise. Specifically, performing radiation shielding designs is an obvious example of a Level 1 service in many jurisdictions, but it is Level 2 in many others. The medical physicist's expertise should also be leveraged for life cycle management of imaging equipment, facility layout optimization (especially for public and personnel safety), and equipment selection.

Imaging facilities often conduct "hands-on" trials or demonstrations of imaging equipment. The reasons for this could include replacement of aging equipment, the chance to experience the latest technology offered by the vendor, or, in some academic settings, the opportunity to beta test potential future technology that the vendor would like assistance in further developing. In many cases, the medical physicist would conduct performance testing on the equipment to both ensure patient safety (if the unit will be used to image patients) and characterize all relevant image quality metrics. Medical physicists are well-equipped to advise on how technology advances and marketed features of imaging equipment could translate into clinical benefit, taking into account their knowledge of regulatory and accreditation requirements, radiation interactions with tissue, and techniques for optimizing image quality and patient radiation exposure.

Medical physicists' backgrounds in informatics vary widely. Some medical physicists have an informatics background that allows them to provide additional support to imaging facilities. Other medical physicists have little experience in this domain, so they may largely defer to on-site information technology (IT) personnel on these matters. Medical physicist involvement in informatics, especially at installation and commissioning of imaging systems, adds significant benefit to a site's QC program. For example, some medical physicists may create automated QC solutions, in which case consistency of Digital Imaging and Communications in Medicine (DICOM) node configurations in an installed base of equipment may be critical. Other medical physicists may adopt an approach that simply requires the system to be functioning at a local level (e.g., imaging equipment and console), entrusting informatics issues to different personnel, having evaluated the radiologist reading area during a separate testing event. Medical physicists may find roles in the informatics domain somewhere between these two extremes.

Medical physicist roles in site planning, emerging technologies, and informatics vary widely, but the medical physicist is an essential member of any committee making decisions about new purchases and life cycle management of imaging equipment and informatics systems. Testing of demonstration or loaner equipment is likely a Level 1 service. Advising on equipment purchases, life cycle management, and facility layout, as well as informatics duties, are considered Level 2 or 3 services, depending on the project.

3.8. Professional Overhead

For the purposes of this report, we consider “professional overhead” to refer to those administrative activities of a medical physicist that are required for overall professional performance and which cannot be definitively attributed to any revenue-generating activities or units of output (such as providing professional consultations or EPEs). Professional overhead is a necessary part of a medical physicist’s work responsibilities. The subcommittee considers overhead items as Level 0. These include, but are not limited to, the following activities:

- Scheduling appointments
- Maintaining calibrations for test equipment
- Preparation for field work and equipment performance evaluations
- Maintaining documentation for continuing education, licensure, maintenance of certification
- Professional travel planning
- Participation in mandatory in-service training
- Participation in staff meetings

Furthermore, medical physicists deliver more value to the patient care process by contributing relevant implications of rapid changes in medical imaging, related technologies, and regulatory drivers. To this end, medical physicists need to keep abreast of changes pertinent to the field by reviewing relevant scientific, professional, and regulatory references and assessing the implications for their client(s). This information gathering often occurs by medical physicists engaging in interactive consultation with their colleagues via email, text message, professional on-line bulletin boards, and email distribution list servers.

The medical physicist should regularly allocate and spend time acquiring technically and clinically relevant information and consulting with other colleagues. All medical physicists should engage in these essential activities, though the time required may not be specifically identified and allocated in consulting or employment contracts, as these services are often considered “value added.”

3.9. Operations Management

All diagnostic medical physics practice models are based on the fundamental principle that diagnostic medical physicists deliver services to other individuals or groups, often those who provide direct patient care. Examples include radiologists, radiology and facility administrators, radiologic and nuclear medicine technologists, nurses, and other groups who work with or around sources of radiation.

Since the goal of a diagnostic medical physics practice or department is to deliver a *service*, one or more persons must assume responsibility to assure that the expectations of services are clearly understood and delivered. Several examples include, but are not limited to:

- Clarifying clients’ expectations regarding services provided, response time, accountability, etc.
- Allocating personnel to fulfill service commitments
- Assuring that expectations have been met
- Performing client relations
- Resolving financial issues
- Resolving HR issues
- Other administrative work

Like professional overhead, the time required for operations management varies significantly with the size of the medical physics service group, the level of supervisory responsibility of the medical physicist, and the scope of services provided. In some practice environments, a medical physicist performs operations management work, but medical physics service groups often utilize skilled administrative personnel to perform some or all of these essential tasks. For example, a solo medical physicist employed by a hospital or in a solo consulting practice will often perform all operations management tasks personally, and these tasks may only consume approximately 5% of their time (~2 hours per week). Larger medical physics service groups require a higher percentage of time to deliver these services due to the associated increase in complexity. Hence, to maximize the efficient use of scarce and relatively costly medical physics resources, it is not uncommon for medical physics groups to use administrative or operations specialists to handle these tasks.

While not strictly “medical physics” work, these tasks are essential to the success of the medical physicist or service group. They, too, fall under Level 0 activities. Without proper attention to these operations management issues, clients will not receive the full value of the medical physicist’s work.

3.10. Personnel Management

As the size of a diagnostic medical physics group increases, personnel management assumes an increasing level of importance and requires a corresponding amount of time. All medical physics groups should provide periodic performance appraisals to medical physics and administrative personnel as a means of effectively communicating mutual expectations and promoting professional development. Depending on the degree of interaction with a group, staff meetings, team building, and other management responsibilities assume a greater portion of the medical physicist’s time. Some activities may be delegated to operations management personnel, including time sheets, payroll and benefits issues, and filing mandatory government forms. Like operations management, personnel management is considered a Level 0 activity.

Elements of personnel management that often require the input of a medical physicist with management responsibility, and which may be time consuming, include but are not limited to:

- Staffing assessment
- Recruiting and hiring
- Conflict resolution among imaging medical physicists or between medical physics personnel and clients
- Assigning and prioritizing work or projects
- Determining schedules for vacations and professional meetings
- Employee performance reviews, performance improvement plans, progressive discipline, etc.

4. Conclusion

The model presented here frames the diverse duties currently performed by medical physicists and should enable individuals to contribute meaningful data about their own services and activities to a comprehensive workforce survey. This report may also be useful for medical physicists when advising administrative and leadership personnel on medical physicist staffing, purchased services, or a combination of both. Historically, diagnostic medical physics support requirements have largely been quantified by considering imaging equipment inventories and time requirements for routine EPEs. However, practice has evolved to include services and activities that do not lend themselves to effort estimates based on equipment inventories.

The present and future needs for diagnostic medical physics services and staffing are best evaluated using a study that accounts for the breadth and depth of services needed to promote and sustain quality patient care; these services are provided today in diverse practice models and settings that will

likely evolve further over time. Some medical physics services and activities can and should be quantified via a focused survey of the AAPM membership, while others are difficult and unnecessary to quantify precisely. Those that are less quantifiable are also often those that are novel, emerging, or have not yet become a universal standard practice in all institutions. As such, they are growth opportunities for diagnostic medical physics. The pace of change in medical imaging suggests that further changes will affect diagnostic medical physics practice sooner than such a study could feasibly be repeated. A model that is flexible will maintain some predictive capability if it can be used with new data as they become available, allowing this resource to remain relevant for several years, even in the face of major new developments.

References

- ¹AAPM Professional Policy 17. “Scope of Practice of Clinical Medical Physics.” Available from: <http://www.aapm.org/org/policies/details.asp?id=317&type=PP>.
- ²AAPM Professional Policy 1. “Definition of a Qualified Medical Physicist.” Available from: <http://www.aapm.org/org/policies/details.asp?id=316&type=PP>.
- ³American College of Radiology. “ACR Ultrasound Accreditation Program Requirements.” Revised 11/8/16. Available from: <http://www.acraccreditation.org/~media/ACRAccreditation/Documents/Ultrasound/Requirements.pdf?la=en>.
- ⁴National Council on Radiation Protection and Measurements. “Radiation Dose Management for Fluoroscopically-guided Interventional Medical Procedures.” NCRP Report No. 168. Bethesda, MD: NCRP, 2011.
- ⁵The American College of Radiology, American Association of Physicists in Medicine. “ACR-AAPM Radiation Safety Officer Resources”. Revised January 4, 2016. Available from: <https://www.acr.org/~media/ACR/Documents/PDF/QualitySafety/Radiation-Safety/ACRAAPM-RSO-Resources.pdf?la=en>.
- ⁶Cody, D. D. et al. (2013). “AAPM Medical Physics Practice Guideline 1.a: CT Protocol Management and Review Practice Guideline.” *J. Appl. Clin. Med. Phys.* 14(5):3–12. doi: 10.1120/jacmp.v14i5.4462. Available at: <http://jacmp.org/index.php/jacmp/article/view/4462/3058>. Date accessed: 3/5/16.
- ⁷Kanal, E., A. J. Barkovich, C. Bell, et al. (2013). “ACR Guidance Document on MR Safe Practices.” *J. Magn. Reson. Imaging* 37:501–30. Available from: <http://onlinelibrary.wiley.com/doi/10.1002/jmri.24011/pdf>.
- ⁸The American College of Radiology. “MRI Accreditation Program Requirements.” Revised 5/3/16. Available from: <http://www.acraccreditation.org/~media/ACRAccreditation/Documents/MRI/Requirements.pdf?la=en>.
- ⁹The American College of Radiology Bulletin. “The Physics of Imaging.” June 2015. Available from: <https://acrbulletin.org/acr-bulletin-june-2015/225-the-physics-of-imaging>.
- ¹⁰Pizzutiello, R. “What Does a Medical Physics Consultant Do and Why Do I Need One?” *J. Am. Coll. Radiol.* Published on-line February 2016. <http://dx.doi.org/10.1016/j.jacr.2015.12.023>.
- ¹¹Conference of Radiation Control Program Directors. Suggested State Regulations [Online Version]. <http://crcpd.org/SSRCRs/default.aspx>.
- ¹²Mammography Quality Standards Act. 42 USC §263b (2003); 21 CFR §900.1 (2003).
- ¹³Food and Drug Administration. “Mammography Quality Standards; Final Rule.” Available at: <http://www.fda.gov/downloads/radiation-emittingproducts/mammographyqualitystandardsactandprogram/documentarchives/ucm117277.pdf>.

- ¹⁴Medicare Improvement for Patients and Providers Act of 2008 (MIPPA). Public Law 110–275. July 15, 2008. Available from: <https://www.gpo.gov/fdsys/pkg/PLAW-110publ275/pdf/PLAW-110publ275.pdf>.
- ¹⁵Cypel, Y. S. and J. H. Sunshine. (2004). “Diagnostic Medical Physicists and Their Clinical Activities.” *J. Am. Coll. Radiol.* 2:120–26. Available from: [http://www.jacr.org/article/S1546-1440\(03\)00031-0/fulltext](http://www.jacr.org/article/S1546-1440(03)00031-0/fulltext).
- ¹⁶AAPM. “AAPM Diagnostic Radiology Residents Physics Curriculum.” June 2016 version. Posted at: <http://www.aapm.org/education/ERG/DIARAD/>.
- ¹⁷ABR. “ABR Diagnostic Radiology Core Examination Study Guide.” Updated 11-7-6. https://www.theabr.org/sites/all/themes/abr-media/pdf/CORE_Exam_Study_Guide_FINAL%28V11%29.pdf.
- ¹⁸ABR. “ABR Core Exam Physics Blueprint.” <https://www.theabr.org/sites/all/themes/abr-media/pdf/Physics.pdf>.
- ¹⁹AAPM. Report No. 160. (2010). “Radiation Safety Officer Qualifications for Medical Facilities.” Online version. Retrieved from http://www.aapm.org/pubs/reports/RPT_160.PDF.

Appendix I

Level I EPEs and Discussion

The majority of Level 1 services are sufficiently standardized that most medical physicists will perform similar work for these services. While there is greater variability among medical physicists for Level 2 and 3 services, the similarity of Level 1 services across a variety of locations and practice types is high enough that it is possible to give reasonably consistent typical time/work values.

The time values given in Appendix 1 for EPEs are not recommendations. Rather, they are considered reasonable time allotments for Level 1 medical physics EPEs for the various imaging modalities. The values were derived by consensus of the subcommittee; they are similar to those reported by Cypel and Sunshine.¹ There are many reasons why an individual medical physicist's results may vary from these tabulated values: varying regulatory requirements, frequency (or rarity) of specific modality testing events, clinical scheduling conflicts, abnormal equipment behavior, interruptions due to other important medical physicist job functions, etc.

The EPE times in Appendix 1 were developed based on published resources, including ACR QC manuals, accreditation program requirements, or ACR-AAPM technical standards. Mammography testing requirements are defined in the *Mammography Quality Standards Act*² (MQSA), as amended, and manufacturer QC manuals. A reasonable set of QC tests to be done by the medical physicist in radiography and fluoroscopy may be found in some state regulatory documents, ACR-AAPM technical standards, AAPM Report No. 74,³ CRCPD SSR,⁴ or NCRP Report No. 99.⁵

The tabulated values are proposed by the subcommittee to include preparation of a deliverable report, communication of results and recommendations, as well as a review of the site's quality control (QC) program for that equipment. The tabulated values also include modality-specific modifiers, intended to reasonably capture the average additional time spent on follow-up testing events. Follow-up events may include performance evaluations after, for example, x-ray tube or detector replacement, acquisition or radiologist viewing display replacement, software upgrades, other equipment repairs or upgrades, etc.

The subcommittee is aware that the time required to perform Level 1 EPEs may vary depending on a host of factors: condition of the equipment, familiarity with the unit's software, specific testing requirements for different manufacturers, availability of other personnel to assist, etc. These values should be considered typical, but it is not unreasonable for a specific unit to require less or more time.

The subcommittee describes common diagnostic medical physics responsibilities intended to capture categorically the individual tasks performed by medical physicists. The common responsibilities are:

- Professional consultation and communications
- Regulatory and accreditation compliance
- EPEs
- Delivery of training and education
- Patient safety and quality improvement
- RSO duties
- Technology and informatics
- Professional overhead
- Operations management
- Personnel management

THE REPORT OF AAPM DIAGNOSTIC WORK AND WORKFORCE STUDY SUBCOMMITTEE:
An Updated Description of the Professional Practice of Diagnostic and Imaging Medical Physics

Table 1: Typical times for Level I Equipment Performance Evaluations (EPEs) (travel not included)				
Task	Description	Hours per EPE	Modifier	Total hours per year for Level I services only
MQSA physics survey, S/F	Annual MQSA physics services for analog (screen-film) mammography systems. Includes hands-on survey time, QC program review, and report preparation**.	6.0	1.3	7.8
MQSA physics survey, DR only, no DBT*	Annual MQSA physics services for DR systems. Includes hands-on survey time, QC program review, printer and one primary RWS (review workstation) evaluation, and report preparation**.	5.0	1.3	6.5
MQSA physics survey, DR* w/DBT	Annual MQSA physics services for digital breast tomosynthesis (DBT) systems. Includes hands-on survey time, QC program review, printer and one primary RWS (review workstation) evaluation, and report preparation**.	8.0	2.0	16
MQSA physics survey, CR mammography*	Annual MQSA physics services for CR mammography systems. Includes hands-on survey time, QC program review, printer and one primary RWS (review workstation) evaluation, and report preparation**.	6.0	1.3	7.8
MQSA physics survey, remote primary RWS or printer*	Annual physics services for remote primary RWS (review workstation).	1.0	1.0	1.0
Primary RWS physics survey	Annual physics services for primary RWS (review workstation).	1.0	1.0	1.0
SBB physics survey	Annual physics services for stereotactic breast biopsy (SBB) systems. Includes hands-on survey time, QC program review, and report preparation**.	3.0	1.0	3.0
MRI annual physics survey	Annual MRI system physics services. Includes hands-on survey time, QC program review, report preparation**, and 2.0 hours for completion of the ACR MR safety program review checklist. ⁶	8.0	1.0	8.0
CT annual physics survey	Annual CT system physics services. Includes hands-on survey time, QC program review, report preparation**, and a review of up to six commonly used protocols.	4.0	1.8	7.0
Ultrasound annual physics survey	Annual ultrasound physics services. Includes hands-on survey time, QC program review, and report preparation**. Assumes one ultrasound system with three transducers.	2.0	1.0	2.0
NM dual-head SPECT annual physics survey	Annual physics service for dual head nuclear medicine (NM) SPECT system. Includes hands-on survey time, one well counter, one dose calibrator, one thyroid probe, QC program review, and report preparation**. Includes test described in ACR Nuclear Medicine Accreditation Program Requirements.	8.0	1.0	8.0
PET annual physics survey	Annual physics service for PET system. Includes hands-on survey time, one well counter, one dose calibrator, QC program review, and report preparation**. Includes test described in ACR PET Accreditation Program Requirements.	6.0	1.0	6.0
Radiography annual physics survey	Annual physics service for a radiography x-ray system, per x-ray tube. Includes hands-on survey time, QC program review, and report preparation**.	2.0	1.1	2.2
Fluoroscopy annual physics survey	Annual physics service for a fluoroscopy x-ray system, per x-ray tube. Includes hands-on survey time, QC program review, and report preparation**.	3.0	1.1	3.3
FGI annual physics survey	Annual physics service for fluoroscopically guided interventional (FGI) systems. Includes hands-on survey time and report preparation**.	6.0	1.3	7.8
Minimal risk x-ray system annual physics survey	Annual physics service for x-ray imaging system classified as minimal risk, e.g., DEXA, cabinet, dental, etc. Includes hands-on survey time and report preparation**.	1.0	1.0	1.0
<p>*Unlike other modalities, digital mammography QC testing (computed radiography (CR), DR and DBT) requirements vary depending on the manufacturer's Food and Drug Administration (FDA)-approved QC program. Therefore, the time required can vary significantly for units from different manufacturers.</p> <p>**Report preparation can vary greatly depending on the level of automation and templates used.</p>				

Table 2: Reference Community Hospital			
Equipment	#	Level I EPE hrs/yr per unit	Total hrs/yr for Level I EPE
CT	5	7	35
Radiographic	15	2.2	33
Table-tower and Mobile Fluoroscopy	15	3.3	49.5
Angiography/FGI	5	7.8	39
Ultrasound (3 transducers per unit)	6	2	12
Transducers	18	–	–
Mammography	4	6.5	26
Stereotactic Breast Biopsy	1	3	3
SPECT	2	8	16
PET-CT	1	6	6
MRI	2	8	16
Radiologist Workstation	6	1	6
Minimal threat device(s) (e.g., DEXA or dental)	5	1	5
TOTAL			246.5

For illustrative purposes, the subcommittee has defined a Reference Community Hospital as one with 250 beds and two associated outpatient imaging facilities. It includes the following **total** imaging equipment inventory.

Assumptions to determine annual time available per full-time equivalent (FTE) medical physicist for Level 1, 2 or 3 work:

- 2,080 (40 hrs × 52 weeks) total work hours in one year
 - ♦ 80 hours allotted for Level 0 services, such as continuing education
 - ♦ 40 hours sick leave
 - ♦ 160 hours holidays and vacation
 - ♦ 160 hours overhead (travel between easily accessible nearby sites, breaks, meetings, waiting for equipment, etc.)
- 1,640 hours remain to perform Level 1, 2, or 3 work

For hospitals with multiple locations, some Level 0 services may be shared across the group of facilities, but some percentage of Level 0 services will have to be accounted for at each facility.

It is important to acknowledge that medical physicists may be performing services for employers or clients located throughout a city, state, region, or nation and that the amount of time spent traveling between facilities will vary depending on each medical physicist’s employment arrangement. However, it is important to recognize that travel time may be significant and should be included in an estimated workload per FTE if work is performed at more than one location. Depending on the work area, this accounting may include public transportation, driving at an average speed per local traffic conditions, transport by air, etc.

At one extreme, if one assumes that the medical physicist only performs Level 1 EPEs, they may be able to perform all the EPEs at six or seven such facilities per year. Typically, however, a medical physicist has other responsibilities at the institution (e.g., serving on the radiation safety committee, assisting with accreditation submissions, answering emails or questions related to the equipment’s clinical performance, helping with regulatory matters like radioactive material (RAM) license renewal, attending inspections), etc.). These activities may significantly reduce the amount of time

available to perform Level 1 EPEs. At the other extreme, the medical physicist may have so many additional duties (e.g., RSO, a PACS administrator) that the facility may need to contract additional medical physics support to perform some of the Level 1 EPEs.

References—Appendix I

- ¹Cypel, Y. S. and J. H. Sunshine. (2004). “Diagnostic Medical Physicists and Their Clinical Activities.” *J. Am. Coll. Radiol.* 2:120–26. Available from: [http://www.jacr.org/article/S1546-1440\(03\)00031-0/fulltext](http://www.jacr.org/article/S1546-1440(03)00031-0/fulltext).
- ²Mammography Quality Standards Act. 42 USC §263b (2003); 21 CFR §900.1 (2003).
- ³AAPM. (2002). Report 74. *Quality Control in Diagnostic Radiology*. Online version. Retrieved from http://www.aapm.org/pubs/reports/RPT_74.PDF.
- ⁴Conference of Radiation Control Program Directors. “Suggested State Regulations.” Online Version. <http://crcpd.org/SSRCRs/default.aspx>.
- ⁵National Council on Radiation Protection and Measurements. “Quality Assurance for Diagnostic Imaging.” NCRP Report No. 99. Bethesda, MD: NCRP, 1988.
- ⁶The MR safety checklist is currently included as a tab in the MR Annual Equipment Evaluation Summary Form, posted on: <http://www.acraccreditation.org/Modalities/MRI>.

Appendix 2

Examples of Level 2 Services

The following is a list of possible Level 2 services. The list is neither complete nor definitive; it is intended to provide examples as guidance for medical physicists and those who may procure their services. Local or regional regulatory requirements may require some of these services and that they be done by a medical physicist, making them Level 1 for clients in those jurisdictions. Additionally, accreditation requirements may change after publication of this report, possibly altering the Level of a service listed below.

- Education
- Variety of RSO duties:
 - ♦ Review of personnel dosimetry/ALARA program
 - ♦ Auditing of radiation safety program
 - ♦ Sealed source inventories
 - Sealed source leak tests
 - Survey meter calibrations
 - ♦ Radiation Safety Committee meetings
 - ♦ Occupational dosimetry record review
 - ♦ Preparing for state inspections
 - ♦ Annual radiation protection program review
 - ♦ Sealed source inventory and leak tests
 - ♦ Compliance audit
 - ♦ Radiation Safety Committee meetings
 - ♦ Operating and safety procedures
 - ♦ Document version control
 - ♦ Radiation shielding design and evaluation
 - ♦ Unsealed radiopharmaceutical therapy support
 - ♦ PPE (lead apron) QC
 - Investigation and resolution of radiation safety issues
- Policy & Procedures—writing, reviewing, updating
- Laser Safety Officer/managing Laser Safety program
- MR Safety Officer/MR Safety Expert/managing MR Safety program
- Licensing and registration of equipment/radiation sources, related correspondence
- Acceptance testing/commissioning (where not required as Level 1)
- Professional service in associations/societies, participating in processes to develop and update regulations
- Communication with institutional officials, physicians, techs, management, administration
- Rounding
- Institutional committee service
- Training of physicians and other clinical personnel
 - ♦ Residency, MD or MP
 - ♦ Allied health
 - ♦ Non-certified MPs (junior physicists)
- Hazmat duties
- NRC NM safety training for technologists

- Interacting with clinical/biomedical/service engineers
- Observing radiation safety practices
- Oversight of service engineers
- DRL QC program
- CT protocol committee
- FGI protocol committee
- Patient dosimetry
- Fetal dosimetry
- Dose registry
- Extended or specialized EPEs
- Qualification of equipment for clinical trials/core lab “accreditation” testing
- Shielding design, depending on jurisdiction and circumstances

Appendix 3

Review of Previous Data and Reports

The first American Association of Physicists in Medicine (AAPM) report to examine the relationship between the service of diagnostic radiology and the quality level of support to be provided by diagnostic medical physicists appeared in the President's Column of the 1990 July/August Newsletter of the AAPM, which was subsequently published as AAPM Report 33 in 1991.¹ The report stressed the role of the imaging medical physicist in the tasks of:

- meeting federal, state, and other regulatory compliance;
- equipment and facility selection, testing, and maintenance;
- quality control that emphasized image quality, patient dose assessment, and radiation safety;
- the need to allow time for the physicist to engage in continuing education to assure maintenance of skills with advancing technologies; and
- administrative and other duties.

The report generally emphasized the need to provide a sufficient working staff of qualified medical physicists, which it defined, along with support staff, such as quality control technologists. Some simple guidelines on medical physics staffing were provided based on the number of x-ray tubes, ultrasound units, MRI systems, and nuclear medicine imaging heads. The report was not able to provide recommendations for PET due to limited data on that modality at that time.

The AAPM then provided further elaboration on the specific roles and duties of a diagnostic medical physicist, emphasizing the diverse responsibilities across a wide range of venues and disciplines. Report 42 in 1994 elaborated on the clinical roles and responsibilities.² By 2002, the growth of medical imaging technologies and image-guided procedures using radiation created challenges for quality and safety; AAPM report 74³ in 2002 described the rapidly expanding role of the medical physicist in addressing those challenges in complex healthcare environments. This was supplemented in 2004 by investigations sponsored by the American College of Radiology (ACR) on the expanding roles of clinical diagnostic medical physicists that surveyed the activities of over 1,500 medical physicists.⁴

In the ACR-sponsored investigation, known as the Sunshine report, 1,511 random AAPM members were surveyed, with a 56% response rate. Of respondents, only 50% did "partly or only diagnostic medical physics" work, leading to an actual sample size of $N = 427$. A critical review of the Sunshine data and respondent profile leads the practicing imaging physicist of today to believe in earnest that an updated and more thorough description of his or her professional activities is overdue. For example, the data were acquired with a survey of 40 multiple choice questions, asking respondents to incorporate a 12-month look back; it is questionable how accurately respondents would be able to recall their previous 12 months of practice. Only 13% of respondents reported being in private practice; anecdotally, this is extremely low, suggesting that the appropriately sub-specialized AAPM members were not sufficiently engaged in the survey process. For respondents that only practiced diagnostic medical physics, the median number of "units responsible for" was 25 (mean = 85, 25th to 75th quartile range = 2–100). For respondents that partly practiced diagnostic medical physics, the median number of "units responsible for" was 10 (mean = 41, 25th to 75th quartile range = 3–50). The overall median number of units that all respondents "evaluated or consulted on" was 57; no definitions are available for the reader to distinguish between "responsible for" and "evaluated or consulted on." While some of the data is confusing, and the respondent profile does not appear to represent the current cohort of imaging physics professionals in the United States, some of the reported data was considered by the subcommittee to be reasonable and useful; namely some of the reported data regarding

time spent on equipment evaluations. These data were considered by the subcommittee during discussions and consensus building.

The previous decade has witnessed further burgeoning growth in the field of what is traditionally referred to as “diagnostic medical physics,” but which has always spilled over into some therapeutic activity. Computed tomography (CT) continues to expand as a premier diagnostic modality. This and the increasing uses of fluoroscopic radiation to guide interventional procedures, along with some unfortunate occurrences of radiation injury in patients from each of these procedures, have captured the attention of regulatory and accreditation bodies that are demanding changes to assure these types of events are minimized for the future. In their regulations and accreditation requirements, these bodies have recognized the important roles that medical physicists play in providing patient care that combines high-quality imaging from sophisticated technologies while maintaining superior conservation of radiation use. Meanwhile PET, single-photon emission computerized tomography (SPECT), MRI, and ultrasound have experienced their own technological revolutions, creating an ever-changing medical environment with ever-changing challenges. An unprecedented demand for medical physics services has subsequently resulted. The driving force behind all this activity is quality care for the patient through the safe, efficacious, and appropriately conservative application of all forms of medical radiations.

References—Appendix 3

- ¹AAPM Report 33. (1992). *Staffing Levels and Responsibilities of Physicists in Diagnostic Radiology*. Online Version. Retrieved from http://www.aapm.org/pubs/reports/RPT_33.pdf.
- ²AAPM Report 42. (1994). *The Role of The Clinical Medical Physicist In Diagnostic Radiology*. Online Version. Retrieved from http://www.aapm.org/pubs/reports/RPT_42.pdf.
- ³AAPM Report 74. (2002). *Quality Control in Diagnostic Radiology*. Online Version. Retrieved from http://www.aapm.org/pubs/reports/RPT_74.PDF.
- ⁴Cypel, Y. S. and J. H. Sunshine. (2004). “Diagnostic Medical Physicists and Their Clinical Activities.” *J. Am. Coll. Radiol.* 1:120–26.